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## Programs and Majors

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Strong programs in business, the humanities, education, arts and sciences, and human services compliment our well-known strength in engineering. Lehigh students can choose from an array of courses and enjoy the resources and facilities of a major research university and the atmosphere and personal attention of a small college. While most of the undergraduate programs listed are offered as majors, many are also available as minors. Graduate programs are offered in many of the subjects listed as well.

### Academic Programs and Majors

- Accounting
- Africana Studies
- American Studies<sup>1</sup>
- Anthropology
- Applied Mathematics<sup>1</sup>
- Applied Science
- Architectural History
- Architecture
- Art
- Art History
- Arts and Engineering<sup>2</sup>
- Asian Studies
- Astronomy
- Astrophysics
- Behavioral Neuroscience
- Biochemistry
- Bioengineering
- Biology
- Business Economics
- Business Information Systems
- Chemical Engineering
- Chemistry
- Chinese
- Civil Engineering
- Classical Civilization
- Classics
- Cognitive Science
- Computer Engineering
- Computer Science
- Counseling and Human Services<sup>1</sup>
- Counseling Psychology<sup>1</sup>
- Design
- Earth and Environmental Sciences
- Economics
- Educational Leadership<sup>1</sup>
- Electrical Engineering
- Elementary Counseling<sup>1</sup>
- Elementary and Secondary Education (5-year program)<sup>2</sup>
- Energy Systems Engineering<sup>1</sup>
- Engineering Mechanics
- Engineering Physics
- English
- Environmental Engineering
- Environmental Policy Design<sup>1</sup>
- Environmental Studies
- French and Francophone Studies
- Finance
- German
- Globalization and Educational Change<sup>1</sup>
- History
- Industrial and Systems Engineering
- International Relations
- Instructional Technology<sup>1</sup>
- International Counseling<sup>1</sup>
- Journalism
- Journalism/Science Writing
- Learning Sciences and Technology<sup>1</sup>
- Management
- Marketing
- Materials Science and Engineering
- Mathematics
- Mechanical Engineering
- Molecular Biology
- Music
- Music Composition
- Pharmaceutical Chemistry
- Philosophy
- Physics
- Political Science
- Psychology
- Religion Studies
- School Psychology<sup>1</sup>
- Science, Technology, and Society
- Secondary Counseling<sup>1</sup>
- Sociology and Anthropology
- Sociology/Social Psychology
- Spanish and Hispanic Studies
- Special Education<sup>1</sup>
- Statistics
- Structural Engineering<sup>1</sup>
- Supply Chain Management
- Theatre
- Women, Gender, and Sexuality Studies

### Cross-Disciplinary Programs

- Africana Studies
- American Studies
- Arts and Engineering<sup>2</sup>
- Asian Studies
- Bioengineering
- Civil Engineering /Environmental Science
- Cognitive Science
- Computer Science and Business (CSB)
- Electrical Engineering/Engineering Physics
- Enterprise Systems Leadership<sup>1</sup>
- Environmental Studies
- Global Citizenship
- Global Studies
- Integrated Business and Engineering (IBE)
- Integrated Degree
- in Engineering, Arts and Sciences (IDEAS)
- Music and Engineering/Science<sup>3</sup>
- Pre-Dental Science
- Pre-Medical Science
- Pre-Optometry Science
- Science, Technology, and Society
- South Mountain College

<sup>1</sup> Graduate level only

<sup>2</sup> Dual-degree (5-year) program

<sup>3</sup> Music and Engineering/Science is not a major in itself. However, Lehigh attracts many engineering and science students who wish to continue their active involvement in music and the music department as dual majors, minors, or elective participants.

## Mission Statement

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To advance learning through the integration of teaching, research, and service to others.

Excellence is the hallmark of a university of distinction. Excellence requires a total quality commitment, which must characterize every activity of Lehigh University.

Lehigh is an independent, coeducational university with programs in the arts and humanities, business, education, engineering, and the natural and social sciences, offering bachelor's degrees primarily to full-time, residential students and graduate degrees through the doctorate for both full-time and part-time students. Lehigh is small enough to be personal, yet large enough to provide stimulating diversity and to play important national and international roles.

Since Lehigh's founding in 1865, the faculty has emphasized the integration of the academic disciplines, combining the cultural with the professional, the theoretical with the practical, and the humanistic with the technological in a modern, liberal education that serves as preparation for a useful life. Lehigh is an intellectually unified community of learners, and in this sense Lehigh is an *integral university*.

Lehigh strives to earn international prominence as a university of special distinction through its integration of teaching, research, and service to society. The integrating element of teaching, research and service is *learning*, which is the principal mission of all members of the Lehigh community. Our mission of advancing learning has three aspects:

*Teaching.* The development of future leaders in our global society is first among Lehigh's purposes and first among our achievements. Preparation for leadership requires the best of teaching, in which both mentor and student are so deeply engaged that they become joint owners of the learning process.

*Research.* Lehigh is deeply committed to the creative search for new understanding of nature and human society as an essential element of the learning process. The scholarly inquiry and research of Lehigh faculty and students add value to instruction on our campus, and contribute to the distinction of our university.

*Service.* The special commitment of the Lehigh community to experiential learning through service to others imbues the entire university with a sense of purpose and value in the larger society. Lehigh is extensively involved in developing partnerships with industry, government and others in education and human services to meet the needs of our society. In a societal sense, Lehigh is devoted to the concepts of unity, community, and cooperative achievement.

Lehigh believes that its graduates must develop critical thinking and effective communication as their habit; they must have both a broad understanding of human affairs and a domain of true competence; they are expected to live by a set of mature cultural and personal values, accept the virtue of work as a vehicle of service, and have the will to live and work with exceptional self-discipline.

Respect for human dignity is very important at Lehigh, a caring community deeply committed to harmonious cultural diversity as an essential element of the learning environment. In order that all members of the Lehigh community might develop as effective and enlightened citizens, the University encourages physical, social, ethical, and spiritual development as well as rigorous intellectual development.

Lehigh on the Web

[www.lehigh.edu](http://www.lehigh.edu)

Admissions information:

[www.lehigh.edu/admissions](http://www.lehigh.edu/admissions)

Parents & family:

[www.lehigh.edu/parents](http://www.lehigh.edu/parents)

Other hot links

Catalog:

[www.lehigh.edu/catalog](http://www.lehigh.edu/catalog)

Academic programs:

[www.lehigh.edu/programs](http://www.lehigh.edu/programs)

Lehigh at a glance:

[www.lehigh.edu/lufacts](http://www.lehigh.edu/lufacts)

Campus visits, interviews and open houses:

[www.lehigh.edu/visitinglehigh](http://www.lehigh.edu/visitinglehigh)

Maps and Directions

[www.lehigh.edu/maps](http://www.lehigh.edu/maps)

## Academic Calendar

Lehigh University defines a semester as 14 weeks and 70 individual days of instruction to be followed by 2 days of a reading-consultation and study period in preparation of 9 consecutive calendar days of final examinations with four periods per day of 3 hour exam blocks. The summer term is 12 weeks with measured sessions. The academic year consists of one summer and two regular terms.

### Fall 2013

August 26	Monday	First Day of Class/Registration day
September 1	Sunday	Last day web registration; Last day to add courses without instructor's signature
September 1	Sunday	Degree awarding date
September 2	Monday	Labor Day - Classes held
September 6	Friday	Last day of registration; Last day drop/add without a "W"
September 13	Friday	Last day to select or cancel pass/fail grading
September 5	Thursday	Rosh Hashanna
September 14	Saturday	Yom Kippur
September 24	Tuesday	Four o'clock exam Day 1
September 26	Thursday	Four o'clock exam Day 2
September 30	Monday	Four o'clock exam Day 3
October 1	Tuesday	Applications for January degree due
October 2	Wednesday	Four o'clock exam Day 4
October 3	Thursday	Four o'clock exam Day 5 (if needed)
October 14-15	Monday-Tuesday	Pacing Break - no classes
October 16	Wednesday	Mid-term grades due
October 29	Tuesday	Four o'clock exam Day 1
October 31	Thursday	Four o'clock exam Day 2
November 4-15	Monday-Friday	Registration for Spring
November 4	Monday	Four o'clock exam Day 3
November 6	Wednesday	Four o'clock exam Day 4
November 7	Thursday	Four o'clock exam Day 5 (if needed)
November 12	Tuesday	Last day to withdraw from a course with a "W"; Last day for January doctoral candidates to deliver advisor approved dissertation drafts to dean
November 27-29	Wednesday-Friday	Thanksgiving Vacation
November 26	Tuesday	Last day for hourly exams
December 6	Friday	Last day of classes; Last day to drop a course with WP/WF grades; Last day for January master's degree candidates to electronically upload thesis and deliver final paperwork to the Registrar's Office; Last day for January doctoral degree candidates to complete all degree requirements
December 7	Saturday	Review-consultation-study period for Tuesday classes
December 9	Monday	Review-consultation-study period for Monday classes
December 10	Tuesday	Final exams begin
December 18	Wednesday	Final exams end
December 26	Thursday	Grades due

### Spring 2014

January 12	Sunday	Degree awarding date
January 13	Monday	First day of class/Registration day
January 19	Sunday	Last day web registration; Last day to add courses without instructor's permission
January 24	Friday	Last day for registration; Last day to drop a course without a "W"
January 31	Friday	Last day to select or cancel pass/fail
February 3	Monday	Last day for filing applications for May graduation
February 11	Tuesday	Four o'clock exam Day 1
February 13	Thursday	Four o'clock exam Day 2
February 17	Monday	Four o'clock exam Day 3
February 19	Wednesday	Four o'clock exam Day 4
February 20	Thursday	Four o'clock exam Day 5 (if needed)
February 28	Friday	Mid-term grades due
March 3-7	Monday - Friday)	Spring Break
March 10	Monday	Classes resume
March 25	Tuesday	Four o'clock exam Day 1
March 27	Thursday	Four o'clock exam Day 2
March 31	Monday	Four o'clock exam Day 3
April 2	Wednesday	Four o'clock exam Day 4
April 3	Thursday	Four o'clock exam Day 5 (if needed)
April 4	Friday	Last day for May doctoral candidates to deliver advisor approved dissertation drafts to dean
April 8	Tuesday	Last day to drop a class with a "W"
April 7-18	Monday-Friday	Registration for Fall and Summer
April 15	Tuesday	Passover - classes held on weekdays
April 18	Friday	Good Friday - classes held
April 18	Friday	Last day for hourly exams
April 25	Friday	Last day of classes; Last day to drop a class or withdraw with WP/WF grades; Last day for May master's candidates to electronically upload thesis and deliver final paperwork to the Registrar's Office; Last day for May doctoral candidates to complete all degree requirements
April 26	Saturday	Review-consultation-study period for Tuesday classes
April 28	Monday	Review-consultation-study period for Monday classes
April 29	Tuesday	Final exams begin
May 7	Wednesday	Final exams end
May 10	Saturday	Grades due
May 19	Monday	University Commencement Day
July 1	Tuesday	Deadline to apply for September degree
July 25	Friday	Last day for September doctoral candidates to deliver advisor approved dissertation drafts to dean
August 8	Friday	Last day for September masters candidates to electronically upload and deliver paperwork to the Registrar's Office; Last day for September doctoral candidates to complete all degree requirements

## Information of General Interest

### Accreditation

Lehigh University is accredited by the Middle States Association of Colleges and Schools.

Both the undergraduate general and accounting programs and the master of business administration programs are accredited by the Association to Advance Collegiate Schools of Business (AACSB) International.

The engineering programs that are accredited by the Engineering Accreditation Commission or the Computing Accreditation Commission of ABET, <http://www.abet.org> are listed under the Undergraduate Studies section, P.C. Rossin College of Engineering and Applied Science, Major Programs. The bachelor of science in computer science in the College of Arts and Sciences is also accredited by the Computing Accreditation Commission of ABET, <http://www.abet.org>

The computer science and business program is accreditation by the Computing Accreditation Commission of ABET, <http://www.abet.org> and the American Assembly of Collegiate Schools of Business.

The Commonwealth of Pennsylvania approves for educational certification various programs within the College of Education. Programs in chemistry are approved by the American Chemical Society.

The department of theatre is accredited by the National Association of Schools of Theatre, recognized by the U.S. Department of Education as the accrediting body for the field of theatre.

### Policy of Equality

Lehigh University provides equal opportunity on the basis of merit without discrimination because of race, color, religious creed, ancestry, national origin, age, handicap, sex, sexual orientation or union membership.

### Admission Guidelines

The total undergraduate and graduate enrollment of Lehigh University is regulated by action of the Board of Trustees, with a resulting limitation in the number of candidates who can be admitted each year to the various divisions of the university.

Because of the limitations on enrollment, the Office of Admissions, under the leadership of the Dean of Admissions and Financial Aid, conducts a selective review of candidates for admission. Several criteria are used in an attempt to predict a student's ability to successfully complete four years of rigorous study at Lehigh University.

The material that follows pertains to undergraduates. Graduate students should consult Admission to Graduate Standing (p. 35).

The admission policy of the university is designed to enroll students with a variety of backgrounds. The course work or units required for admission represent the equivalent of the usual four-year college preparatory curriculum with certain specific courses required for enrollment in certain programs within the university. Evidence of academic growth, ability to learn, and motivation are examples of qualities that may not be reflected in the accumulation of units. Such qualities are also considered by the admissions committee.

### Minimum subject matter requirements

English	4
Foreign Languages <sup>1</sup>	2
Social Science	2
Laboratory Science	2
College Preparatory Mathematics	3
Elective Subjects	3
<b>Total Credits</b>	<b>16</b>

<sup>1</sup> Only in exceptional cases, and for otherwise well-qualified candidates, will the Committee on Admissions waive the Foreign Language requirement for admission to any one of the three undergraduate colleges.

Students planning on enrolling in the P.C. Rossin College of Engineering and Applied Science must have studied mathematics through trigonometry, and should have studied chemistry, physics and

mathematics through pre-calculus. Calculus is strongly recommended. Students planning to enroll in the College of Business and Economics must have completed mathematics through trigonometry, but also should strongly consider taking pre-calculus and calculus. Candidates for the College of Arts and Sciences preparing for a Bachelor's of Science degree must also take math through trigonometry.

Minimum course work requirements can be misleading since most students who gain admission to Lehigh University exceed the minimum course work. Strength of preparation may be difficult to assess since each individual comes from a different background. However, the Committee on Admissions will be aware of things such as (in no particular order):

- Rank or relative rank in class
- The student's grades within the context of the school environment
- Evidence of improvement or deterioration in grades during the secondary school career with particular attention paid to performance in senior year courses
- The quality of performance in courses that relate to the student's anticipated area of study
- The difficulty of courses taken with special attention given to courses recognized as accelerated by national academic organizations
- Comments and recommendations from the principal, headmaster, guidance counselor, teachers, or other professional educators within the school system
- Performance on standardized testing
- Extra-curricular/work experience with particular emphasis placed on demonstrated leadership
- Demonstrated interest in Lehigh University

### Entrance Examinations

**SAT/ACT:** Each candidate for admission to the first year class is required to take either the Scholastic Assessment Test (SAT) with the writing component or the American College Test (ACT) with the writing component. Students are required to submit their scores directly to Lehigh through the College Board (CEEB code 2365). It is not the responsibility of the high school guidance office to forward the results. If, during the evaluation process, it is discovered that the test results are missing, the student will be notified by e-mail. Delays in the decision-making process can result if the Committee on Admissions does not have the scores.

The Committee on Admissions recommends that students take the exam in the junior year and again as early as possible in the senior year. In the evaluation process, the highest score in each category for the SAT will be used regardless of the test date.

**SAT Subject Tests:** SAT Subject Tests are recommended, but not required. It is also recommended that students who plan to study a foreign language take the SAT Subject Test or Advanced Placement Test for the language they intend to study. Students interested in advanced placement and/or receiving college credit in chemistry, English, or a foreign language should take the SAT Subject Tests. Please read the Advanced Placement section for specific requirements.

Test information and applications may be secured from high school guidance offices or the College Board: College Board SAT Program, 45 Columbus Ave., New York, NY 10023-6917. Additional information can be found online at [www.collegeboard.com](http://www.collegeboard.com) (<http://www.collegeboard.com>).

Candidates should register for the tests no later than one month prior to the test date (two months for candidates who will be tested in Europe, Asia, Africa, Central and South America and Australia).

All applicants whose native language is not English must take the TOEFL (Test of English as a Foreign Language). A minimum target score of 90 on the TOEFL Internet-based Test (iBT) is recommended for admission. A minimum target score of 570 on the Paper-Based Test is recommended for admission. The TOEFL Computer-Based Test (CBT) has been discontinued and is no longer valid for admissions.

For further details on TOEFL requirements, including iBT subscore requirements, please contact either the Office of Admissions or the ESL Department. IELTS results will be accepted in place of the TOEFL with a recommended minimum score of 7.0. Note: Although students who have scored 570 or higher on the Critical Reading section of the SAT are not required to submit TOEFL/IELTS scores, it is highly recommended.

## Recommendations

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The Office of Admissions requires, as part of a candidate's file, a letter of recommendation from the guidance counselor, principal, or headmaster from the candidate's school. One teacher recommendation is also required. In addition to academic qualifications, recommendations should address the candidate's personal qualifications such as character, intellectual motivation, participation in school activities, and established habits of industry and dependability.

## Campus Visits

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Prospective first-year students and their parents are highly encouraged to visit Lehigh and to meet with an Admissions representative for a group information session and to participate in a campus tour. Informal interviews are also available but are not required for admission. No appointment is necessary for a group information session or campus tour, but interviews must be scheduled by appointment. Visit [www.lehigh.edu/visitinglehigh](http://www.lehigh.edu/visitinglehigh) for a schedule of information sessions and tours. A call to the Office of Admissions is recommended because the schedule can change several times during the year as the academic calendar changes. While visiting our campus, it is often possible to meet with faculty, coaches or other professional staff of the university. Requests for such meetings should be made prior to the actual visit so as to facilitate scheduling.

The Office of Admissions is open for interviews most weekdays beginning at 8:15 a.m. Tours are available two times a day during the school year. Some Saturday morning tours are available during the summer and fall.

In rare cases, an interview may be required if, in the opinion of the Dean of Admissions and Financial Aid, the additional information gained through an interview would be helpful in making the correct decision regarding admission. In such cases, the candidate will be notified of our request.

## How to Apply

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Students may apply by using the Common Application on-line at [www.commonapp.org](http://www.commonapp.org) (<http://www.commonapp.org>). Online submission of the application is required. Students are also required to submit the Lehigh Questions and Writing Supplement, found on the Common Application Website. For information on how to apply for need-based financial aid, visit [www.lehigh.edu/assistance](http://www.lehigh.edu/assistance).

Applications should be filed according to the following deadlines:

November 15 — Early Decision I

November 15 — Seven-year BA/MD Program

January 1 — Early Decision II (Declare by January 15)

January 1 — Regular Decision

January 1 — Seven-year dental program with the University of Pennsylvania

January 1 — Seven-year optometry program with the SUNY State College of Optometry

Each application must be accompanied by an application fee of \$70. This fee is non-refundable and does not apply towards tuition fees. Waivers of application fees are accepted when requested on the appropriate forms from the school counseling office. Students for whom the application fee is a hardship should consult the counseling office at their schools.

## Early Decision

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Our program is a binding Early Decision plan, meaning that the student who is admitted to Lehigh under this program must withdraw all other

applications filed and must not initiate any new applications to other schools. Additionally, the student, his or her parents/guardians, and guidance counselor must sign an Early Decision Agreement form to confirm their understanding of this provision. Students applying Early Decision should be sure that Lehigh is their first choice school. Early Decision I is for students who meet the November 15 deadline. Notification will be completed around mid-December. Early Decision II is for students who have met the January 1 regular application deadline and who declare their intention to apply Early Decision II by January 15. These students will be notified mid-February. It is understood that all Early Decision candidates will continue to perform at a satisfactory academic level throughout the remainder of his or her senior year.

The Early Decision plan is not for everyone. It is for the student who has begun early and been active in his or her college search, and is sure that he or she wants to attend Lehigh. While pursuing admission under the Early Decision plan, students may apply to other institutions, but may only have one Early Decision application pending at any time. Additionally, Early Decision candidates forfeit the ability to compare financial aid offers from other schools. When reviewing an Early Decision application, the Committee on Admissions will defer a decision on any candidate when there is insufficient information to make an Early Decision commitment. It is also possible that a student may be denied admission. The Committee on Admissions will give Early Decision applicants some slight advantage in borderline cases because of the commitment of applying early, but the student must still present a strong record.

All candidates are considered for merit based aid during the application review. Early Decision candidates who are applying for need based financial aid must file the CSS/Financial Aid Profile application, available at [www.collegeboard.com](http://www.collegeboard.com) (<http://www.collegeboard.com>), and submit this application along with prior year tax forms to the Office of Financial Aid no later than November 15. Early Decision applicants are fully evaluated for need-based financial aid eligibility and provided a tentative financial aid award along with their letter of Admission to Lehigh (as long as all application materials are received by the deadline). In addition to the CSS/Financial Aid Profile, the Free Application for Federal Student Aid (FAFSA) and current year tax returns are also required by February 15. This form may be accessed online at [www.fafsa.ed.gov](http://www.fafsa.ed.gov) (<http://www.fafsa.ed.gov>) after January 1. Lehigh's code for FAFSA is 003289.

## Admission and Deposit

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Admissions decisions are mailed to each student and are also posted online via the Campus Portal. An admitted student may secure a place in the entering class by notifying the university that he or she intends to enroll at Lehigh and by forwarding the appropriate enrollment deposit postmarked by May 1. This fee is applicable towards the fall-term bill. Students who do not attend will forfeit their deposit.

## Transfer Students

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Each August, students who have attended another college or university are admitted with advanced standing. Candidates for transfer admission must meet the high school subject matter requirements prescribed for incoming first-year students, and are required to have at least one year of full-time study at another institution. Exceptions to fulfilling high school requirements will be granted following the review of a college level transcript. The academic performance at the college level is the primary focus when giving consideration to admission.

Candidates who have been dropped for poor scholarship, who are not in good standing, or who have been released for disciplinary reasons are not eligible for admission.

Each candidate must submit an official transcript and course descriptions from each institution attended. An admissions decision cannot be made without this information. Applicants for the fall semester should have their application submitted by March 1. Applications may be obtained by visiting Lehigh's Web site at [www.lehigh.edu/tapply](http://www.lehigh.edu/tapply). Each application must be accompanied by an application fee of \$70.

Students are encouraged to take an active role in seeing that the various components of their admission application have arrived at the university.



Students will be notified by the Office of the Registrar as to the total credits Lehigh will grant to the student in advanced standing.

### Housing

Every effort is made to accommodate transfer student housing needs. All students are required to live on-campus through the end of the sophomore year. Contact the Office of Residential Services, Rathbone Hall, Lehigh University, 63 University Drive, Bethlehem, PA 18015 or call (610) 758-3500. This office also can provide information about off campus housing. Fraternities and sororities often have room for members or boarders. Information on this option may be obtained through the Assistant Dean for Fraternity and Sorority Affairs, 227-229 Warren Square, Lehigh University, Bethlehem, PA 18015 or call (610) 758-4157.

### Advanced Placement

The university offers capable students who have superior preparation an opportunity for advanced placement and/or college credit. Many secondary schools, in association with the College Board, offer college-level work. Students participating in these courses should write the Advanced Placement Tests offered by the College Board.

Entering first-year students that request the College Board to send their advanced placement scores to Lehigh are considered for advanced placement.

Some departments noted below offer examinations during Freshman Orientation to students who studied college-level subjects in secondary school but did not write the advanced placement tests. Entering first-year students wishing to write an examination in any Lehigh course should notify the Office of the First-Year Experience via email at [fyex@lehigh.edu](mailto:fyex@lehigh.edu) by the date given on the first-year student portal. The student should specify the number and title of the course. Students who receive credit on the basis of advanced placement grades need not write Lehigh tests to confirm the credit granted.

Current practice at Lehigh is as follows:

#### Art, Architecture and Design

Eight credit hours for ART 001 and ART 002 are granted to students who earn a grade of 5. Three credit hours for Art Elective in Art History are granted for those students who earn a grade of 4. Those students who earn grades of 5 on the Advanced Placement Studio Art Examination receive four credit hours for DES 003.

#### Biology

Four credit hours for EES 031 and EES 022, Introduction to Environmental/Organismal Biology and Exploring Earth Lab, given to those who earn grades of 4 or 5.

#### Chemistry

Eight credit hours for CHM 030 and CHM 031 are granted to students who earn a grade of 5. Those students who earn a grade of 4, or who score 750 or higher on the SAT II chemistry subject test, are granted 4 credit hours for CHM 030 and may apply to the department for a special examination that, if completed successfully, will result in an additional four credit hours for CHM 031.

#### Computer Science

Students who receive a grade of 4 or 5 on the AP exam will receive 2 credits for CSE 001 and 2 credits for CSE 002.

#### Economics

Students will receive two credit hours of Economics Elective for a score of 4 or 5 on the microeconomics or macro economics exam. Students receiving a score of 4 or 5 on both the microeconomics and macroeconomics exams will receive 4 credits for ECO 001 and 2 credits of Economics Elective and satisfy the College of Business and Economics degree requirements.

#### English

Students who earn a score of 5 on one of the College Board Advanced Placement Tests in English (either in English Language and Composition or in English Literature and Composition) or who achieve a score of 750 or higher on the writing section of the SAT receive six hours of Lehigh credit for freshman English (and exemption from the requirement). Students who receive a score of 4 on either of the Advanced Placements Tests in English or who have a score of 700-749

on the writing section of the SAT or a score of 5 on the IB High Level Examination will receive three hours of credit in freshman English; these students must complete the six-hour requirement by taking an English course ENGL 011. No credit is awarded for ACT scores.

#### Environmental Science

Students scoring a 4 or 5 on the environmental science exam will receive 3 credits for EES 002 and 1 credit for EES 022.

#### Government and Politics

Four credits for POLS 001 are awarded to those students that score a 4 or 5 on the American Government test, and four credits for POLS 003 are awarded to those that score a 4 or 5 on the Comparative Politics exam

#### History

Students earning a grade of 4 or 5 in the American History Advanced Placement examinations will receive 4 credits for History electives. Students earning a grade of 4 or 5 in the European History exam will receive four credits for History Elective.

#### Latin

Students receive three semester hours of credit for a grade of 4 or 5 in the Virgil examination; those who successfully write in more than one area (e.g. Virgil and lyric poetry) receive six hours of credit. Credit will be awarded for LAT 099 Latin Elective. Students receiving credit for Latin and who wish to continue their study of Latin must consult with the Director for proper placement.

#### Mathematics

Four semester hours of credit for MATH 021, Calculus I, are granted to those who earn grades of 4 or higher on the Calculus AB examination. To those who earn a grade of 4 or higher on the Calculus BC examination, eight hours of credit are granted for MATH 021 and MATH 022, Calculus I and II. Credit for MATH 021 and MATH 022 or both may also be earned by passing the examination offered by the Mathematics Department during Freshman Orientation. Students regardless of whether they have taken the advanced placement examination may take this examination or not.

#### Modern Languages and Literature

Students receive four semester hours of credit at the intermediate level I for grades of 4, and eight hours of credit at the intermediate level I & II for grades of 5 on the advanced placement tests. Those who write the SAT II subject tests and score 600 to 699 receive four hours of credit; 700 and above receive eight hours of credit. The maximum number of credits given is eight. Those students receiving grades of 4 or higher on the Spanish literature examination will receive 4 credits for SPAN 151.

#### Music

Three semester hours of credit for Music elective are given to those students who earn a grade of 3 or higher on the Advanced Placement test in Music, Listening/Literature of Music: Theory.

#### Physics

Five hours of credit are given for PHY 011, PHY 012, for a grade of 5 on the Physics B examination or a grade of 4 on the mechanics section of the Physics C examination. If a student receives credit for PHY 011, four hours of credit will be given for PHY 021, PHY 022, for a grade of 4 on the electricity and magnetism section of the Physics C examination. A test is offered during Freshman Orientation.

#### Psychology

Four credit hours of PSYC 001 are granted to students who earn a grade 4 or 5.

#### Statistics

Students scoring a 4 or 5 will receive 4 credits; for MATH 012 if enrolled in the College of Arts & Sciences or the College of Engineering & Applied Science, or 3 credits for ECO 045 if enrolled in the College of Business & Economics.

#### International Baccalaureate

Students who earn the international baccalaureate may be granted credit in higher-level or advanced subjects with scores of 5 or better or "B" or better. All students will have their credentials evaluated on an individual basis for specific course equivalency. Lehigh must receive the Official IB transcript before credit will be assigned.

## Estimate of Expense for Undergraduates

Principally three areas of income support the operating expense of Lehigh University: tuition and fees, endowment earnings, and gifts and grants. The university is conscious that educational costs are significant and it strives to maintain a program of high quality instruction while recognizing that there are limitations on what families can afford to pay. Costs will vary somewhat from student to student depending upon the various options chosen.

### Tuition, Room, and Board

There are three major plans that cover the major expense associated with university attendance. These are as follows:

#### The Tuition Plan

The university provides comprehensive academic and student services under its tuition plan. The tuition sum is inclusive of most athletic events, basic treatments in the Health Center, libraries, and laboratory services. A technology fee of \$300 is charged to all full-time students. An additional \$470 fee is charged to all students enrolled in the College of Engineering and Applied Science or with a declared major in natural science. The full-time tuition rate is charged to students enrolled in twelve or more credit hours per semester. For students enrolled in less than twelve credit hours, tuition is charged on a per-credit-hour basis.

#### University Housing Plan

A variety of living arrangements are available. The university provides housing for approximately 2,500 students on campus in a wide selection of residence facilities and approximately 900 students in fraternity and sorority housing. The housing arrangements are grouped within four basic categories, with rates associated with the category level. First and second year students are required to reside in university housing. Second year students may choose residence hall or Greek housing options. Third, fourth and fifth year undergraduate students contracting for residence hall housing are required to submit a \$400 housing deposit. This deposit is credited toward the room charge for the respective semester. The deposit is either full or partially refundable based upon a published schedule.

#### University Meal Plan

Nine meal plans are available. First year residents are required to participate in the Category 1A Meal Plan or one of the Category I Meal Plans. Upper-class students living in a residence hall are required to participate in the Category 1A Meal Plan or one of the Category I or II Meal Plans. Students residing in a fraternity or sorority are expected to participate in their house meal plan but also have the option to choose any of the university plans offered. Students residing in campus apartments or any off-campus facilities have the option to choose any of the plans offered.

Each board plan includes Dining Dollars. This pre-paid declining balance account was designed for maximum flexibility and convenience and can be used at most dining locations on campus to further increase your purchasing options.

## Cost of Attendance

Tuition, Room, and Board charges are listed for the academic year (fall and spring semesters) with one-half charged for each semester. Other Fees are typically charged per occurrence.

Tuition, 2013-2014	\$43,220
Technology Fee	\$300
University Housing	
Category I (Dravo, Drinker, Richards, McClinticMarshall, Centennial I & II)	\$6,640
Category II (ROTC, UMOJA, All Greek Houses, Warren Square, Hillside)	\$7,110
Category III (Taylor, Trembley Park Suite Singles, Brodhead House)	\$7,390
Category IV (Sayre Park Village, Campus Square, Trembley Park Apartments)	\$7,730

*NOTE: The above University Housing rates are based on multiple occupancy.*

## Board

The number of meals specified is per week.

Category IA (Carte Balance)	\$ 5,420
Category I (19 meals including \$100 Dining Dollars)	\$ 4,920
14 meals including \$200 Dining Dollars	\$4,920
225 Block Plan any 225 meals per semester including \$100 Dining Dollars	\$4,920
Category II (150 Block Plan any \$150 meals per semester including \$300 Dining Dollars)	\$4,340
Category III (75 meals per semester including \$500 Dining Dollars)	\$2,640
Category IV (50 meals per semester including \$500 Dining Dollars )	\$2,070
Category V (The Dining Dollars \$600 Dining Dollars)	\$600

Based upon the above charges, most first-year students are normally billed the tuition rate and technology fee along with the Category I or II room fee and a Category I meals board plan. The total cost for the four areas would be \$55,080 to \$55,550 for the 2013-14 academic year.

### Other Fees

(applied to prevailing circumstances)

Tuition charge per credit for part-time status or audit	\$1,805
Engineering and Science Fee per year (for specified students)	\$470
Application fee (for undergraduate admission consideration)	\$70
Late preregistration (assigned to all fulltime students who do not select their full class load during the designated period each term)	\$100
Late registration	\$40
Late application for degree	\$25
Examination makeup (after first scheduled makeup)	\$200
Late payment (after announced date)	\$35
Returned check fine	\$25
Key/lock change (lost or non-return), room door, residence halls/sorority	\$15
Identification card (replacement)	

The university reserves the right at any time to amend or add charges and fees, as appropriate, to meet current requirements. Fees applicable to the 2013-14 academic year will be announced no later than March 2013.

### Other Expenses

A student should plan to meet various other expenses. These expenses include the purchase of books and supplies from the Lehigh University Bookstore located in Campus Square. Necessary purchases supporting one's academic program should average approximately \$1,200 per year. The Bookstore carries basic goods for students' needs. A student should also plan an allowance to handle personal and travel expenses.

## Billing and Payments

Billing statements are available online for both the student and any person the student authorizes. Semester billing statements are available approximately six weeks prior to the start of each semester. Payments are due as follows: Fall semester by the first business day of August, Spring semester by the first business day of January, and all Summer Sessions five days prior to the start of classes. Billing statements are also addressed to the student and mailed to the student's home address as recorded in the BANNER Student System. If registration occurs after bills are issued, payment is still due prior to the start of classes. Accounts not settled by the due date are subject to a late payment fee.

Persons desiring a payment plan can elect participation in the university's educational payment plan which provides for the payment of tuition, room, and board over four months per semester. Deadlines to participate are July 1<sup>st</sup> for Fall Semester and December 1<sup>st</sup> for Spring Semester.

The university also offers a plan under which enrolled undergraduate students can pre-pay more than one year of tuition. Enrollment period is through June to lock in the following academic year tuition rate. Complete information is available from the Bursar's Office.

Students attending the university under a provision with a state board of assistance or with financial aid from other outside agencies must provide complete information to the Bursar's Office if assistance is to be recognized to avoid late payment fees.

## Refunds of Charges

### Tuition and Academic Fees

An undergraduate student in good standing who formally withdraws or reduces his or her course enrollment below twelve credit hours before 60% of the semester has been completed during the fall and spring semesters will be eligible for a tuition refund. An undergraduate student in good standing who formally withdraws or reduces his or her course enrollment before 60% of a session has been completed during the summer sessions will be eligible for a tuition refund.

A graduate student in good standing who formally withdraws or reduces his or her course enrollment before 60% of the semester has been completed during any semester will be eligible for a tuition refund.

The tuition refund for a student who withdraws or drops a course(s) is calculated on a daily basis. No refunds for tuition can be made for courses or workshops with five class sessions or less after the first day of class. Additional penalties may apply to withdraw from special programs or courses held at off-campus locations, such as Study Abroad or Geology Field Camp.

The date used to calculate refunds is based on when a properly authorized withdrawal or drop/add is received by the Registrar's Office.

Academic fees (such as Technology Fee, Engineering and Science Fee, course associated fees, etc.) are generally non-refundable after the first day of classes.

In the event of a medical withdrawal or death of a student, certified by the Dean of Students, tuition will be refunded in proportion to the semester remaining.

### Tuition Credit/Refund for a Disciplinary Suspension or Expulsion

A student who is suspended from the University during the semester in which the incident occurred is eligible for a tuition credit that will be applied to the semester immediately following the period of suspension. The amount of tuition credited will be based upon the tuition refund schedule for a voluntary withdrawal and the tuition rate in effect during the semester in which the incident occurred less any required financial aid adjustments and any outstanding balance on the student's account. The date used to calculate the tuition credit will be the date of the incident that resulted in the suspension. Tuition credit not utilized in the semester immediately following the period of suspension is forfeited.

A student who is *expelled* from the University forfeits all payments for tuition and fees incurred for the semester the incident occurred.

If the decision to suspend or expel a student is made in a semester subsequent to the semester in which the incident occurred, the student is eligible to receive a 100% tuition refund less any required financial aid adjustments and less any other outstanding balance on the students' account for any courses that the student is unable to complete as a result of the suspension/expulsion. Refunds will not be distributed until all disciplinary procedures including the appeals process are complete.

The University may, in its sole discretion, place a hold on the student's academic records at the time of the incident, which will limit access to transcripts and other educational records until the disciplinary process is complete.

Please note that financial aid is not guaranteed for students who exceed 8 semesters of enrollment because of a disciplinary suspension.

### Refund Specifics

Credit balances resulting from an overpayment with a bank card are eligible to be refunded as a credit transaction to the bank card by contacting the Bursar's Office.

Credit balances resulting from an overpayment with a check drawn on a domestic bank require a minimum two week waiting period before a refund check will be issued.

Credit balances resulting from loans, grants, scholarships, and other forms of financial aid are eligible for refund after the 10<sup>th</sup> day of class.

All refund checks will be payable to the student unless

1. the student has authorized in writing a parent or guardian listed in the Banner Student System to receive the refund, or
2. the check payment on the account was clear that the payment was from an unrelated organization or institution, such as a sponsoring corporation.

Refund checks are mailed to the student's university post office address or, if none, to the student's "home address" listed in the Banner Student System. Any exception to this policy must be authorized in writing by the student.

Students receiving financial aid that drop below full time status must have their financial aid package re-evaluated by the Office of Financial Aid prior to the issuance of any refund check.

### Residence Hall/Housing Refunds

Residence hall rooms are rented on an annual basis only. A student who signs a housing contract is expected to reside in and be financially responsible for residence hall housing for both the fall and spring semesters of the specific academic year for which the contract was signed. A student who forfeits a housing reservation and who returns to the university at any time during the contracted academic year is still obligated for housing charges if vacancy in the residence hall facilities exists and without regard to location. An advance housing deposit is required by rising third, fourth and fifth year undergraduate students to hold housing. This deposit is either full or partially refundable based upon specific criteria and a published refund schedule.

Prior to registration, housing rental refunds are made in full in the event a student does not register because of illness or injury; is dropped from the university due to academic reasons; attends a university-approved study abroad or co-op program; graduates; or voluntarily withdraws from the university. After registration, prorated housing rental refunds are granted based on separation from the university due to illness or injury. In the event of voluntary withdrawal, a prorated refund is possible only with the provision that the lease can be transferred to another student for whom no other university accommodations exist. Prorated refunds are based upon the date the room has been vacated and the room key is returned to the Office of Residential Services. Any student suspended or expelled from the university will not be granted any housing rental refund.

### University Meal Plan Refunds

Meal plan refunds are made in full in the event a student does not register and has not purchased any meals from the plan.

After registration, a student who purchases meals on the plan but withdraws from the university will receive a pro-rata meal plan refund based on the number of unused weeks remaining on the plan. The Dining Dollar portion is non-refundable.

Any student suspended or expelled from the university will not be granted a meal plan refund.

Meal plans may be changed within the requirements of the living area up to the tenth day of class each semester at the Bursar's Office with charges assessed per an established proration schedule.

After the tenth day of class, a student who wishes to change a meal plan must petition and receive approval from the Office of Student Auxiliary Services. If the change is approved, an adjustment will be processed on a pro-rata basis to the meal portion of the plan charge as of the week following the last meal purchased.

### Adjustments to Financial Aid

The Office of Financial Aid is responsible for determining the appropriate redistribution of charges and refunds when students receive any financial assistance. These decisions are made on the basis of federal, state and institutional policies. Any refunds due to the Title IV programs will be refunded in the following order:

- Federal Direct Unsubsidized Stafford Loan
- Federal Direct Subsidized Stafford Loan
- Federal Perkins Loan
- Direct PLUS Loan
- Federal Pell Grant
- Federal SEOG
- Any other Title IV program

### Financial Aid

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The mission of the Office of Financial Aid is to reduce the financial barriers to a Lehigh education for those families whose resources alone would make it impossible to meet the cost of attendance. The university is deeply committed to providing need-based financial aid.

Lehigh expects each family to make every effort to pay tuition and other educational expenses. Our aid program is designed to measure the difference between our costs and the amount of money your family can be expected to contribute towards those costs. That difference is called "financial need" and represents financial aid "eligibility." The majority of Lehigh's funds are awarded on the basis of financial need. Students must file on time and meet academic progress requirements to be eligible for consideration. Our merit-based aid program is explained below.

The basic components of financial aid consist of gift aid (grants and scholarships) and self help (employment and loan assistance). Gift aid is generally not repayable. The majority are awarded on the basis of "need" and are renewable on the basis of continuing "need", satisfactory academic progress criteria and on time filing. Employment provides money for books and personal expenses, and is paid through biweekly payroll checks based on hours worked. Loans are repayable funds from one or more sources, repayable after the student ceases to be enrolled on at least a halftime basis.

Additional sources of aid include, but are not limited to: state agencies, employers, and various clubs, churches, religious and fraternal organizations, and foundations. High school guidance counselors are able to provide information about local aid programs. There are also database scholarship search organizations that can be accessed via the World Wide Web. Some examples are [www.fastweb.com](http://www.fastweb.com) (<http://www.fastweb.com>), [www.collegeboard.com](http://www.collegeboard.com) (<http://www.collegeboard.com>), [www.collegenet.com](http://www.collegenet.com) (<http://www.collegenet.com>) and [www.gocollege.com](http://www.gocollege.com) (<http://www.gocollege.com>). (Caution: there are many scam operations that promise great things if you send them a check. It is better to limit your efforts to the proven sites referenced above. ) You are expected to take maximum advantage of any outside financial assistance for which you may qualify, including Federal Grant and state grant programs to enable Lehigh to spread its own funds further and to limit student borrowing.

The financial aid office website carries complete information: [www.lehigh.edu/financialaid](http://www.lehigh.edu/financialaid)

### Application Procedures

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#### Application Procedures for 2013-2014

Students who are applying for institutional aid are required to file both the Free Application for Federal Student Aid (FAFSA – online [www.fafsa.ed.gov](http://www.fafsa.ed.gov) (<http://www.fafsa.ed.gov>)) and College Scholarship Service CSS PROFILE (online [www.collegeboard.com](http://www.collegeboard.com) (<http://www.collegeboard.com>)). Additional forms, such as tax returns (2012 for the 2013-14 academic year) business supplements for self employed and Non Custodial Parent Statements for those who are divorced or separated should file on-line at [www.collegeboard.com](http://www.collegeboard.com) (<http://www.collegeboard.com>). The financial aid website: [www.lehigh.edu/financialaid](http://www.lehigh.edu/financialaid) details the timeline for all applicants (early decision, transfer and continuing) and provides more detailed information including links for all forms.

### International Candidates

International students are eligible for university-funded financial aid. Opportunities are limited. Two forms are required: the International Student Financial Aid Application and the Certificate of Finances. The forms can be found on the Admissions website under "Applying to Lehigh." Students not funded as entering first year students are generally not considered eligible in future semesters.

### Renewal of Aid

It is necessary to reapply for financial aid for each year of study and is limited to four years, for a four year program. Extensions beyond that time period require petitions to the Committee on Undergraduate Financial Aid. Applications and filing instructions are available in December in the Office of Financial Aid, or as otherwise posted. In general, renewal requires on time filing, continued financial need and satisfactory academic progress. Some awards carry specific GPA requirements which are outlined on your award notification.

To receive itype of aid, you must be making satisfactory academic progress. The written university policy on satisfactory academic progress is available in the Office of Financial Aid. Generally speaking, it includes 1) remaining in good standing (based on your GPA), 2) advancing a minimum of 24 new credits per academic year (minimally, 12 credits per semester) 3) keeping pace with your class, progressing from freshman to sophomore, etc. and 4) filing all required paperwork on time. Recipients of Lehigh grants and scholarships are expected to achieve at least a 2.00 GPA each semester (or higher as noted on the financial aid notification). Students on academic or disciplinary probation are not normally eligible for university grant aid during any period of the probation. Students not maintaining satisfactory progress, as defined by Lehigh or the appropriate governmental agency, may be ineligible for all forms of federal aid, including loans and employment. Appeals, based on extenuating circumstances, may be submitted to the Committee on Undergraduate Financial Aid using forms provided by the Office of Financial Aid.

### Sources of University Aid

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Several forms of university-funded aid, based on need and merit, are available.

#### Lehigh University Grants

Funds budgeted from general income to provide need-based, non-repayable assistance. Lehigh University Grants are also used as a 'placeholder' until we are notified of the amounts we are able to award for each of the endowed funds.

#### Sponsored Scholarships

Individuals, foundations, and corporations provide these funds through annual contributions to the university. Lehigh has 60 such sponsored funds. Lehigh University grants are also used as a "placeholder" until we are notified of the amounts we are able to award for each of the endowed funds.

#### Endowed Scholarships

Income from invested gifts to the university make these need based scholarships possible. The university has over 800 such funds, half of which are for general, unrestricted use. Curriculum, geographic, outside interests, etc. restrict most of the others.

#### Lehigh University Academic Merit Awards

The equivalent of seven full tuition awards (awarded as one half or full tuition) will be awarded to entering freshmen. Selections are made by the Office of Admissions based on academic excellence, extra curricular and leadership activities. Awards are renewable for four years of undergraduate study and require a 3.0 average and satisfactory progress toward a Lehigh degree.

#### Dean's Scholarships

Approximately 70 scholarships, in an annual amount of \$10,000 will be awarded to entering freshmen. Selections are made by the Office of Admissions based on academic excellence and significant extra-curricular and leadership activities. Awards are renewable over four years of undergraduate study, and require a 3.00 average and satisfactory progress toward a Lehigh degree.

**Baker Gifted Arts Scholarships**

Awards are given to students from Northeast Pennsylvania and are valued at \$3,000 per year, renewable over four years. Selections are made by the faculties of the Music and Theatre departments, and are based on taped performances and letters of recommendation.

**Army ROTC Leadership Awards**

In certain instances, the university may supplement an Army ROTC scholarship with a leadership award that is equal to the cost of room and board. These are highly competitive and require a 2.5 average for renewal.

**Merit Scholarships**

Lehigh is a collegiate sponsor of the National Merit Scholarship program. Scholarships ranging from \$1,000 to \$2,000 per year may be awarded to Merit finalists selecting Lehigh as their first choice college, and who are not also receiving another form of National Merit scholarship.

**Rodale Scholarship in Journalism**

Qualified students may receive a \$2,500 scholarship (which may be renewed for three additional years); opportunities to intern at Rodale Press or other prominent media; and one-on-one instruction with Lehigh faculty.

**Athletic Awards**

Alumni Student Grants are awarded on the basis of financial need and exceptional athletic talent as evaluated by the Department of Intercollegiate Athletics. Alumni Student Grants replace the loan and employment portion of a financial aid package. Lehigh also awards NCAA grants in the sports of wrestling, football, and men's and women's basketball. A limited number of full, three-quarter, half or quarter tuition awards are available in other sports.

**President's Scholars Program**

This program provides an opportunity to receive free tuition for a fifth year of study, up to 12 months immediately following the awarding of the baccalaureate degree. The Registrar is responsible for determining eligibility. For further eligibility requirement information please go to the Registrar's Office Web page at [lehigh.edu](http://lehigh.edu).

**Availability of Jobs**

If you are offered work-study as part of your aid package, the Office of Financial Aid will provide you with the necessary forms and orientation to student employment. Jobs are available throughout the university and are funded through federal and university sources. Pay rates range from the federal minimum wage to \$10.00 per hour. You are paid on a bi-weekly basis, as you work and submit timesheets. Your work-study earnings are not deducted from your billed expenses.

The Job Locator Development Program is designed to assist you if you do not qualify under the Federal Work-Study program to find employment off-campus or with a number of incubator companies located on the Mountaintop Campus. This program is coordinated through the Office of Career Services.

**Aid from the Government**

Lehigh University is an eligible participant in federally funded student aid programs. Campus-based programs, where the university makes the awards based on the dollars available, include:

Federal Supplemental Educational Opportunity Grants  
Federal Perkins Loans  
Federal Work Study

Direct entitlement programs (where the government directly, or through commercial lenders for loan programs, provides the necessary funds) include:

Federal Pell Grants  
Federal Direct Stafford Loans  
Federal Direct Unsubsidized Stafford Loans  
Direct Parent Loan for Undergraduate Students (PLUS)

Please visit our website at [www.lehigh.edu/financialaid](http://www.lehigh.edu/financialaid) for more detailed information on any of these programs.

**Information for All Financial Aid Applicants**

1. Confirm that the correct Lehigh Identification Number (LIN) is listed on all forms.
2. Keep copies of all forms filed for your records.
3. In our efforts to "go green" we no longer print copies of your award notification. Current students must check their portal accounts for information on awards and missing information. Students may add parents to their accounts to enable them to view this information. Additional information on setting this option, contact the Registrar's Office

Submit the appropriate state grant application, especially if a resident of Ohio, Massachusetts, Connecticut, Rhode Island, Pennsylvania, Maryland, Delaware, Vermont, or West Virginia - states from which Lehigh students have brought scholarships. Be guided by the specific instructions. The FAFSA will be the basic form for state grant consideration, although some states do require a supplemental application. Students should be sure to meet all filing deadlines to be eligible for assistance.

**Student Rights and Responsibilities****Student Rights**

Students have the right to know

- the cost of attendance;
- the refund policy for students who withdraw;
- the financial assistance available from federal, state and institutional sources;
- procedures and deadlines for submitting applications for financial aid;
- how financial aid recipients are selected;
- how eligibility was determined, including all resources the aid office considered available to the student;
- how and when funds will be disbursed;
- an explanation of each type of award received;
- for any student loan received: the interest rate, total amount to be repaid, when repayment begins, the length of the repayment period, and the cancellation or deferment provisions of the loan;
- for any Federal Work-Study or university-funded job: a description of the job, the hours to be worked, the rate of pay, and how and when the student will be paid;
- the criteria used to determine satisfactory academic progress for financial aid purposes; and
- how to appeal a decision by the Office of Financial Aid concerning any aid award.

**Student Responsibilities**

It is the student's responsibility to:

- read directions thoroughly, complete all application forms accurately, and to comply with any deadlines;
- provide any supplemental information or documentation required by the Office of Financial Aid or other agency if applicable;
- read, understand, and keep copies of any forms the student is required to sign;
- repay any student loans received;
- attend an entrance interview and an exit interview if federal, state or university loans are received while in attendance at Lehigh;
- notify the Office of Financial Aid of any change in enrollment status or financial status (including any scholarships or grants received from outside sources); changes of address and enrollment status must also be reported to lender(s) for any loan(s);
- satisfactorily perform the work agreed upon in a Federal Work-Study or university-funded work program; and
- know and comply with all requirements for continuation of financial aid, including satisfactory academic progress requirements.

For additional information write to the Office of Financial Aid, Lehigh University, 218 W. Packer Avenue, Bethlehem, PA 18015; telephone

(610) 758-3181; FAX (610) 758-6211, email [financialaid@lehigh.edu](mailto:financialaid@lehigh.edu) or visit our website [www.lehigh.edu/financialaid](http://www.lehigh.edu/financialaid).

## Campus Life

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To learn more about campus life at Lehigh University, please view our Student Handbook at <http://www.lehigh.edu/~indost/conduct/handbook/>.

## Religious Activities

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The Religious Program is under the general supervision of the university chaplain. The chaplain participates in the ceremonial life of the University and conducts special university worship services throughout the year. All worship services are interdenominational, with some being inter-religious. Roman Catholic masses are held regularly. The Newman Hall can be contacted for a schedule of services.

Lehigh University is non-denominational. Packer Memorial Church, dedicated in 1887 in honor of the University's Founder, Asa Packer, continues to be the center for campus worship services.

The University Chaplain works with representatives of campus religious groups of all faiths and assists students in planning religious life programming. The chaplain's office sponsors an Oxfam Fast in November, organized the original Community Service Desk that helps coordinate volunteer services on campus, and creates opportunities for discussion of moral and spiritual issues through the Chaplain's Forum. In addition to providing pastoral counseling, supporting religious groups, and helping bring speakers to campus, the chaplain seeks to provide leadership to the university on religious and ethical issues.

Over fifteen religious groups on campus provide opportunities for religious fellowship. The groups include the Catholic Student Union for Roman Catholic students under the guidance of a resident priest; the Jewish Student Center, which sponsors various activities for Jewish students; and organizations for Hindu and Muslim students. A variety of Protestant Christian organizations are available to students, including the Lehigh Christian Fellowship and the Fellowship of Christian Athletes.

The chaplain's office makes information about religious life available to all students through the Chaplain's web page and can be contacted at any time for information about worship opportunities and religious activities either on campus or in the local Bethlehem community.

## Student Organizations

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Lehigh offers a wide variety of extracurricular activities and student organizations. The student-run campus newspaper keeps the campus informed while the student-run campus radio station and the many drama and musical organizations entertain. Additionally, the Lehigh University Student Senate (<https://senate.web.lehigh.edu>) recognizes over 150 student clubs ranging from academic organizations and cultural groups to special interest and political organizations. Student club activities are open to everyone.

Students are invited to view a complete list of campus organizations by going to the HUB (<https://lehigh.collegiatelink.net/organizations>) or by visiting the Lehigh University homepage and selecting the link to clubs and organizations.

Questions about clubs and organizations can be directed to the Office of Student Activities at [instuact@lehigh.edu](mailto:instuact@lehigh.edu) or 610-758-6670.

## Lehigh University Theatre

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In Spring, 1997, the department of theatre moved to the Zoellner Arts Center, Lehigh's impressive performing arts facility. Three theaters, scene and costume shops, a dance studio, music practice rooms, classrooms and more enhance the department's curricular activities. The department of theatre's annual production program includes four productions in the three hundred-seat Diamond Theater and multiple lab productions in the one-hundred seat Black Box Theater. The plays range from classics to world premieres and recent mainstage seasons have included: *Oleanna*, *The Crucible*, *Urinetown*, and *The Laramie Project*.

Shows directed and produced by students as class projects or independent work occur regularly in the Black Box Theater. Recent lab theatre productions have included: *Another Antigone*, *Another Moon Called Earth*, *Cellmates*, and *Wildwood Park*. Many events are

sponsored by the Mustard and Cheese Drama Society, the country's second oldest collegiate drama club.

Auditions and production crews are open to all members of the university community. Production opportunities exist in performance, choreography, set and costume construction, properties management, lighting, sound, house management and publicity. Advanced students have opportunities to direct or design, under faculty supervision.

Outstanding work in the Diamond or black box theaters may be recognized with Williams Prizes and theatre department prizes in acting, directing, design, playwriting and technical production.

Professional guest artists - directors, playwrights, designers, and actors - frequently visit the Lehigh campus to work on productions, teach classes, and conduct seminars and workshops for all interested students. The department also sponsors artists-in-residence, guest lecturers, workshops, and touring performances.

## Musical Organizations

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The music department offers students an array of ensembles in which to perform and develop leadership skills. The choruses, bands, orchestra, and ensembles are conducted by members of the faculty and managed by elected student leaders. Nearly all performances except Christmas Vespers are held in Baker Hall in the Zoellner Arts Center.

Students earn one credit per semester for each ensemble or lesson course in which they are registered.

### Lehigh University Philharmonic Orchestra

The Lehigh University Philharmonic Orchestra, directed by Eugene Albuiescu, is a body of 60-70 players from diverse backgrounds. Though primarily a student orchestra, faculty and community members also participate, creating an ensemble that contains unique intersections between students of all majors and professionals, campus and community. Students bring the great works of orchestra repertoire to life in four pairs of concerts a year in Baker Hall, Zoellner Arts Center. Membership is by audition.

### Jazz EnsembleS

The Jazz program, directed by Bill Warfield, consists of a number of groups large and small, including the Jazz Ensemble, the LU Jazz Repertory Orchestra, the LU Funk Band, and a number of combos. The ensembles perform contemporary literature as well as the music of the more traditional bands such as Basie, Ellington, Goodman and Herman. A distinguished faculty of jazz musicians teaches private lessons and coaches the combos. Membership is by audition.

### Marching 97

The Marching 97 meets during the fall semester and plays at each Lehigh home game, as well as several away games. Made up of students from all of the colleges at Lehigh, the band is a student-run organization dedicated to building a positive Lehigh spirit at games and off the field. Band camp is held three days during the week prior to the start of classes. No audition is required.

### Symphonic Band

The Symphonic Band meets and performs only in the spring semester of each year. The ensemble consists of students, faculty and staff who are interested in playing music. No audition is necessary.

### Wind Ensemble

The Wind Ensemble under the direction of David B. Diggs, is a select group of students dedicated to performing music for woodwinds, brass and percussion. These students represent many diverse majors. In 1999 the Wind Ensemble was honored by Downbeat Magazine, receiving the award for the most outstanding college classical symphonic band.

### Lehigh University Choral ARTs

The Lehigh University Choral Arts, directed by Steven Sametz, is the umbrella organization for a number of vocal ensembles:

#### Lehigh University Choir

The Choir is an active force in campus life. The 60 mixed voices of the Choir, drawn from all majors of the University, are auditioned at the beginning of the academic year. They give four major concerts on campus and tour internationally. The Choir frequently performs with orchestra and regularly performs new music, including many works

written especially for them. They have been heard five times on National Public Radio. The Choir has toured to Austria, China, France, Germany, Korea, Portugal, Russia, Thailand, Taiwan, and has performed in Avery Fisher Hall at New York's Lincoln Center.

#### **Lehigh University Choral Union**

The Lehigh University Choral Union, composed of students, faculty, staff, and Lehigh Valley community members performs three times a year with internationally known soloists and a full symphony orchestra. The 200 singers of the Choral Union bring major works such as Beethoven's Ninth Symphony, Mahler's Second Symphony, and the Brahms Requiem to a broad audience. No audition is required.

#### **Lehigh University Glee Club**

The recently revived Glee Club sings traditional and new music for male voices under the direction of Steven Sametz. Enthusiastically welcomed by alumni and the university community, the Glee Club has thrilled audiences on campus, on tour in China, and at Lincoln Center, where they performed with the University Choir.

#### **Dolce**

Dolce – Lehigh University's Women's Ensemble under the direction of Sun Min Lee begins a new tradition of women's music on campus. They perform on campus and in the community. This group sings a variety of music written especially for female voices as well as music adapted for the group. Members of Dolce also sing with the University Choir.

### **Volunteer and Community Services**

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Lehigh's Community Service Office, located in the garden level of the University Center, room B001, is a place where students, faculty, staff, and student organizations interested in volunteering in the community can get information. The Office is staffed by undergraduates who serve as Student Coordinators, two Graduate Assistants, an Administrative Coordinator and the Director of Community Service.

Students are involved in a wide range of service programs. Some of the projects include tutoring and mentoring programs with local youth through opportunities such as the America Reads and America Counts program. Many students are also active in local hospitals, with environmental groups, senior citizen centers, and shelters. In addition to the work with outside agencies, the Community Service Office has its own major programs that aim to meet the needs of the South Bethlehem community, such as Lehigh's Move Out Collection Drive, Parents' Night Out, Spring Fling, Spooktacular, Wonderful World of Sports, Broughal Bowling, and Livin' La Vida Lehigh. The Office also provides students with week-long service initiatives over the four school breaks, giving students the opportunity to travel around the country to serve in homeless shelters, on environmental projects, Habitat for Humanity and with youth programs. Additionally, Live.Learn.Serve. is a residential living community for Lehigh students who are interested in making a difference in the local community through service and civic engagement. The program offers students the unique opportunity to meet and live with other students that have similar interests, while participating in an array of service events, such as trips to local soup kitchens, daycare centers, assisted living homes, and more!

Part of the Lehigh experience is getting involved. If you are interested in making a difference in the greater Lehigh Valley area, contact the Community Service Office at (610) 758-6674 or check out our web site at [www.lehigh.edu/service](http://www.lehigh.edu/service).

#### **Guest Speakers**

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Students have the opportunity to hear a wide variety of notable speakers. Among those to visit the campus have been former Attorney General Janet Reno; Rwandan genocide survivor Paul Rusesabagina; writer Salman Rushdie; poet and writer Maya Angelou; playwright Edward Albee; former Pakistani Prime Minister Benazir Bhutto; author Elizabeth Gilbert; Lee Iacocca; General Colin Powell; author and comedian John Hodgman; Titanic discoverer Robert Ballard; and novelist John Irving. Thomas Armstrong, director of the Whitney Museum, spoke with students during a week-long residency. An Engineering Expo with speakers representing many prominent industries featured Peter Bridenbaugh, former vice president of science and technology. From art to engineering, the campus stays in touch with

current issues, trends, and movements through its many and varied speaker series.

Speakers are invited by various committees and academic departments. Several of the committees, including the Visiting Lecturers Committee, welcome participation by students as well as faculty and staff. Major lectureships include the Connell Lecture (on religion), the Distinguished Lecture Series: Leaders of Practice (Education Department), and The Kenner Lecture on Tolerance. Lectures are also presented by the Humanities Center and the Friends of the Library.

### **Campus Athletics**

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The mission of the "Campus Athletics" program is to promote the value and benefits of personal fitness, team sport experiences and lifetime sport skills, through diversified **educational, participatory, competitive**, and/or **instructional** programs for the campus community.

#### **Club Sports**

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A Club Sport is formed when a group of students voluntarily organize in the aim of seeking structured and often competitive sport opportunities in an area of common interest. Club sports are structured and guided by the principles and obligations of other student organizations, and are not formally recognized until they are fully compliant with such expectations. The initiative, organizational commitment and personal investment required for club sports participation fosters an extraordinary learning and leadership experience.

Competition can range from a club varsity status such as Men's Ice Hockey and Men's Rowing to competitive sports such as Cycling, Equestrian, Men's and Women's Rugby, Skiing, Water Polo or non competitive sports that includes Badminton and Gymnastics just to name a few. In total, there are 37 recognized club sports that are active.

#### **Intramural Sports**

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Intramural sports are organized, structured, and competitive activities that are played within the University. At Lehigh, members form teams from IFC, Pan-Hellenic, off campus houses and dorms. These teams and individuals accumulate trophy points in sporting contests for an overall All University Champion in one of four divisions: Upper-class Greek, Upper-class Independent, Women and Freshmen. Intramural sports, which varies from 11 to 15 activities, offers our students a high degree of physical fitness, establish habits of regular and healthful exercise, foster the development of self confidence, good sportsmanship, and a spirit of cooperation.

#### **Fitness**

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The Fitness Programming initiatives at Lehigh exist to promote the development of a physically educated person, who is defined as one who has learned skills necessary to perform a variety of physical activities, is physically fit, participates regularly in physical activity, and knows the implications of and the benefits from involvement in physical activities, and values physical activity and its contribution to a healthful lifestyle. Our programs focus on activities in which a person can participate over the course of a lifetime, and which contribute to the development of health-related components of physical fitness through sport.

#### **Recreation**

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The entire Lehigh community is invited to compete in both organized leagues such as summer softball and others during the academic year to informal activities such as lap swimming in our pool, playing pickup basketball, refining your dance moves in the Dance Studio which are all located in Taylor Gym. The Goodman Campus offers a wide range of open space, to throw a Frisbee, kick a soccer ball or play a friendly game of touch football.

You can run on our nationally known cross country course, hit a tennis ball at the Lewis Tennis Center or drive a bucket of golf balls at the Mulvihill Golf Learning Center. The opportunities are endless!

## Welch Fitness Center

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The Welch Fitness Center and Racquet Sports Complex, located in Taylor Gymnasium, is a multi-dimensional facility intended for use by students, faculty, and staff. The center provides the University community the opportunity to improve their health and physical fitness through the use of the "state of the art" equipment and programs. The 10,000 square foot 3 tiered complex offers an expansive amount of cardiovascular and weight training equipment, racquet ball and squash courts and the Lane Challenge Climbing Wall.

We offer individuals the opportunity to learn more about fitness by providing facility orientations and self directed conditioning programs. Other opportunities include individualized computer strength programs, body composition assessments, personal training and health promotion education. The Welch Fitness Center coordinates the campus group fitness and instructional programs

Taylor Gym and Welch Fitness Center provide opportunities for open recreation and leisure activities and formalized programs such as aerobics, instructional programs and numerous physical fitness programs that are conducted in the Welch Fitness Center.

## Risk and Liability

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Campus Athletics strongly encourages all participants to consider his/her personal health and physical condition prior to participation in any physical activity. Such participation involves physical exertion, fundamental skills for that sport or activity, and may involve physical contact. The participant, being aware of any conditions predisposing his/her to injury or illness, and in consideration of the inherent physical exertion and possible contact involved, may wish to seek the advice of a physician prior to participation.

**Campus athletics is not responsible for injury incurred during participation. All participants are responsible to supply appropriate insurance coverage.**

## Athletic Opportunities

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Students can participate in many intercollegiate, recreation, and intramural athletic programs. NCAA Division I intercollegiate varsity sports include the following. FALL: football, men's and women's cross country, men's and women's soccer, women's field hockey, and women's volleyball. WINTER: men's and women's basketball, wrestling, men's and women's indoor track and field, and men's and women's swimming and diving. SPRING: baseball, men's and women's tennis, men's and women's golf, men's and women's outdoor track and field, men's and women's lacrosse, women's softball and women's rowing.

Athletic facilities are located in Taylor Gymnasium and Grace Hall on the Asa Packer campus, and on the Murray H. Goodman campus, which is located one and one-half miles south of the main campus. The 500 acre Goodman athletic complex includes Stabler Arena, which seats 5,600 and hosts all Lehigh basketball games and tournament wrestling matches. The campus also contains Goodman Stadium, a 16,000 seat football stadium, and the Philip Rauch Field House, which includes a one eighth mile track and indoor basketball courts. The four court Lewis Indoor Tennis Center was completed in 1994. The Ronald J. Ulrich Sports Complex features artificial turf and natural grass fields for lacrosse, soccer and field hockey, including Frank Banko '41 Field and Ulrich Field. Other facilities on the campus include a championship cross country course, baseball and softball fields, outdoor tennis courts, the John C. Whitehead Football Practice Complex, the A. Haigh Cundey Varsity House, numerous practice fields, an all-weather, nine lane, outdoor 400 meter track, and a golf clubhouse and driving range.

**Lehigh is affiliated with the National Collegiate Athletic Association (NCAA), the Patriot League and the Eastern Intercollegiate Wrestling Association (EIWA). Lehigh frequently hosts collegiate championship events in men's and women's sports and is the summer training camp facility of the Philadelphia Eagles of the National Football League.**

## The Student Code of Conduct

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Intellectual honesty and mutual respect are not accidental values in a university. They are, for students and professors alike, a presupposition of the pursuit of truth, which brings universities into existence. It is essential that an academic community uphold these values. The student code of conduct and the student conduct system are mechanisms by which the university endeavors to develop in all students a sense of responsibility to the Lehigh University community.

The Lehigh University Student handbook (<http://www.lehigh.edu/~indost/dos/hbook.html>) contains information relevant for the student members of our community. All students have an obligation to read and be familiar with the Student Handbook, the Code of Conduct, and the other policies contained therein.

## In Bethlehem, An Educational Tradition

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Lehigh University shares in the historical heritage of Bethlehem, even though, having been founded in 1865, it is a relative newcomer. The fact that Lehigh was established in Bethlehem reflects the tradition of education established by the community's first settlers thirty years before the founding of the nation.

The first Moravians were among the many German religious sects that came to the New World, and especially to Pennsylvania, during the early 1700s. But unlike William Penn, who established his sylvania as a new land where he might hold his Quaker beliefs away from England's oppression, the Moravians came as missionaries with the intent of converting the Indians to Christianity. For this purpose they settled the Lehigh Valley.

The early Moravians were industrious. Their first building, the Gemein Haus (community house) was completed in 1741. This building stands today, one of thirty-nine remarkably preserved pre-Revolutionary War buildings constructed by the Moravian settlers and in continuous use ever since by the Moravian community. Many of these buildings are located on Church St., west of the City Center; industrial buildings are located in the 18th Century Industrial Area in the Monocacy Creek valley west of the business district.

The leader of the Moravians was Count Nicholas von Zinzendorf of Dresden. He arrived in the settlement in time for their observance of Christmas Eve in 1741 and gave the settlement the name Bethlehem—"house of bread".

The settlers built high-quality structures of stone, demonstrating principles of engineering that were not generally used elsewhere. They were interested in music, and established the first symphony orchestra in America. In 1748, the settlement had a fourteen-man orchestra. The community's first organ was built in 1757 by John Gottlob Klemm. The musical tradition, including the trombone choir, continues today, perhaps most visibly in the Bach Choir of Bethlehem, whose yearly Bach Festival is held in the university's Packer Memorial Church. In 1985, the 300th anniversary of the birth of Johann Sebastian Bach was observed.

Zinzendorf envisioned Bethlehem as the center for manufacturing; outlying Moravian settlements, such as Nazareth, Pa., would be primarily devoted to agriculture. On October 15, 1742, a large barn was "raised" with the help of most of the residents. Three months later a grist mill at the community spring produced the first flour. In 1758, the Sun Inn was built along Main St., a haven for travelers. Reconstruction of the picturesque inn was completed in 1982, and it now operates as a community center and restaurant.

Zinzendorf's determination that Bethlehem would be a major industrial center was assisted by the completion in 1755 of the water works, the first public utility in the New World.

The Moravian dedication to education was an extension of the philosophy of John Amos Comenius, who had written, "Everyone ought to receive a universal education." The Moravian educational institutions that continue today, including Moravian Academy and Moravian College, stem from this tradition.

The Moravians, although avowedly opposed to war, found their community pressed into service as a hospital when Washington's troops bivouacked at Valley Forge during the winter of 1777-78. Washington



came to the community once, and many other Continental Army officers were visitors.

The Sun Inn was also used as a hospital during the war; among its patients was an aristocratic renegade from France, Marie Joseph Paul Ives Gilbert Motier, the Marquis de la Fayette. Lafayette had come to assist the Continental Army aboard his own ship, the "Victory." Fifty years later a college in Easton was named in his honor and it became Lehigh's traditional football rival.

The first bridge across the Lehigh River was built in 1794. It was replaced in 1816, but the latter was destroyed by a flood in 1841. In 1759, the turnpike (toll road) over South Mountain, generally along the route of the present Wyandotte St. hill, was opened. The present Hill-to-Hill Bridge was built some fifty years ago.

"Black gold." During the late 18th century, anthracite was found in the mountains north of the Lehigh Valley. In 1818, the Lehigh Coal Co. and the Lehigh Navigation Co. were formed, one to mine the anthracite on the upper Lehigh River, the other to transport it down river to metropolitan markets.

The Lehigh River was difficult to navigate. Consequently, in 1829 the Lehigh Canal was completed from Mauch Chunk (now Jim Thorpe), through Bethlehem to Easton, where it connected with the Delaware Canal. During the 1840s, iron mines were opened in the area, and several blast furnaces, fueled by coal, were in operation. Zinc ore, was found in neighboring Upper Saucon Township. In the 1850s Asa Packer built the Lehigh Valley Railroad. These origins eventually led to the heavy industry that continues in the Lehigh Valley today.

When Asa Packer founded Lehigh University in 1865, one of his objectives was to make possible broadly based education for young people of the region, combining the technical skills needed to run the flourishing industry of the Lehigh Valley with a liberal education.

In addition to its role as a steel-making center, Bethlehem today is a major tourist attraction. The Moravian community sets up an elaborate nativity scene and the entire city is decorated with lighting during the holiday period. The Moravian tradition of a single candle (now electric) in each window is widely observed.

Atop South Mountain is a steel tower known as the Star of Bethlehem. During the holiday period, the star's hundreds of bulbs create a 95-foot-high star that can be seen for many miles. The star was the gift to the community of Marion Brown Grace, wife of Eugene Gifford Grace, the steel magnate and president of the university board of trustees.

The community of Bethlehem has a population of approximately 78,000 persons with segments from a variety of nations who retain traditions of their country of origin.

There are five principal independent colleges in the Lehigh Valley besides Lehigh. They are Lafayette, DeSales University, Moravian, Muhlenberg, and Cedar Crest. A cooperative program is maintained that allows cross-registration for courses as well as shared cultural events. There are also two community colleges in the area.

In August 1984, Bethlehem held its first Musikfest, a 10-day annual festival that features a variety of musical performances and ethnic foods. An instant success, Musikfest was the brainchild of Jeffrey A. Parks, a lawyer and 1970 Lehigh graduate.

## University Resources

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Lehigh University offers a variety of resources to support the campus community.

### Library and Technology Services

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The exponential growth and increasing sophistication of information technology offer new and exciting opportunities for enhanced teaching, learning, and research. At Lehigh University, one merged organization called Library and Technology Services (LTS) delivers communications, computing, distance education administration, enterprise systems implementation, faculty development, library, and media services to capitalize on these new opportunities. Additional information about Library and Technology Services can be found at [www.lehigh.edu/lts](http://www.lehigh.edu/lts).

### Libraries

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Lehigh University has two major library facilities, the Linderman Library and the Fairchild-Martindale Library. The Lehigh University library collection comprises over one million volumes. Subscriptions to periodicals are mostly in electronic format, and the collection of ebooks is growing at a rapid rate.

The historic Linderman Library reopened after an extensive renovation as a showcase for humanities programs and collections, as well as an intellectual center for the campus at large. The 1878 high Victorian rotunda and the 1929 grand reading room were retained in all their magnificence. Among the new features are: seminar rooms, a computer classroom, exhibition space, group studies, a cafe, and wireless throughout. Linderman houses books and journals in the humanities and Lehigh's impressive collection of rare books including Darwin's Origin of Species and John James Audubon's four-volume elephant folio edition of Birds of America. Digital library projects highlight various aspects of the collection from "Digital Bridges" (books on 19<sup>th</sup> century bridge construction and "Beyond Steel" (materials examining the social and cultural impact of the Lehigh Valley's industrial past) to the Brown and White student newspaper archive. In addition, Special Collections holds numerous archival collections that focus on industrial and regional history.

The Fairchild-Martindale Library contains electronic and print books and journals in all branches of science, engineering, mathematics, and the social sciences, including business and education. It provides collaborative learning spaces, wireless connectivity, and comfortable lounge areas. As a government depository of long standing, the Fairchild-Martindale Library holds print and electronic federal and Pennsylvania documents.

The Libraries offer students, faculty, and staff a full range of electronic journals, full text and image databases easily accessible from on and off campus. The library web page [library.lehigh.edu](http://library.lehigh.edu) serves as a gateway to these resources, as well as encompassing news items, a blog, library hours, and an invaluable set of library research guides (Libguides). The web page also provides quick access to most library services and to research assistance. Interlibrary loan via ILLiad or PALCI (Pennsylvania academic libraries) allows for rapid and easy borrowing from collections in other libraries. There is also desktop delivery of scanned articles in Lehigh's print journal collection (JSCAN). Students and faculty may borrow books directly from other academic libraries in the Lehigh Valley Association of Independent Colleges (LVAIC).

### Networking and Voice Communications

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Lehigh University is a "wired" campus in every sense of the word. A highspeed fiber optic backbone network ties together campus buildings and student residences, including fraternities and sororities. The Campus Portal allows each member of the Lehigh community to fully customize their access to web-based information and applications. Student computer use in the residences is supported by the WIRED program. Staff communicate with students in advance of their arrival at Lehigh to identify for them compatible hardware and software for use on the campus network. When students bring their computers to campus, staff assist them with their initial setup and provide continuing assistance with any networking problems throughout the semester. The front line

WIRED consultants are well-trained students who live in the residences and can readily provide prompt, onsite assistance. See [www.lehigh.edu/wired](http://www.lehigh.edu/wired).

Lehigh also provides secure wireless connectivity in many campus settings – see [www.lehigh.edu/wireless](http://www.lehigh.edu/wireless). Through Lehigh's enterprise systems, convenient interactive services such as online course registration and online grades are offered to students. There is also a parent portal configured to parent's needs and interests. Library and Technology Services supports a telephone system.

### Computing

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Providing technology and consulting services to support classroom teaching, laboratories, and other aspects of the academic and research programs is a strategic priority for Lehigh University. About 600 Windows and Macintosh personal computers are distributed across campus for convenient use by students at more than 27 computing sites. For example, there are more than 100 computers in the libraries and computing center, and 100 in Rauch Business Center. A twenty-four hour site at Grace Hall has 30+ machines. There are e-readers, tablets, and portable laptops equipped with wireless networking available for short-term loan at the Libraries and at the Media Center.

Students and faculty have access to site-licensed software applications and central file storage from on and off campus. LTS provides software at public sites such as desk top publishing and graphics software, programming languages, mathematical and statistical packages, and specialized applications for engineering, scientific publishing, and creative writing.

Lehigh provides access to a variety of high performance computing systems suitable for large scale computation and compute-intensive applications. These systems contain over 2000 processing cores and over 4 terabytes of memory available to tackle the most complex and demanding research projects. For more information, see [www.lehigh.edu/computing/hpc](http://www.lehigh.edu/computing/hpc). University computing capacity and Internet bandwidth are continuously being increased to meet escalating demand and the campus is also connected to the research-based Internet2 network.

The Technology Resource Learning Center supports faculty innovation -- see the Faculty Development section of this catalog for details. Library and Technology Services provides technical support for the many computer classrooms, suitable for individual "hands-on" instruction. 85% of all Lehigh University classrooms are equipped with permanently-installed computer projection systems. Laptops and portable computer projectors are available through Instructional Media Services to enable faculty or students to give computer-based presentations in any space.

### Instructional Media Services

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Library and Technology Services offers an extensive media collection and streaming video services for courses. Videos and DVDs and available for viewing (all users) and for shot-term loan (faculty and graduate students) from Fairchild-Martindale Library Lending Services.

The Digital Media Studio offers students and faculty consulting assistance, a video editing lab, and a wide range of technology to support the creation of professional audio, graphic, and video materials for classroom presentations, projects, and portfolios. Students can scan and edit text, and these images can be output to printers or to computer files for further manipulation. Digital still and video cameras, a video and photography studio, and editing software facilitate the production of audio and video material to support the academic program. Loaner projectors, laptops and audio recorders are also available.

A third media facility, the International Multimedia Resource Center (IMRC), is located in nearby Maginnes Hall.

### Student Services

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The library, computing center, and most distributed computing facilities are open seven days per week and for evening hours during the fall and spring semesters. During final exams the Fairchild-Martindale Library

is open 24 hours. For most of these hours, a help desk located at the Fairchild-Martindale Library provides general help for students and faculty onsite and for telephone inquiries relating to both library research and computing. Help desk staff refer more specialized questions to experts as needed.

Students may also take advantage of virtual help desks where they enter the questions or problems relating to library research, computing hardware or software, or telecommunications at any hour of the day or night for response at a later time, usually within one working day. Most library and computing services are available electronically, for example, interlibrary loan and seminar registrations. "Live chat" library reference and computing help services are also available during many hours.

Each semester Library and Technology Services offers an extensive program of seminars and course-based instructional sessions for students. Attendees learn how to use software applications, library resources, and the Web-authoring tools. LTS professionals work closely with faculty to integrate library, computing and media resources into the curriculum. They facilitate the use of course management software, online courses of various kinds, and course projects in a wide range of disciplines using interactive Web sites created by faculty and students.

Through seminars and policies on the use of print and electronic resources, students are taught computer ethics, recommended computing practices such as frequent backup and password changes, and an understanding and respect for state and federal laws governing copyright, privacy, and destruction or vandalism of library resources or computer systems, networks, databases or software. A free electronic newsletter, LTS Digest, with quick tips and updates is published throughout the year and is available to students who subscribe. There is also a newsletter, the LTS Connection.

Library and Technology Services maintains a variety of facilities for printing, scanning, copying, and duplicating within the constraints of copyright and yearly paper consumption restrictions. In the library, public photocopiers, scanners, and microform printers are maintained for convenience in copying print or microform resources. The Digital Media Studio (described under Instructional Media Services) can duplicate audio and video resources. There are printers at most computing sites. Students are strongly encouraged to print responsibly by using the duplex feature, never printing multiple copies, and examining documents to eliminate unneeded sections before printing.

## **Student Employment**

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Student assistants are essential for the operation of most Library and Technology Services functions. Working for LTS, graduate and undergraduate students gain valuable skills and good work habits. At the job fair, held each fall, there are opportunities to learn in-depth about the jobs available.

## **Lehigh University Art Galleries – Museum Operation (LUAG)**

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The Lehigh University Art Galleries (LUAG) are visual laboratories that maintain and develop the university's teaching art collection, and present temporary exhibitions designed to make visual literacy a result of the university learning experience. More than twenty exhibitions a year in six campus galleries introduce students and the community to current topics in art, architecture, history, science, and technology. The exhibition schedule is supplemented by lectures, films, workshops, and research opportunities in the teaching collection. The galleries occupy exhibition, storage, office and workshop space in several campus locations. The Main Gallery and Lower Gallery teaching collection exhibitions are in the Zoellner Arts Center. Other galleries are: DuBois Gallery, Maginnes Hall; the Gallery at Rauch Business Center; Girdler Student Gallery, University Center; and Siegel Gallery, Iacocca Hall on the Mountaintop Campus. The Muriel and Philip Berman Sculpture Gardens are located on Memorial Walkway, Mountaintop Campus, and Saucon Fields on the Murray H. Goodman campus. The Ralph L. Wilson Study Gallery is located in Building J, Mountaintop Campus and available by appointment. LUAG offices are in the Zoellner Arts Center.

## **Exhibitions & Programs**

Exhibitions and gallery events supplement formal classroom study in the visual arts, create educational opportunities for the entire student body, and enrich the cultural life of the campus and the community at large. The annual schedule includes the exhibition of works from the teaching collection, the use of borrowed objects, and traveling exhibitions on loan from major museums and cultural institutions. Experts in various fields serve as guest curators of special project exhibitions as well as artists in residence. Interdepartmental projects encourage increased involvement by faculty and students. Undergraduates may take advantage of courses in museum studies including internship and independent study in the collection.

## **Collections**

Lehigh University's teaching art collection is a work/study collection intended as a resource for students pursuing formal study in the visual arts, Art & Architecture History and museum studies, for the faculty, and for interested members of the community. Each year, several exhibitions are prepared from the collection and works are loaned to major museums throughout the nation.

The teaching art collection consists of a variety of works by Old Masters and contemporary artists. Important collection groups include: the Marion B. Grace Collection of European Paintings (Gainsborough, Reynolds, Goya, Hobbema, Hoppner, and others); the Dreyfus Collection of French Paintings (Bonnard, Sisley, Vuillard, Courbet); the Ralph L. Wilson Collection of American Art (paintings by Prendergast, Sloan, Henri, Lawson, Bellows, Davies, Burchfield; prints by Whistler, Hassam, Motherwell, Johns, Rauschenberg, Calder, Warhol); the Prasse Collection of Prints (Delacroix, Matisse, Renoir, Kent, Kunyoshi, Rivera); the Philip and Muriel Berman Collection of Contemporary Sculpture (Kadishman, Unger, Tumarkin, Bertoia, Shaw and Segal).

Among various interconnected collections within the overall teaching collection are the Fearnside Collection of European Old Master Prints and Drawings; the Baker Collection of Chinese Porcelains; the Langermann Collection of Pre-Columbian and Ethnographic Sculpture; the Mr. and Mrs. Franklin H. Williams African Collection (gold weights of the Akan and West African objects); the Photography Collection (Fox-Talbot, Warhol, Atget, Steiner, Mendieta, Kasebier, Brandt, Siskind, Martinez-Canas, Serrano); the Latin American Collection (Morell, Chambi, Bedia, Ayon) and the Contemporary Prints and Drawings Collection (Bearden, Rivers, Soto, Ruscha, Tobey, Kitaj, MarcaRelli, Cruz Azaceta, Segal, Lam, Picasso, Llinas, Golub, Jimenez, Piper, Young, Simpson).

## **Faculty Development**

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The Center for Innovation in Teaching and Learning aims to foster excellence in teaching and learning by providing faculty with tools, development opportunities, workshops, and consultation services.

Faculty Development works closely with the other divisions of Library and Technology Services to provide a coordinated array of support for faculty. Faculty seeking help developing effective writing assignments to teach disciplinary subject matter and communication skills are encouraged to meet with Writing Across the Curriculum Coordinator. The TRAC (Technology, Research and Communications) Writing Fellows Program trains students to serve as peer tutors in discipline-based courses and consult with faculty on developing effective writing assignments.

Faculty Development offers confidential, voluntary consultations with faculty about their teaching, which may include discussions of effective approaches to teaching, classroom observation visits, informal mid-semester evaluations of classes, assistance with course development questions, and advice on the effective incorporation of academic technology into courses.

Dr. Gregory Reihman, Associate Vice Provost and Director of the Center for Innovation in Teaching and Learning, may be contacted at 610-758-6840 or [grr3@lehigh.edu](mailto:grr3@lehigh.edu). Dr. Gregory Skutches, Writing Across the Curriculum Coordinator, may be contacted at 610-758-4932 or [grs206@lehigh.edu](mailto:grs206@lehigh.edu). The Faculty Development web site is accessible at [www.lehigh.edu/~infldi](http://www.lehigh.edu/~infldi). Writing Across the Curriculum website is at <http://trac.web.lehigh.edu>

## Lehigh University Press

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Lehigh University Press represents a clear expression of faculty and institutional commitment to the advancement of scholarship. Press management rests with a Director, Monica Najar (History), and with an Editorial Board comprised of university faculty.

The Press is interested in all fine scholarship but has strength in Studies in Eighteenth-Century America and the Transatlantic World. By linking the name of the university to a list of exemplary work by scholars across the nation, the Press reinforces the value of excellence in scholarship for faculty, graduate, and undergraduate students alike. Recent publications by the Press have won national awards, including Patricia D'Antonio, *Founding Friends: Families, Staff, and Patients at the Friends Asylum in Early Nineteenth-Century Philadelphia* (2006: The American Journal of Nursing's Book of the Year) and Sarah Fatherly, *Gentlewomen and Learned Ladies: Women and Elite Formation in Eighteenth-Century Philadelphia* (2010: The Philip S. Klein Prize for the best book on a topic that illuminates the history of Pennsylvania).

Recent publications include: Jean R. Soderland and Catherine S. Parsynski, *Backcountry Crucibles: The Lehigh Valley from Settlement to Steel*; Charles K. Jones, Francis Johnson (1792-1844): *Chronicle of a Black Musician in Nineteenth-Century Philadelphia*; Dorothy T. Potter, *Food for Apollo: Cultivated Music in Antebellum Philadelphia*; Mark E. Blum, *Kafka's Social Discourse: An Aesthetic Search for Community*; Anthony E. Clark, "China's Saints" *Catholic Martyrdom during the Qing (1644-1911)*; Kenneth C. Wolensky, *The Life of Pennsylvania Governor George M. Leader: Challenging Complacency*; Franklin L. Kury, *Clean Politics, Clean Streams: A Legislative Autobiography and Reflections*; John C. Greene, *Theatre in Dublin 1745-1820* (8 vols., 1-2 History, 3-8 Calendar); Robert J. Houle, *Making African Christianity: Africans Reimagining Their Faith in Colonial South Africa*; William Pencak, *Contested Commonwealths: Essays in American History*; Connie A. Shemo, *The Chinese Medical Ministries of Kang Cheng and Shi Meiyu, 1872-1937, on a Cross-Cultural Frontier of Gender, Race, and Nation*; Deborah Logan, ed., *Harriet Martineau and the Irish Question*, Amalia Ran, *Made of Shores: Judeo-Argentinian Fiction Revisited*.

For more information, contact:

Lehigh University Press  
Lehigh University, B040 Christmas-Saucon Hall  
14 East Packer Avenue  
Bethlehem, PA 18015  
Phone: 610-758-3933  
Fax: 610-758-6331  
Website: <http://inpress.sites.lehigh.edu>

## Resources for Students

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The Student Affairs division is dedicated to fostering student success by providing a balanced, rich and integrated living and learning environment. Virtually every student enrolled is touched by Student Affairs, beginning with orientation through the Office of First-Year Experience, and continuing through programs devoted to leadership development, community service, residential life, activities, academic support, a vibrant campus life and advocacy and equity programs. Students are supported through the Health and Wellness Center and Counseling and Psychological Services, and our highly trained and fully accredited Lehigh University Police Department, which collectively work to ensure a safe and healthy living environment. I encourage you to visit our departmental websites to learn more about each of these areas.

Student Affairs <http://lehigh.edu/~instuaff/>

Dean of Students <http://lehigh.edu/~indost/>

Counseling and Psychological Services <http://lehigh.edu/~incso/>

Health and Wellness Center <http://lehigh.edu/health/>

Lehigh University Police Department <http://lehigh.edu/~inlpd/>

### Alcohol, Drugs, and Other Lifestyle Choices Programs

At Lehigh University, alcohol, drug and other addiction services are provided as a resource for students directly and indirectly affected by alcohol and/or drug use or concerned about other lifestyle choices such as excessive gambling and internet use. Services are offered through

the University Counseling & Psychological Services (UCPS) office, and counselors are able to meet with students in a confidential setting to discuss personal choices and concerns; determine whether engaging in particular behaviors is negatively affecting personal goals and quality of life; and collaborate together in identifying strategies to initiate change and develop a more sustainable and healthy lifestyle.

These services include a variety of resources to assist students, including confidential brief individual counseling and group therapy; consultation for students concerned about friends; and referral to outside treatment programs and community resources. On-campus counseling may allow students to successfully enter into recovery without having to disrupt their university careers. At other times, referrals to in-patient or outpatient treatment programs can be made. Aftercare services can be provided once a student returns to campus, utilizing on-campus counseling or by referral to 12-step group meetings held on campus and in the surrounding community.

In addition, counseling staff members are available to lead outreach discussions on various topics including alcohol and other drugs, gambling, and peak performance lifestyle choices. Students are strongly encouraged to contact any of the UCPS staff by phone (610-758-3880) or e-mail ([incso@lehigh.edu](mailto:incso@lehigh.edu)) to answer further questions about available services, or to visit the 4th floor of Johnson Hall during office hours (8:00 a.m. to 5:00 p.m. with some additional evening hours), Monday through Friday.

### Disability Support Services

In accordance with the federal legislation, specifically Section 504 of the Rehabilitation Act of 1973 and the recently amended Americans with Disabilities Act (2008), Lehigh University is committed to ensuring equal access to students who are substantially limited by a disability. Services for students with a documented disability who are in need of academic support services are coordinated by the Dean of Students Office (610-758-4152). Services for students with physical disabilities who require assistance with nonacademic needs are coordinated by the Dean of Students Office, in conjunction with Facilities Services. Students requesting accommodations must present the University with current and comprehensive documentation. For more information refer to our website at: <http://www.lehigh.edu/~inacsup/disabilities/>

### Health & Wellness Center

The university offers health services to all students at the Health and Wellness Center in Johnson Hall. Clinicians including physicians and nurse practitioners see patients by appointment 8:15 a.m. to 4:30 p.m. Monday to Friday. A registered nurse is present to see patients on Saturday 10:00 a.m. to 2 p.m. with a provider always on call. Saturday clinics are for urgent issues only. During breaks and summers, hours are shortened.

Nurses and providers treat a variety of illnesses and injuries. Gynecologic care is available, and allergy injections can be administered. Some laboratory studies can be done at the Health Center; students are referred to local facilities for X-rays. Patients are referred to local medical and surgical specialists when indicated. More seriously ill students are sent to a local hospital Emergency Department.

Incoming students must comply with immunization requirements. There is no charge for most of the care provided to students. Exceptions include referrals to physicians, labs, hospitals or other medical facilities outside the student Health and Wellness Center. A low-cost university-sponsored insurance plan is available, which complements the services of the Health Center. Families are urged to review existing insurance coverage and to consider purchasing the university sponsored plan if they are not adequately covered. Students should carry their insurance cards with them and know which lab they can utilize to facilitate outside lab testing.

For more information, please consult our web page at [www.lehigh.edu/health](http://www.lehigh.edu/health).

### Counseling and Psychological Service

The University Counseling and Psychological Service, at 610-758-3880, is located on the fourth floor of Johnson Hall. The office is open from 8:00 - 5:00 (with some additional evening hours), Monday through Friday. Most services are free of charge. Counselors are available for 24-hour emergency consultations via campus police (610-758-4200).

## 1. Philosophy & Mission

The University Counseling and Psychological Service (UCPS) is dedicated to the belief that a person's college years are a time of challenge, inquiry, experimentation, productivity and change. Services are designed to help students not only manage crises, but to thrive in meaningful ways . . . to grow in self-understanding in order to make more satisfying and better use of their personal and interpersonal resources. Individual contacts, group therapy, faculty and staff consultation, and numerous outreach activities are some of the primary means by which the mission is accomplished. UCPS staff members are committed to providing assistance to all registered Lehigh students interested in personal, social, and academic growth and discovery, and to the larger campus community through consultation, teaching, research, and various other types of involvement.

## 2. Direct Services

To accomplish its mission, and while upholding the established state and APA (American Psychological Association) ethical principles and code of conduct for psychologists, the UCPS provides a variety of services to the Lehigh University community including:

- **Crisis Intervention Services**

The UCPS provides assistance to individuals and groups in crisis. Psychologists provide 24-hour coverage through the campus dispatcher (call dispatcher at 758-4200 and ask for psychologist on call).

- **Group and Individual Psychotherapy**

Ongoing group and relatively brief individual counseling and psychotherapy services are available for registered students. Although students do not have direct access to a university psychiatrist, counselors in an ongoing working relationship with a student may schedule meetings with the UCPS consulting psychiatrist to discuss additional treatment options. All counseling services within the UCPS are confidential.

- **Peak Performance**

Peak Performance services offer students a unique opportunity to improve concentration and develop skills that will enhance their academic, social, and/or athletic ability. Additionally, Peak Performance training helps individuals maximize their performance and minimize the negative effects of stress. This can be achieved via individual consulting or via workshops and training sessions offered in the center or where students are actually practicing and performing on campus.

- **Outreach Programming**

The UCPS provides programming focused on the developmental needs of college students—designed to enhance the capacity of students to maximize their personal, social, and academic potential. These presentations occur in various settings, including living residences, classrooms, athletic sites, and meeting rooms across the university. Topics may include issues related to race, eating and body image, sexuality, drinking and other drug use, study styles, athletic performance, grieving, stress, and relationships.

- **Assessment and Evaluation**

Upon request and when appropriate, UCPS personnel administer and use personality and career exploration instruments. They also utilize a wide variety of assessment tools when assisting groups and individual students.

- **Consultation Services**

Staff members provide consultative services to the university community with the objective of helping students, faculty and staff identify and resolve difficulties that may be exerting a negative effect on some individual, group, or system. This may include the use of referral resources within the university or in the local community.

- **Training**

One component of UCPS work is to help persons such as residence life staff, peer counselors, university personnel, student leaders, and faculty more effectively advise, counsel, interact and communicate with others. A second component is to enhance the development of persons specifically interested in

securing the identity and skills of a psychologist - these typically being advanced graduate students, doctoral level interns, and professional staff.

- **Advocacy**

Staff of the UCPS advocate for those students and groups who struggle for understanding and respect in a society sometimes blinded by traditional norms and expectations. Through dialogue, education, programming, consultation, and direct service, the staff is committed to being engaged with issues such as racism, sexism, and other practices that destroy self and group esteem.

### **Center for Academic Success: University Center 403**

Mastering time management, study skills appropriate for college level courses, as well as specific subject matter is imperative for academic success. The Center for Academic Success provides undergraduate and graduate tutors for most first and second year courses as well as study skills strategies and presentations to individual students and student groups. Center staff members work closely with other Academic Support Services to ensure that students are supported in their academic endeavors.

### **The Writing and Math Center: 110 Drown**

Success at Lehigh depends, in part, on mastery of a number of advanced academic skills. The Writing and Math Center supports these vital academic abilities, providing trained consultants in writing and math. The Center provides individual or small group tutoring for students enrolled in undergraduate math courses, and writing consultation in all areas for students and for the Lehigh community. Tutoring and consultations are provided by graduate students; the service is free of charge.

### **Career Services**

One function of a college education is to foster the growth and development of the student to prepare for a meaningful and satisfying life after college. Lehigh provides career planning services for undergraduate and graduate students as an integral part of the career development process.

Career planning can best be described as an educational process through which students

1. identify and develop their abilities, aptitudes, and interests;
2. learn the relationship between their capabilities and interests, their university experiences, and professional opportunities outside the university; and
3. prepare for those opportunities.

Career Services assists students through the process of researching targeted organizations that provide the types of work desired, interviewing for specific positions through which career or professional interests can be satisfied, and then selecting from the available options the one that best meets the student's needs. This part of the process requires students to develop skills in such areas as effective resume and cover letter writing, interviewing techniques, and individual job search strategies to enhance productive interactions with employers.

The goals of this process are: to enable Lehigh students to think of themselves as educated individuals with skills and abilities of value to employers; to think in terms of functional responsibilities rather than simply linking major subjects to jobs; to acquire and develop the skills necessary to become self-reliant and informed decision-makers; to prepare for a competitive job market; and to develop the potential to become self-reliant managers of their own careers.

The Office of Career Services is committed to the preparation and education of all Lehigh students during the transition from the academic environment to the work place. Career Services offers the following resources and services to help students prepare for professional opportunities after graduation:

### **Career Counseling**

Students may meet with professional counselors to discuss their career options and goals, individual job-search strategies, effective interviewing, and related interests. Self-assessment tools are available to assist students in identifying interests, skills and values.

### Career Services Ambassadors

Ambassadors are student volunteers who have applied and interviewed to be trained to provide career assistance to their peers. Ambassadors are available throughout the semester to students who walk in with quick questions regarding resume assistance, the LUCIE system, library resources, and general job searching help.

### Career Resources

Among the resources available in the Career Library are books and articles on career planning, current information on career opportunities, occupational information, graduate school resources, job search directories, a library of employer literature, and a database of alumni contacts who have volunteered to assist students with their job search strategies. Students may obtain our Career Planning Guide that describes how to use the on-campus interviewing system, prepare for interviews and plant/office visits, write resumes and cover letters, and develop individual strategies.

### Workshops and Special Programs

Throughout the year counselors conduct a variety of seminars and presentations in collaboration with academic departments, professional societies, and other interested campus organizations. Workshops are offered on resume writing, interviewing techniques, networking, career portfolios, job searching and internet strategies. Special programs are conducted each semester, including career panels and mini career classes.

### Experiential Education

Experiential Education programs are designed to enable Lehigh students to make educated decisions about career choices. Through participation in these programs, students gain firsthand knowledge and experience in a particular career field. Experiential Education programs include: internships, part-time positions, externships and cooperative education.

### On-Campus Interviewing

Career Services works with over 200 organizations that interview on campus each year. Students utilize web-based software called LUCIE (Lehigh University Career Information Exchange) to view job openings, apply for positions using an on-line resume and sign-up electronically for specific interview times. Employers interview undergraduate and graduate candidates from all four colleges. Each year the OCI program is kicked off by a Career Fair that showcases nearly 200 employers interested in recruiting Lehigh students.

### LUCIE

LUCIE is a searchable job listing database available on Career Service's Web Page at [www.lehigh.edu/careerservices](http://www.lehigh.edu/careerservices). Job openings for internships, full-time and advanced-level positions can be searched by employer, location, job function, or major. Undergraduates and graduate students from all four colleges will find listings related to their fields of study.

### Pre-professional Advising

The pre-professional advisor, along with a faculty advisory committee, provides information and guidance to candidates pursuing careers in medicine, dentistry, and other health professions, including individualized advising, special programs on health-related topics and field trips. In addition, information and assistance is provided for students interested in law school and legal careers.

The office is open throughout the year. The main phone number is (610)-758-3710 and the website is [www.lehigh.edu/careerservices](http://www.lehigh.edu/careerservices).

### Office of Fellowship Advising

The Office of Fellowship Advising (OFA) helps Lehigh undergraduates apply for competitive national fellowships and scholarships. It publicizes opportunities, oversees the selection of candidates for awards that require university nomination and, with the assistance of Fellowship Advisors, guides students through frequently complicated application procedures.

The OFA web-site (<http://www.lehigh.edu/~inofa/>) contains descriptions of a wide variety of fellowships and scholarships, with links to the foundations' official sites. The descriptions are divided into two categories. "Undergraduate Awards" are grants which students hold before taking their bachelor's degrees and, in a few cases, during the

summer following graduation. "Graduate Awards" are fellowships for which students apply either as seniors or as graduate students. Other sections of the site provide three types of information: the latest news and deadlines of the major awards; advice about how to present an effective application; and a compendium of publications, databases, and web-sites pertaining to awards in general.

Students who are interested in applying for awards and faculty members working with motivated, well-qualified students are encouraged to contact the OFA director, Richard Barsness ([rwb0@lehigh.edu](mailto:rwb0@lehigh.edu)), or [inofa@lehigh.edu](mailto:inofa@lehigh.edu).

### Office of International Affairs

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Dr. Mohamed S. El Aasser, Vice President for International Affairs and Professor of Chemical Engineering

<http://www.lehigh.edu/international/>

*To further globalize Lehigh's mission of advancing learning through the integration of teaching, research and service to others through a systematic and sustained engagement between the Lehigh Community and the World-At-Large.* (Mission Statement, Lehigh's International Portfolio, December 2009)

The Office of International Affairs is a new stem within university which was established July 2009. Its two overarching goals:

1. to further the internationalization of Lehigh's community and
2. expanding Lehigh's International footprint through sustainable faculty exchange programs, development of strategic partnerships with international academic institutions and through the involvement and expansion of the Lehigh's international alumni.

The establishment of the Office of International Affairs is a clear demonstration of Lehigh's commitment to these goals and aspirations. The office provides the leadership and services necessary for catalyzing meaningful interactions among numerous Lehigh constituencies, including faculty, students, staff, alumni, and potential collaborators around the world. The office also provides the necessary coordination for international activities at the university, ensuring a comprehensive and coordinated approach to current and new initiatives. The Office of International Affairs is made up of three directorates, Iacocca Institute, International Programs, and International Services. Below is additional information about the many programs contained in each of these areas.

### Iacocca Institute

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#### Iacocca Institute®

111 Research Drive; 758-6723

Richard Brandt, Director, Iacocca Institute and Director, Global Village; Trisha Alexy, Curriculum Director, Global Village; Mary Frances Schurtz-Leon, Candidate Manager, Global Village; Diana Q. Shepherd, Director, Pennsylvania School for Global Entrepreneurship. Iacocca Professors: S. David Wu, professor, industrial and systems engineering; Nada Sanders, professor, department of management; Peter Zeitler, professor, earth and environmental sciences; and Lee Kern, professor, education and human services.

Over the years, Lehigh University has developed an impressive ability to forge university-industry-government partnerships. These partnerships are critical not only to the future of universities but, also to improve U.S. competitiveness. It is primarily through partnerships — with companies, schools, government agencies and other universities — that the Iacocca Institute pursues its mission of preparing current and future leaders for a globally competitive marketplace. One of these partnering activities is the Global Village for Future Leaders of Business and Industry® (GV).

The Global Village provides young adults from around the world the chance to experience a total-immersion leadership program. Its purpose is to provide personal and organizational change needed to thrive in the emerging global economy. During the GV program, participants who share the dream of a leadership career in business and industry focus on developing knowledge of business and industry, enhancing leadership and entrepreneurial skills, and establishing a powerful global network. To date, more than 1660 interns representing 131 countries have graduated from the program and are now part of the growing list of GV alumni. GV participants are diverse in culture and background.

They represent students of undergraduate and graduate institutions, and managers from global corporations and family-owned businesses.

Global Village on the Move was established through a growing interest among our partner institutions to deliver the Global Village in their own countries, regions and territories. While GV is not a mobile program, the Iacocca Institute determined that shorter seven-to-ten day versions could be delivered in collaboration with existing recruitment partners outside of North America. Qualified partners will have visited and provided attendees to the GV flagship program. The opportunity to provide a collaborative immersion learning experience, cultural experience, and similar curriculum pattern in other countries has allowed us to work with partners in Peru 2000, Spain 2003, Australia 2005, United Arab Emirates 2006, Malaysia 2010, Peru 2011, and Italy 2012. Future programs are scheduled for China 2013, Russia 2014, India 2015 and Luxembourg 2016.

The Iacocca Institute fulfills its mission for leadership development of the next generation in the Pennsylvania School for Global Entrepreneurship (PSGE). PSGE is designed as a unique learning program to educate top high school students from the U.S. and around the world on global entrepreneurship. The four-week residential program focuses on challenging students as they develop greater cultural awareness and learn business practices with other students, faculty, and entrepreneurs. To date, PSGE has trained over 880 students from 57 countries and 9 states.

The Iacocca Institute was established in 1987 with the support of Lee A. Iacocca, former chairman and chief executive officer, Chrysler Corporation, and a member of Lehigh's Class of 1945.

For more information, contact Richard M. Brandt, Director, Iacocca Institute®, and Director, Global Village for Future Leaders of Business and Industry®, Iacocca Hall, Lehigh University, 111 Research Drive, Bethlehem, PA 18015.

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### Lehigh University's Fulbright Program Office

Bill Hunter, Director, International Outreach  
215 Coxe Hall, 32 Sayre Drive, Bethlehem, PA 18015-3123  
Phone: (610) 758-4505  
wdh3@lehigh.edu [www.lehigh.edu/~inglobal/](http://www.lehigh.edu/~inglobal/)

The Fulbright Program Office serves as a facilitator between the various Fulbright offices nationwide and the Lehigh faculty and graduate coordinators. In this capacity, the Office regularly publicizes scholarship opportunities for faculty seeking to research or lecture overseas. Conversely, the Office notifies Lehigh faculty of opportunities to host Fulbright Occasional Visiting Lecturers or Scholars in Residence on campus.

The Office also works directly with the Fulbright Placement Officers, encouraging them to send Fulbright student applications to Lehigh for consideration. Once admitted, the Office provides Fulbright students, as well as Fulbright Scholars coming to Lehigh, with orientation and assimilation programs, local familiarization tours, and coordinates the Fulbright Association on campus.

For more information, contact Bill Hunter at 610-758-4505 or [wdh3@lehigh.edu](mailto:wdh3@lehigh.edu) To learn more about Lehigh's commitment to the Fulbright Program, please visit the following web site: <http://www.lehigh.edu/fulbright/>

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### Global Union

Bill Hunter, Director, International Outreach  
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Phone: (610) 758-4505  
wdh3@lehigh.edu [www.lehigh.edu/~inglobal/](http://www.lehigh.edu/~inglobal/)

The Global Union, located in Coxe Hall Room 215, is a collaboration of more than 40 student clubs and organizations that promote global awareness and cultural understanding within the Lehigh community. Students involved in the Global Union hail from all corners of the globe, including nearly half from the United States.

The Global Union hosts panel discussions on world issues, one of the nation's largest International Education Week celebrations, dinners and cultural festivals, musical performances, and a language exchange

program. All events at the Global Union are free and open to the Lehigh community.

The Global Union lounge is open from Monday - Thursday from 4-10 p.m. for student meetings and program presentations. To reserve the space, click on: [http://www.lehigh.edu/~inglobal/lounge\\_reservations.html](http://www.lehigh.edu/~inglobal/lounge_reservations.html)

For more information regarding the Global Union, see the website at <http://www.lehigh.edu/~inglobal/>

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### International Internships

Carol S. Ham  
Director, International Internships  
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(610) 758-3467  
[csh205@lehigh.edu](mailto:csh205@lehigh.edu) [www.lehigh.edu/liiip](http://www.lehigh.edu/liiip)

#### International Internship for global leadership program

There are many opportunities for Lehigh University students to gain hands-on experience in an international setting. For a complete listing, please refer to the Study Abroad website (<http://www.lehigh.edu/%7Eincis>). Lehigh University's International Internship for Global Leadership Program, as referenced here, specifically relates to a program that provides students with fully-funded fellowships to participate in internship, research, or practicum experiences in organizations around the world. The program provides full-time, non-credit bearing experiences that run for six to twelve weeks over the summer, allowing for a true cultural immersion. For more information, please visit <http://lehigh.edu/intint/oiiai/>.

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### Lehigh University/United Nations Partnership

Bill Hunter, Director, International Outreach  
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Phone: (610) 758-4505  
[wdh3@lehigh.edu](mailto:wdh3@lehigh.edu) [www.lehigh.edu/~inglobal/](http://www.lehigh.edu/~inglobal/)

Lehigh University is the sixth university in the world to be certified as a Non-governmental Organization affiliated with the United Nations (UN) Department of Public Information. Through this partnership, Lehigh students, staff, and faculty attend private briefings with ambassadors and UN officials, take tours of UN headquarters, and attend conferences, workshops and symposia at the UN. Lehigh also hosts an Ambassadorial Speaker Series on campus and places one intern per semester at the UN.

For more information about the Lehigh University/United Nations Partnership, see the website at: <http://www.lehigh.edu/~inunited>

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### Study Abroad Office

Neil McGurty, Director; Katie Welsh Radande, Associate Director; Kaitie Brown, Advisor; Noel Panebianco, Advisor; Jodeen Gemmel, Coordinator; Karen Weaver, Administrative Clerk.

Coxe Hall, 32 Sayre Drive, Bethlehem, PA 18015. Phone (610) 758-3351; Fax (610) 758-5156; email: [studyabroad@lehigh.edu](mailto:studyabroad@lehigh.edu); [www.lehigh.edu/studyabroad](http://www.lehigh.edu/studyabroad); facebook: Lehigh Study Abroad.

Lehigh University recommends international study. We support programs that offer rigorous academic environments, immersion in host cultures, and opportunities for personal growth. Students should return to Lehigh with an enhanced ability to appreciate global concerns.

Every student who studies abroad has different reasons and goals.

High priorities for many students include developing sophisticated perspectives on global economic, social, and political issues, seeing the theoretical come to life in a real-world context, learning a new language, engaging with people and cultures different from their own, developing valuable career skills, and earning academic credit toward a Lehigh degree. Many students find that study abroad is a catalyst for intellectual and personal growth.

The Study Abroad Office conducts extensive advising activities, guiding students through the process of identifying programs that fit personal and academic goals; group and individual advising sessions take place regularly. Study Abroad options exist for all majors and can take place

Freshman through Senior year. Students should start discussing study abroad options with their academic advisor and the Study Abroad Office as early as Freshman year.

#### **Semester/Year**

Lehigh approves over 200 semester and year-long programs of academic study in over 60 countries. The programs are evaluated by faculty in order to ensure high academic quality and immersion in host cultures. Academic credit is given for programs approved by Lehigh faculty only. Students must receive a 'C' or better for credit to transfer.

Grades earned on semester and year programs are not factored into the student's GPA. Semester study abroad may include a combination of traditional coursework along with credit-bearing internships, research, or service learning.

#### **Summer and Winter Break Study Abroad**

Lehigh offers several faculty-led summer and winter (break) study abroad programs. Past programs have included: Business and Music in Belgium; Business in Prague; Microfinance Abroad in various locations; Art and Architecture in Vicenza; History in Paris; Internships and Language in Shanghai; Sustainable Development in Costa Rica; French and African Studies in Martinique; Architecture in Munich; Research Practicum in Ireland. Several programs include internship opportunities for credit in addition to coursework. Lehigh credit and grades are applied to a student's transcript and are factored into the student's GPA.

Lehigh University sponsors several six-week summer language programs in Europe through LVAIC, the Lehigh Valley Association of Independent Colleges. Credits and grades transfer to Lehigh and are factored into the student's GPA.

#### **Other International Experiences**

Lehigh offers other short-term international experiences such as International Internships, ServeAbroad Antigua, Choir, Engineers without Borders (EWB), Philharmonic, Interfaith Dialogue: Lehigh in Israel, Athletics Leadership in Croatia, and others.

To view all program options and begin planning for a Study Abroad Experience, visit [www.lehigh.edu/studyabroad](http://www.lehigh.edu/studyabroad).

### **Office of International Services**

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#### **English as a Second Language**

Program Director: Timothy Bonner

#### **Credit Instruction**

English as a Second Language (ESL) credit courses are offered to both undergraduates and graduates who wish to increase English proficiency in the areas of writing, reading, speaking, and presentation skills. All credit courses are at an advanced level of English study. For undergraduates, ENGL 003 and ENGL 005 are designed to supplement English department required courses, ENGL 001 and ENGL 002. Undergraduates can also take ENGL 015 for credit (see description below). Graduate students should contact their departments regarding acceptance of credit towards residency requirements. ESL credit courses are open to regularly enrolled students or General College Division students with placement or permission by ESL Director.

#### **StepUp Intensive English Program**

A non-credit intensive ESL program called StepUp is offered to intermediate to advanced ESL students who wish to study university/academic English in a challenging environment. This program is open to the general public. Contact the ESL program for information and a brochure or refer to our website, [www.lehigh.edu/~inesl](http://www.lehigh.edu/~inesl).

#### **International English Language Center (IELC)**

For ESL students who want to improve their ability to use and comprehend English on-campus and off-campus in formal and informal settings.

The ESL International English Language Center provides private English language tutoring for undergraduate and graduate international students and their spouses wanting to improve their speaking, listening, reading, writing and grammar, and test preparation for the SPEAK, TOPSS, TOEFL, GRE and GMAT.

The ESL Language Center is located in the ESL Department Office in Coxe Hall, Room 205. Contact the ESL office for more information: (610)

758-6099 or email [inesl@lehigh.edu](mailto:inesl@lehigh.edu). Also, please visit our website for online English assistance and information [www.lehigh.edu/~inesl](http://www.lehigh.edu/~inesl)

#### **English Testing for Teaching Assistants**

New Teaching Assistants must take the SPEAK test (or new TOPSS) prior to the beginning of their teaching semester (A TSE score of 55-60 is acceptable; however, please note that the TSE was discontinued as of March 31, 2010. TSE scores are valid for two years from the test date). Students who do not pass the SPEAK/TOPSS are not eligible for a TA position. Contact the ESL Office for an appointment upon arrival to campus. Refer to our website for additional information.

#### **The Freshman Composition Requirement**

The courses ENGL 003 and ENGL 005 (Composition and Literature for International Writers I and II,) may be applied towards the composition requirement for undergraduates. See the English department course listings for additional information.

#### **ESL Teacher Training**

In conjunction with the English Department, ESL offers ENGL 310 (Introduction to Theories and Methods of ESL Instruction) and ENGL 314 (ESL Teaching Practicum). See the Department course listings for descriptions. (These teaching courses can also be taken for graduate credit as part of the TESOL certificate in the College of Education.) For more information about English as a Second Language at Lehigh, refer to our web site at [www.lehigh.edu/~inesl](http://www.lehigh.edu/~inesl).

#### **English as a Second Language**

Timothy Bonner, Director  
205 Coxe Hall (32 Sayre Drive)  
Bethlehem, PA, 18015, (610) 758-6099  
[www.lehigh.edu/~inesl](http://www.lehigh.edu/~inesl)

The English as a Second Language Program (ESL) offers academic semester and summer courses for undergraduate and graduate students and their families. In addition, academic support is provided for ESL students through the IELC Language Center, conversation groups, and language enrichment courses.

#### **English Department Credit Courses**

After reviewing placement test results, undergraduates may be required to take ENGL 003 and ENGL 005 (Composition and Literature for International Writers I and II) in substitution for required ENGL 001 and ENGL 002 or ENGL 015 (Speech Communication for Intl. Speakers). Native English speaking or near native-speaking upperclass and graduate students who are interested in the ESL field as a career can get an introduction to teaching ESL/EFL in ENGL 310 and ENGL 314. (Refer to the English department course offerings.)

#### **ESL Program Credit Courses**

Both undergraduate and graduate students may select from a variety of supplemental ESL credit courses in conversation, listening, accent reduction, reading, and writing offered throughout the year. (Refer to the English as a Second Language course offerings.)

#### **StepUp Intensive English Non-credit Program**

The StepUp Program provides an intensive academic English experience for both enrolled Lehigh students and for other students preparing to enter a U.S. university or who need professional English skills for the workplace. StepUp enhances English skills in academic reading and writing and formal academic language, and provides an orientation to American university culture. For more information, view our website at [www.lehigh.edu/~inesl/StepUp](http://www.lehigh.edu/~inesl/StepUp)

#### **International English Language Center (IELC)**

The Language Center offers English language study through the use of interactive ESL software and private tutoring. Call the ESL Office or view the IELC program on our website.

### **International Students and Scholars Office**

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Gang Wang, 32 Sayre Drive, Coxe Hall, Bethlehem, PA, 18015-3123; (610) 758-4859. Fax (610) 758-5156. E-mail: [intnl@lehigh.edu](mailto:intnl@lehigh.edu). <http://www.lehigh.edu/~intnl/>

The International Students and Scholars Office (ISS) is a university-wide resource for students and scholars from abroad, and for U.S. students and faculty who are interested in the global focus. Its mission



is to provide support services for international students and scholars to ensure maximum opportunities for them to achieve their goals; be a resource to the faculty, staff and administration on issues related to international students and scholars, cross-cultural communication and diversity; support the University's efforts to internationalize the campus; and create an environment where the Lehigh community is exposed to a multitude of cultures, traditions and viewpoints by presenting internationally-focused academic, cultural and social programming.

#### **Services**

A variety of cross-cultural programs are initiated by the ISS, including undergraduate and graduate orientations, spouse conversation groups, seminars on immigration matters, international tax advising, Thanksgiving Dinner, the International Bazaar, monthly social programs, and The International Update Newsletter. Lehigh is a member institution of Phi Beta Delta, international honorary society.

The year for international students and scholars at Lehigh begins with the International Orientation. Orientation takes place in conjunction with other programs offered by the undergraduate admissions office and/or graduate departments, starting immediately before the university-wide orientation at the beginning of each semester. Orientation is strongly recommended for all new international students and scholars. Issues discussed include filing for a social security number, opening a banking account, health insurance, and adjustment to university life at Lehigh and to the United States. International Orientation is a time to become accustomed to life in America, and to meet other foreign students. Each person receives a Guidebook for International Students and Scholars.

#### **Additional Special Services for International Students**

##### **Career Services**

Advising and special workshops for careers for international students are provided.

##### **Food Service**

For undergraduate students on the meal plan, menus meet the international dietary needs of the students. There is a stir-fry bar and balanced meals for vegetarian diets.

##### **Health Center**

Fully staffed medical personnel meet both the physical and personal needs of all students. The Counseling Center has special services for international students.

##### **Immigration/Visa Advising**

Complete service is provided by ISS.

##### **Learning Center**

Free tutors are provided in writing, math and science.

##### **National Clubs**

Home country clubs from all regions of the world are established on campus. They form an important part of the cross-cultural dimension of the campus, providing social events, films, and international dialogue.

##### **Phi Beta Delta, International Honor Society**

Lehigh's Beta Pi chapter of Phi Beta Delta, the international honorary society with chapters across the U.S. and overseas, is an important international organization on campus. The purpose of the society is to honor those involved in high academic achievement and service in the international dimension, and to foster international exchange on campus. The honor society has three categories of membership: international students who have demonstrated high scholastic achievement at Lehigh; U.S. students who have demonstrated high scholastic achievement in the pursuit of international studies including study abroad; faculty and staff distinguished in international endeavors. Gisela M. Nansteel, Chapter Coordinator.

##### **Religious Services**

Services for all the major religions are on campus or nearby, including Muslim, Christian, Jewish, Hindu and Buddhist.

## **Special Academic Programs**

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### **Distance Education**

As a proven leader in distance education and innovation, Lehigh University's Office of Distance Education has been committed to providing graduate programs and certificates to working professionals

for over 20 years. Our programs emphasize academic excellence with a distinguished faculty, a shared community of learners, and superior curriculum. We are accredited by the Middle States Commission on Higher Education. Our distance program provides the student with the same level of educational excellence for which Lehigh University is renowned and strives to maintain the same level of quality of instruction and student service that is available to our on-campus students.

Through a unique approach to learning, we utilize two learning platforms for our programs, **Classroom LIVE**, an integrated, web-based virtual environment that delivers graduate programs in real time from classrooms on Lehigh's campus to students, in their homes, at their workplaces, or while traveling, and **Classroom Online**, an asynchronous online format that offers flexible scheduling and participation. To provide the best educational experience for our students, supplemental tools may be used, including podcasts, live web-based conferencing, shared applications, and use of Course Site, Lehigh's course management system.

We offer 10 graduate degrees in a variety of disciplines which include Biological Chemical Engineering, Chemistry, Chemical Engineering, Healthcare Systems Engineering, Management Science & Engineering, Manufacturing Systems Engineering, MBA, Mechanical Engineering, Molecular Biology, and Polymer Science & Engineering. We also offer 8 graduate certificates available either for Credit or Professional Continuing Education. They include Analytical Principles of Pharmaceutical Science, BioOrganic Principles of Pharmaceutical Science, Manufacturing Systems Engineering, Polymer Science & Engineering, Project Management, Quality Engineering, Regulatory Affairs, and Supply Chain Management.

For more information on programs and course offerings, admission, registration and technical requirements, visit the distance education website at [www.distance.lehigh.edu](http://www.distance.lehigh.edu) or call (610) 758-4372.

### **Summer Studies**

The Lehigh summer sessions program has been in existence for more than a century and is still a vibrant piece of the Lehigh experience. Opportunities abound at Lehigh in the summer with more than 200 diverse courses offered on campus, study abroad programs in exciting international locales such as Prague, Belgium, Shanghai, and Ireland, as well as a field camp in the Rocky Mountains. We also offer an ever-increasing array of web-based courses, ranging from basic subjects such as *Principles of Economics* and *Financial Accounting* to eclectic topics including *Beyond Google-Internet Research*, *Technical Writing for Engineers*, *Early American Scandals*, and *Sociology of Cyberspace*, just to name a few. In addition, there are many courses available, appropriate for rising high school seniors, allowing them to get a jump-start on their college career. For more information, visit the summer sessions website at [www.lehigh.edu/summer](http://www.lehigh.edu/summer), see us on Facebook at [www.facebook.com/LehighSummer](http://www.facebook.com/LehighSummer) (<http://www.facebook.com/LehighSummer>) call (610) 758-3966.

### **Continuing Education**

Lehigh University departments and research centers offer a varied selection of non-credit continuing education programs for adults. Reflecting Lehigh's traditional educational strengths, these offerings focus on professional development, organizational problem solving, and technical skills. They carry no regular academic credit, but participants can often earn some form of continuing education credentials.

Lehigh continuing education programs are designed to meet specific needs. Contents, schedules, and timing are adapted to effectively serve the audiences for which they have been developed. Apart from programs presented on the Lehigh campus, a number of seminars are available for "in-house" presentation to organizations on a contract basis. For more information about these programs, contact the appropriate department or research center.

## Undergraduate Studies

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A listing of undergraduate and graduate courses offered by Lehigh University can be found in the Courses, Programs, and Curricula section (p. 55), under each departmental heading. For purposes of record, all approved courses are listed. It must be understood, however, that the offerings in any given semester are contingent upon a number of factors, including student needs as determined at the time of registration.

### CREDIT HOURS

Each course is designated a credit value of the course in terms of semester hours ("credit hours").

### COURSE NUMBERING

The course numbering system specifies which courses can be applied to the program of study as the student progresses toward the undergraduate or graduate degree. In general, the numbering series is as follows:

- **0-99.** Courses primarily for freshmen or sophomores. Not available for graduate credit.
- **100-199.** Intermediate-level undergraduate courses. Not open to freshmen except on petition. Not available for graduate credit.
- **200-299.** Advanced undergraduate courses. Courses in the College of Business and Economics and specific departments as noted in the listings are open to freshmen and sophomores only on petition. Not available for graduate credit in the major field.
- **300-399.** Advanced undergraduate courses. Same as 200-299, but available for graduate credit in major field.
- **400-499.** Graduate-level courses, open to undergraduates only by petition.

### PROVISIONAL COURSES

Each instructional department is authorized to offer provisional courses, or those offered on a trial basis, as well as special opportunities courses. Such courses can become a permanent part of the university curriculum. These courses are numbered, as is appropriate, 95-98 . . . 195-198, . . . 295-298, . . . 395-398, for a maximum of two years.

### PREREQUISITES

Academic preparation required for admission to courses is indicated under "prerequisites" included at the end of each course description. Prerequisites are stated in most cases for purposes of convenience in terms of Lehigh courses. Academic status required for admission, where numbering does not fully describe this status, is also indicated under "prerequisites."

A student who does not have the status (e.g., sophomore standing) or the academic preparation set forth as prerequisites may request special consideration. A student may either obtain online permission from the designated college or department officer. Academic work completed elsewhere must be attested in this manner as being substantially equivalent to prerequisites listed. Each student is responsible to make sure they meet and maintain all conditions of prerequisite for their coursework prior to the start of classes. If a student fails to meet a prerequisite after registration for a given course, the college deans office, registrars office, and/or the instructor may take action to drop the student from a course with unmet prerequisites.

In a few cases, co-requisites are indicated. In such instances the co-requisite course is taken in the same semester.

### INFORMATION LIMITS

The course descriptions are intended to guide the student in selecting appropriate courses. For reasons of space, descriptions are brief. In most cases, courses will have a significantly broader scope than the topics listed in the description. In some courses, material may change from what is described. If there is doubt concerning the appropriateness of any course for the individual's educational objectives, it is suggested that the student confer with the adviser.

### ABBREVIATIONS

Whenever possible, course listings contain information indicating what requirements the course satisfies, the semester or semesters in which it is offered, and the name of the scheduled instructor or instructors.

While all information herein is subject to change, the information is included to serve as a guide in the selection of appropriate courses that best fulfill the student's academic requirements and personal goals.

The symbols following course descriptions for some College of Arts and Sciences courses include:

- GC.** Courses that meet the Global Citizenship program requirements.
- HU.** Courses that meet the Humanities distribution requirements.
- NS.** Courses that meet the Science distribution requirements.
- SS.** Courses that meet the Social Science distribution requirements.
- MA.** Courses that meet the Mathematical distribution requirements.
- ND.** Not designated to meet distribution requirements.

The symbols following course descriptions for some College of Engineering and Applied Science courses include:

- ES.** This code plus the following number indicates that the course satisfies a number of hours of engineering science requirements for ABET accreditation.

## Graduation Requirements

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Students are expected to maintain regular progress toward the baccalaureate degree by carrying the "normal" course load—between 12 and 18 credit hours each semester. Each student is expected to complete the baccalaureate degree by attending four consecutive years and eight semesters. They may, however, wish to accelerate the pace toward graduation by using advanced placement credits, summer session study, and receiving credit for courses through examination. Students will have a limit of 8 calendar years to complete the requirements for the bachelor's degree. Students may petition the Committee on Standing of Students (SOS) for up to a one-year leave of absence for special circumstances beyond their control.

Students in good academic standing earn their degrees by meeting the requirements of their specific degree curriculum as well as general university requirements. Students should confer with their advisors on matters related to curriculum.

Students are expected to satisfy the credit-hour requirements of their chosen curricula. Basic military science credit hours are in addition to the credit hours specified in the curricula. A maximum of six credit hours of advanced military science courses may be applied toward the baccalaureate degree.

## Undergraduate Residency Requirement

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To be eligible to receive a Lehigh baccalaureate degree, the candidate must have completed either a minimum of 90 credit hours in residence, or all of the last 30 credit hours at the University or in residency programs.

## Five-Year, Two-Bachelor-Degree Programs

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The university's five-year, two-degree programs enable a student to receive two bachelor degrees upon completion of five years of study.

The civil engineering and earth and environmental sciences program that affords two bachelor degrees, and the electrical engineering and engineering physics two-degree program are examples of programs in the College of Arts and Sciences and the P.C. Rossin College of Engineering and Applied Science.

Some five-year, two-degree programs appear in the description of courses under Arts-Engineering and Five-Year Programs. It is possible to arrange for a dual bachelor degree program even after studying at Lehigh for some time. Engineering students, for example, who decide at any stage of study that they wish to meet the requirements for both the bachelor of arts and bachelor of science degree may sometimes complete the combined requirements in five years if the decision is made before the third year.

Second degree candidates—A student entering Lehigh to obtain a second bachelor's degree, or those Lehigh students who wish to declare a second degree in another college, or both a B.A. and a B.S. degree within the College of Arts and Sciences must have a minimum of 30

additional credit hours beyond the first degree credit-hour requirements in order to qualify for the second degree. All of the 30 additional credit hours must be taken at Lehigh or in Lehigh residency programs. All special second degree programs must be approved by the dean of the college in which the degree is to be offered and the Standing of Students Committee.

Several ways exist for students to obtain two degrees in five years of study. See listings under ARTS-Engineering; Civil Engineering and Earth and Environmental Sciences; Electrical Engineering and Engineering Physics; and College of Education.

### Advisement

The academic advisor is one of the most valuable resources in the educational process, not only to assist in making academic selections to match the student's particular background, interests, and future objectives, but also to identify program options, to work out an academic pace, and to develop career planning strategies. The advisor will help to identify other resources and support systems available at the university, such as the Center for Academic Success, Counseling and Psychological Services, and Career Services.

Every undergraduate in the College of Arts and Sciences and the P.C. Rossin College of Engineering and Applied Science is assigned a faculty advisor upon matriculation. This advisor will usually change when the student selects a major or program.

Undeclared majors in the College of Business and Economics (CBE) are assigned to a professional advisor in the CBE Undergraduate Center for Student Advancement. When the major has been declared, a faculty member from the major department will be assigned as the academic advisor.

### Guide to Academic Rules and Regulations

The university has adopted over the years numerous rules and regulations. Some of the principal rules and regulations are given here so that currently enrolled and potential undergraduates and graduate students will be apprised of what is expected of them, and what they can expect of the university.

This section concerns academic regulations. Additional regulations can be found in the Lehigh Handbook, and there is a comprehensive statement of all policy in the publication Rules and Procedures of the Faculty. The most up-to-date version of the Student Handbook can be found online at <http://www.lehigh.edu/~indost/conduct/handbook/index.shtml>; the Rules and Procedures of the Faculty can be found online on the Provost's website.

### Eligibility for Degree

In order to be graduated, a candidate for a baccalaureate degree must achieve a minimum cumulative average of 2.00.

To be eligible for a degree, a student must not only have completed all of the scholastic requirements for the degree, but also must have paid all university fees, and in addition all bills for the rental of rooms in the residence halls or in other university housing facilities. Payment also must have been made for damage to university property or equipment, or for any other indebtedness for scholarship loans or for loans from trust funds administered by the university.

#### Responsibility for meeting academic requirements.

Each student is solely responsible for his or her progress toward meeting specific requirements for graduation. Academic advisers, department chairs and the associate deans staff are available to assist the student. It is strongly recommended that the student specifically consult with his or her adviser prior to the senior year to ascertain eligibility for the degree for which he or she desires to qualify and to determine that all program and hours requirements are met.

A student degree audit is available 24/7 via the online student information system for all undergraduate students. All students are recommended to go through this process before registering for each semester, including each in their senior year. The student degree audit will note all program deficiencies based on real-time academic history and current registration information.

#### Final date for completion of requirements.

For graduation, all requirements, scholastic and financial, must have been satisfied prior to the date stated in the university calendar.

### Application for Degree

Candidates for graduation on University Day in May must file with the registrar on or before February 1 a written notice of candidacy for the degree; candidates for graduation in September file a notice of candidacy on or before July 1; candidates for graduation in January file a notice of candidacy on or before October 1.

Failure to file such notice by such dates mentioned debar the candidate from receiving the degree at the ensuing graduation exercises. If a petition for late filing is granted, but before deadline to complete all requirements, a fee is assessed.

### Graduating Thesis

The original of the undergraduate thesis, when required, is accompanied by drawings and diagrams whenever the subject needs such illustration. The original is kept by the university, as a part of the student's record, for future reference; but copies may be retained by students and may be published, provided permission has first been obtained from the faculty.

### Undergraduate Credit and Grades

A "semester hour," used interchangeably with "credit hour," is a course unit normally involving three to four hours of student effort per week during one semester. This includes both in-class contact hours and out-of-class activities. The major parameters influencing the in-class/out-of-class division include the mode of instruction and the level of the course.

### Definitions of Grades

Course grades are A, A-, B+, B, B-, C+, C, C-, D+, D, D-, P, F, N, X and Z. The meaning of each grade is as follows: A, A-, excellent; B+, B, and B-, good; C+ and C, competent; C-, continuation competency (the student has achieved the level of proficiency needed for the course to satisfy prerequisite requirements); D+, D, and D-, passing, but performance is not adequate to take any subsequent course which has this course as a prerequisite. The student must petition to waive a prerequisite. Upon presentation of evidence of substantially equivalent preparation and with the approval of the instructor of the course, the teaching department chair and the chair of the major department, the prerequisite will be waived. P, pass-fail grading with a grade equivalent to D- or higher; F, failing; N, incomplete; X, absent from the final examination; Z, absent from the final examination and incomplete.

Other symbols used for courses on student records are: Cr, credit allowed; NCR – no credit; W, withdrawn; WP, withdrawn with permission and with passing performance at the time of withdrawal; WF, withdrawn beyond the deadline and/or with failing performance.

Grades in the range of A through D-, P, and Cr may be credited toward baccalaureate degrees within the limits of program requirements. Grades of F, N, X, Z, W, WP, and WF cannot be credited toward the degree. Grades of W and WP do not count as hours attempted.

Courses in which grades of D+,D, D-,F, NCR, W, WF, N, X, or Z are recorded do not meet prerequisite requirements.

The grade N (grade) may be used to indicate that one or more course requirements (e.g., course report) have not been completed. It is the obligation of the student to explain to the satisfaction of the instructor that there are extenuating circumstances (e.g., illness or emergency) that justify the use of the N grade. If the instructor feels the N grade is justified, he or she assigns a grade of N supplemented by a parenthetical letter grade, (e.g., NA9). In such cases, the instructor calculates the parenthetical grade by assigning an F (or zero score) for any incomplete work unless he or she has informed the class in writing at the beginning of the course of a substitute method for determining the default grade.

In each case in which an N grade is given, the course instructor will provide written notification to the department chairperson stating the name of the student receiving the grade, the reason for the incomplete

work, the work to be done for the removal of the N grade and the grade for the work already completed.

A student who incurs an N grade in any course is required to complete the work for the course by the fifth day of instruction in the next regular semester. The N grade will be converted into the parenthetical grade after the tenth day of instruction in the next regular semester following receipt of the N grade unless the instructor has previously changed the grade using the removal-of-incomplete procedure. The parenthetical grade will be dropped from the transcript after the assignment of the course grade.

In no case shall the grade N be used to report absence from a final examination when all other course requirements have been met.

N grades do not count as hours attempted and are not used in computations of cumulative averages.

The grade X (grade) is used to indicate absence from the final examination when all other course requirements have been met. The grade in parentheses is determined by including in the grade calculation an F (or zero score) for the missing final exam. The X grade may be removed by a make-up examination if the absence was for good cause (e.g., illness or other emergency). To be eligible for the make-up exam, the student must file a petition and the petition must be approved by the Committee on the Standing of Students. If the student fails to petition, or if the petition is not granted, or if the student fails to appear for the scheduled make-up examination, then the X grade will be converted into the parenthetical grade after the first scheduled make-up examination following the receipt of the X grade. If the petition is granted and the final examination is taken, the X grade will be changed by the instructor using the make-up examination procedures and the parenthetical grade will be dropped from the transcript.

Where valid reasons exist for not taking the make-up examination at the scheduled time, the student may petition for a later examination with a fee. A student's grade that was originally assigned an N, X, or Z grade when converted or computed will be noted with an "\*" asterisk prefix.

The grade Z (grade) is used to indicate both absence from the final examination and incompleteness of one or more course requirements. The instructor calculates the parenthetical grade using an F (or zero score) for the final examination and either an F (or zero score) or the substitute method of calculation as described above for the incomplete work.

The Z grade may be removed by the procedures presented in the previous paragraph for removing the X grade. If this results in an N grade because the course work is still incomplete, the provisional Incomplete (N grade) above shall apply, except that in no case shall the deadline for completion of the work be later than the last day of classes in the first full semester in residence (except summer) following receipt of the Z grade.

X and Z grades do not count as hours attempted and are not used in computations of cumulative averages.

Where failure to complete coursework prevents the student from taking the make-up examination at the scheduled time, the student may petition the Committee on the Standing of Students for a later examination.

A Z grade that is still outstanding after the tenth day of instruction in the next academic-year semester following receipt of the Z grade will be converted into the parenthetical grade. The parenthetical grade will be dropped from the transcript.

### Scholastic Averages and Probation

Scholastic requirements for undergraduate students are expressed in terms of the cumulative grade point average (GPA)—the weighted average of all grades received in residence or at institutions specifically approved for grade transfer. The cumulative GPA is computed at the end of each semester and the second summer session. Following are the cumulative GPA requirements for good standing:

freshmen to 22 earned credits	1.70
sophomores 23 to 51 earned credits	1.80
juniors and seniors with 52 or more earned credits	2.00

For computational purposes students who have completed 22 or fewer earned hours shall be required to achieve a 1.70 cumulative grade point

average. Students who have completed 23 but fewer than 52 earned hours at the end of the most recent graded term shall be required to achieve a 1.80 cumulative grade point average. Students who have completed more than 53 earned hours at the end of the most recent graded term shall be required to achieve a 2.00 cumulative grade point average.

Other undergraduates including all General College Division, Lehigh Valley Association of Independent College cross registered students, high school scholars and R.O.T.C. students will be required to achieve a 2.0 cumulative grade point average – the minimum average required for graduation – to remain in good academic standing.

Any undergraduate student who achieves a 1.69 or lower cumulative grade point average in a given term is eligible to be reviewed by and may be placed on probation or dropped for poor scholarship at the discretion of the Committee on the Standing of Students.

Students who do not meet the above requirements will be placed on scholastic probation. Students who, regardless of their cumulative averages, have failed more than eight hours of course work in any semester are also placed on scholastic probation.

While there is no specific credit hour requirement for good standing, certain categories of students (e.g., those on financial aid and those playing intercollegiate athletics) will be expected to maintain whatever hours are required for eligibility.

#### Removal from probation

Students are removed from probation at such time as they meet the standard listed above, effective at the end of any semester or the second summer session.

#### Dropped for poor scholarship

A student who makes a 2.2 GPA or better in the probationary semester but fails to meet the standards stipulated is continued on probation for another semester. A student who makes less than a 2.2 GPA in the probationary semester and fails to meet the standards stipulated above, is dropped for poor scholarship.

If a student goes on scholastic probation for a second (although not necessarily consecutive) term, a review by the Committee on the Standing of Students will determine whether the student will continue on scholastic probation or be dropped for poor scholarship.

### Course Withdrawal

A student dropping a course within the first ten days of the semester (five days for summer sessions) will have no record of the course on the transcript. A student dropping all courses for which he or she is registered is considered to be withdrawn from the university (p. 28).

A student who withdraws from a course with the approval of his/her advisor and section instructor after the tenth day of instruction and before the end of the eleventh week of instruction will have a grade of "W" assigned to the course.

A student who withdraws from a course with the approval of his/her advisor and section instructor after the eleventh week of instruction and before the end of classes receives a "WP" or "WF" at the discretion of the instructor. A "WF" is considered to be a failing grade.

An Add/Drop form signed by the student's advisor must be submitted to the registrar's office, before the deadlines noted above, to be official. No course may be dropped after the last day of classes during a term as noted on the University Calendar.

### University Withdrawal

A student withdrawing from the university (dropping all courses during a given term) must submit the withdrawal form to the dean of students office. Withdrawal after registration day and during the first 11 weeks of instruction will be noted on the academic transcript by assigning a grade of "W" to all courses. A withdrawal after the eleventh week of instruction and before the end of classes will have the grade of "WP" or "WF" assigned for each course at the discretion of the instructor. The date of the withdrawal will be noted on the academic transcript for a withdrawal at any time during the term.

A student who reduces his or her course load below the minimum required for standing as a full-time student, but does not withdraw from the university, becomes a part-time student for the rest of that semester. Some areas affected by part-time status are financial aid, athletic eligibility, veterans affairs, immigration status, insurance and loan deferment.

## Undergraduate Leave of Absence

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### Undergraduate Leave of Absence

Each student is expected to complete the baccalaureate degree by attending Lehigh for four consecutive academic years. Once a student that has matriculated at Lehigh chooses to deviate from this attendance pattern a revised degree plan, coordinated with his or her adviser and associate dean, must be submitted with a request for a leave by completing a petition to the SOS Committee for an Academic Leave of Absence. Petitions are available from the Registrar's Office or the Dean of Students. The form must be signed by the student's faculty adviser, associate dean of the college and the completed form must be submitted prior to the start of any subsequent enrollment at another college or university.

Current Lehigh University students are prohibited from concurrent enrollment at any other college or university. Courses taken concurrently will not be eligible to apply towards a Lehigh degree. An exception is made for cross registration at another LVAIC institution.

Special opportunity programs like the American University Internship, Hope College Urban Semester and the Institute for Shipboard Education (affiliated with another university), University of Virginia Semester at Sea, Georgetown Washington Semester have limited access to Lehigh University students. For procedures concerning application for these programs please see the Associate Dean of Students for Academic Support.

Students can not assume that a leave will be granted to study at another college or university (this policy does not apply for study abroad through the auspices of Lehigh Abroad or LVAIC programs). The program of study and reason for the leave must be approved by the SOS committee.

If unapproved leaves are taken, students are declared as non returning and must apply for readmission to the University through the SOS committee if they wish to re-enroll. Courses taken at another college or university while on an unapproved leave will not be permitted to transfer toward a Lehigh University baccalaureate degree.

In addition, students taking an unauthorized leave of absence must be aware that their eligibility for student aid is jeopardized.

Any student who is uncertain about attending a future fall or spring term at Lehigh University is urged to discuss the matter with the Dean of Students Office or the Registrar prior to taking any action to withdraw or attend another college or university.

Students may take courses at another institution during a summer term without requesting an academic leave of absence. Check with the Registrar's Office for limitations and processes for transfer course approval.

## Release of Final Grades

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Grades for undergraduate students are available online as soon as possible following the deadline for reporting of grades online using the Banner Student Information System. Undergraduates students who require a printed grade report must submit the request in writing to the Registrar's Office each term. Instructors may develop their own policies for release of unofficial reports of academic progress to individual students, or to their advisers, deans, or financial aid officers, on a need-to-know basis, including early release of unofficial final course grades. Any such policies must respect the rights of students to privacy.

## Repeating of Courses

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If a course is repeated, the final grade received upon repetition of the course is counted in the cumulative average. The original grade and associated credit hours received will be excluded from the cumulative average.

A grade that was originally received in a course may not be changed by repeating the course under the pass-fail option.

Students repeating a course that has been graded C or better may not overload (greater than eighteen credits) during that term. For deletion of a grade from the cumulative average after repeating a course, a student must:

1. file the deletion form with the registrar's office; and
2. repeat the identical course with a final grade at Lehigh

All instances of repeated courses are displayed on the student's academic transcript regardless of repeated status.

## Pass-Fail Systems for Undergraduates

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### Student Option System

The pass-fail grading option is intended to encourage undergraduate students to take challenging courses outside the major field that otherwise might be avoided for fear of lowering grade-point averages. Students are not permitted to take courses numbered below 100 and over 400 using the optional pass/fail grading system and should avoid wasting this option on unsuitable courses, such as courses having no college-level prerequisite or corequisite. The restrictions on the use of the system are listed below.

A student may register for no more than one course pass-fail numbered above 100 and below 400 in any one semester. Students should check the pass/fail restrictions for specific courses. He or she may take a maximum of six courses pass-fail per undergraduate career if the student is on a four-year program, or a maximum of eight courses per undergraduate career with a five-year, two-degree program. If a student changes a course after the first ten days of instruction from pass-fail grading to regular grading, as provided below, that course shall still count toward the maximum number of courses taken pass-fail during the student's undergraduate career.

Each college faculty shall decide under what conditions and which courses or categories of courses throughout the university may be taken for pass-fail credit by students registered in that college, except for courses designated specifically for pass-fail grading. Each college shall keep the educational policy committee advised of changes in its rules.

A student designates the course(s) to be taken pass-fail normally at preregistration but not later than the fifteenth day of instruction in a regular semester or the fifth day of instruction in any summer session. Prior to this deadline, the student may transfer from pass-fail to regular grading, or vice-versa, without penalty. The courses designated for pass-fail grading by the student require the written acknowledgment of the academic adviser.

Since the instructor giving the course is not officially notified which students are taking the course pass-fail, a regular letter grade is reported to the Registrar for the pass-fail students. The Registrar then records "P" for reported letter grades from A through D-, and "F" for a reported letter grade of F.

Under this system, the student surrenders his or her equity to letter grades of A through D-, except as specified below. A grade of P applies to the student's graduation requirements but is not used in the computation of the cumulative average; whereas an F grade is included in the cumulative grade point average.

If a student changes his or her program such that a course previously taken for pass-fail grading is not allowed for pass-fail grading in the new program, the student must submit a petition to the Committee on the Standing of Students requesting acceptance by the new program of the pass-fail grading for that course, or substitution of the original letter grade submitted by the instructor for the pass-fail grade, or the substitution of another course for the course taken pass-fail. The recommendation of the adviser must accompany the petition.

## Transfer Credit

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Transfer of credit from other institutions is the responsibility of the Registrar. Any students planning to take work at other institutions in the United States or elsewhere should initially check with the registrar's office on policies and procedures. Full time students may not be concurrently enrolled at any other institution, except for the LVAIC

Consortium cross registered courses, without the advanced approval of the Committee on Standing of Students. Transfer of grades from institutions other than the LVAIC System is not possible.

- Pass/Fail credit/non-credit courses are not acceptable for transfer.
- Courses taken at a two year or four year institution where a grade lower than a "C" has been earned will not transfer. ("C-" or below will not transfer)
- Transfer courses may not be used to delete a prior grade from one's cumulative grade point average at Lehigh University. Transfer grades are NOT calculated in the Lehigh GPA.
- No student may receive more credit at Lehigh than was granted at the original institution. Courses taken on the quarter system will have credit granted on a 3-2 ratio, no partial credit will be awarded. The student will receive credit equivalent to the number of credits indicated on the transcript, up to the number of credits for the equivalent course at Lehigh. The registrar has the final authority for the amount of credit awarded toward a Lehigh degree.
- No credit will be granted for a course in which the student has already received credit for its equivalent at Lehigh.
- No credit will be granted for continuing education units courses, courses taken on-line, January or intercession courses, correspondence, independent study or any course less than 5 weeks and/or 15 contact hours per credit without the advanced approval of a petition to the Standing of Students Committee.
- Courses taken while in high school may require additional documentation. All questions should be directed to the registrar's office designee in charge of transfer credit. Please check the registrar's office homepage for a staff directory.
- Courses must be taken at an institution that is accredited by one of the six regional associations.

## Course Auditing

A student who is in good academic standing and has not failed any courses in the previous term may be admitted as an auditor in not more than one course, which shall be outside the curriculum requirements. Application for such admission is by petition approved by the departmental chair and the Standing of Students Committee. In no case shall a student who has attended a course as an auditor be given an anticipatory examination for credit or register for the same course in the future. A student completing a course in this manner will have the course and the notation AU indicated on the permanent record. A student rostered on an audit basis may be withdrawn from the course with a grade of W for poor attendance. Audit courses do not count toward full-time status.

## Review-Consultation-Study Period

The Review-Consultation-Study (RCS) period is intended to provide a period of time for informal academic work between the end of the formal instruction period and the beginning of the final examinations.

It is expected that students will use this period to consolidate their command of the material in their courses. Faculty members make themselves available to their students at announced times during this period.

No quiz or exam may be given during the last five class days before final examination period begins and the RCS period.

## Graduation Honors

Beginning with all new degree seeking students in the Fall of 2004 or any students graduating in the Spring of 2008, degrees with honors are awarded by vote of the university faculty to those students who have attained an average of not less than 3.40 in a minimum of 90 credit hours in residence at Lehigh University or in programs approved by the faculty to have grades and credit accepted toward the undergraduate degree.

Degrees with high honors are awarded by vote of the university faculty to those students who have attained an average of not less than 3.60 in a minimum of 90 credit hours in residence at Lehigh University or in

programs approved by the faculty to have grades and credit accepted toward the undergraduate degree.

Degrees with highest honors are awarded by vote of the university faculty to those students who have attained an average of not less than 3.80 in a minimum of 90 credit hours in residence at Lehigh University or in programs approved by the faculty to have grades and credit accepted toward the undergraduate degree.

For the purposes of graduation honors calculations, courses taken more than once at Lehigh will only have the most recent grade used in the calculation. Courses taken under the cross-registration policy of the LVAIC, the Washington Semester and the Urban Studies semester program will be used.

Students who spend part of their career at another institution, or are transfer admits to degree programs and have fewer than ninety hours of in residency courses, may qualify for graduation honors under the following conditions:

The student must have at least sixty credit hours of regularly graded (not pass/fail) courses that meet the residency requirement. The graduation honors category is determined by the lower of the two averages computed as follows:

1. the average of grades received at Lehigh;
2. the average of all grades received at Lehigh and grades for courses taken elsewhere for a regular grade and that are appropriate to be considered for transfer to Lehigh, or in provisionally approved study abroad programs.

## Department Honors

Many departments offer honors work adapted to its curriculum for students who wish to demonstrate unusual academic ability and interest in exploring a chosen field through independent study and research. The precise nature of the program for each student is determined by the academic major department, but may include: unscheduled work or independent study, participation in graduate (400-level) courses, and an honors thesis or project.

Qualified candidates should inform their academic advisers by the end of the junior year of their intention to work for departmental honors. The adviser will give the college and the registrar names of graduating seniors working for departmental honors in particular majors. Names of students graduating which have attained departmental honors are published in the commencement program.

## Honor Societies

There are at least 18 honor and course societies. The three best-known are:

**Phi Beta Kappa.** The oldest honor society in the United States is represented at Lehigh by the Beta chapter of the Commonwealth of Pennsylvania, the 27th oldest chapter in the nation. The chapter's council considers for invitation into its membership those students in each of Lehigh's three undergraduate colleges who satisfy the following profile:

- At least 60 credit hours of coursework completed at Lehigh
- A minimum cumulative GPA of 3.75
- A minimum of 8 credit hours in the natural sciences (including a lab)
- A minimum of 8 credit hours in the social sciences
- A minimum of 8 credit hours in the humanities, especially textual analysis beyond first-year English (the council typically *does not recognize* some courses that carry Humanities credit at Lehigh, such as Public Speaking, Stage Design, one-credit Music lessons, etc.)
- Calculus or advanced mathematics that requires calculus as a prerequisite
- Two years of college-level foreign language study or its equivalent (may be satisfied by four years [9-12] of high school study with excellent grades)
- No disciplinary violations sufficient to warrant probation, suspension, or expulsion

Please note: Satisfaction of this profile guarantees consideration by the Phi Beta Kappa council; it does not guarantee election to Phi Beta Kappa. Any undergraduate who has questions about any of the items in this profile should contact Prof. Scott Gordon, Executive Secretary of Lehigh's chapter. Office phone: 610-758-3307; e-mail: spg4@lehigh.edu

**Beta Gamma Sigma.** Election to membership in Beta Gamma Sigma is the highest scholastic honor that a student in business administration can achieve. Beta Gamma Sigma is the only national honorary scholarship society in the field of business administration recognized by The Association to Advance Collegiate Schools of Business.

**Tau Beta Pi.** Tau Beta Pi recognizes engineering students who have a history of distinguished scholarship and exemplary character. The national organization was founded at Lehigh in 1885. A bronze marker in front of Packard Lab commemorates this event.

Among course societies are the following: Alpha Pi Mu, for those in industrial engineering; Alpha Sigma Mu, materials science and engineering (<http://www.alphasigmamu.org/>). Beta Alpha Psi, accounting; Chi Epsilon, civil engineering; Eta Kappa Nu, electrical engineering; Lambda Mu Sigma, marketing; Omicron Delta Epsilon, economics; Omicron Delta Kappa, leadership; Order of the Omega, leadership in Greek activities; Phi Alpha Theta, history; Phi Beta Delta, international; Phi Eta Sigma, freshman scholastic excellence; Pi Tau Sigma, mechanical engineering; Psi Chi, psychology; Sigma Tau Delta, English; and Sigma Xi, research.

### Special Undergraduate Academic Opportunities

The academic programs in the colleges are supplemented by five-year, two-degree programs as well as opportunities for advanced, foreign, and experiential study.

#### Arts-Engineering Option

The curriculum in arts-engineering is designed for students wanting a professional education in a field of engineering and also the opportunity to study a second field.

Arts-engineers fulfill all requirements for the professional engineering degree for which they are working. However, the first three years of science and engineering courses are scheduled over four years for the arts-engineer. During this period the arts-engineer is a student in the College of Arts and Science pursuing a bachelor of arts or bachelor of science major program.

In many instances it may be advisable to take the two degrees at the end of the fifth year. Arts-engineers working towards the bachelor of science in biology, computer science, environmental science, geological sciences, geophysics, molecular biology, and statistics are advised to pay special attention to the engineering humanities and social science requirements, which must be met in time for the student to qualify for the B.S. in engineering.

Arts-engineers have the same opportunities for multiple majors and special interdisciplinary majors as are available to students working for the baccalaureate (B.S. or B.A. degree only) in the College of Arts and Sciences. Additional information may be obtained by contacting Prof. Bruce Thomas, Art and Architecture, Chandler-Ullmann.

#### Bachelor/Master Degree Programs

Of increasing interest to undergraduates are the two-degree programs that may lead to both a bachelor and a master's degree in five years. The fifth-year program in the School of Education enables those receiving a B.A. or B.S. degree to accomplish professional teacher training and serve as salaried interns in public schools. After the completion of one year of full-time teaching, secondary teachers can receive the master of arts and elementary teachers can receive master of education degrees.

Many other five-year, graduate-level combination programs exist, and students are advised to consult with their adviser in planning such programs. All students receiving masters degrees must be registered as full time degree graduate students for at least one full term.

### Apprentice Teaching

The apprentice teaching program is designed to benefit juniors and seniors who wish to learn about teaching under the guidance of

an experienced teacher. Apprentices often do a limited amount of supervised lecturing or leading of discussions, assist in making up and evaluating written assignments, and are available for individual consultation with students.

To participate in the apprentice teaching program a student must:

1. Have an over-all cumulative grade point average of 2.80 or better;
2. Have a cumulative major grade point average of at least 3.3 and have completed at least two courses in the major field in which apprentice teaching is done;
3. Have previously taken for credit the course or its equivalent in which the apprentice teaching will be done;
4. Or meet the guidelines on file in each college dean's office.

A student may register for apprentice teaching only once each semester, only once in a given course, and only twice during a college career.

To register for apprentice teaching each student-teacher partnership will submit an apprentice teaching agreement, indicating the duties and obligations for approval to the department chair and the dean of the student's college in which the course is taken. This form must be submitted to the registrar before the first day of classes in the semester. To complete the course, the apprentice teachers must submit a written report of their experience to the supervising teacher, who will forward it to the Office of the Provost.

### Experiential Learning

The accommodation of student interest extends beyond regular departmental offerings. Hands-on experiences in learning enrich classroom instruction. Each of the three colleges offers a number of such experiences to undergraduates. Among them:

#### The Philadelphia Urban Semester

Undergraduates in all fields of study can earn 16 Lehigh credit hours by spending a semester studying in the nation's fourth-largest metropolis. They live, work, and study with other students from two dozen other institutions, supervised by faculty of the Great Lakes Colleges Association. This consortium of such leading Midwestern institutions as DePauw, Kenyon, Oberlin, and Wooster is a recognized leader in providing extra-mural academic programs both here and abroad.

The curriculum consists of two four-credit seminars and an eight-credit internship. All students are enrolled in a core "Seminar on the City" which introduces them to the field of urban affairs and to Philadelphia. The second seminar is elected from a half-dozen more specialized urban topics; recent choices available have included "Folklore in Philadelphia," "Art in the City" (which met each week at a different site), and "Justice." Internships involve working four days weekly in a public or private placement which tests the student's aptitude in a variety of practical ways while enhancing appreciation of city life.

#### The Washington Semester

Opportunity is available each year for six juniors or seniors to spend a term studying in Washington, D.C., in cooperation with American University. Lehigh University is a member with 180 other colleges and universities.

Students enroll at Lehigh but spend the semester in residence at American University with the students from other participating colleges.

The curriculum consists of national-government seminars, an internship, and a written research project. Besides the national government program, the student may choose other program offerings such as economic policy semester, journalism, public administration, foreign policy semester and justice semester.

#### Inspection trips

The location of the university in the center of industrial activities of various types affords unusual opportunities for visits to manufacturing plants. Inspection trips to individual plants are a required part of specific courses in various engineering curricula. Written reports may be required. These trips are generally held during the senior year and involve an average expense of \$25 to \$50.

## English as a Second Language

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Timothy Bonner, Director  
205 Coxe Hall (32 Sayre Drive)  
Bethlehem, PA, 18015, (610) 758-6099  
www.lehigh.edu/~inesl

The English as a Second Language Program (ESL) offers academic semester and summer courses for undergraduate and graduate students and their families. In addition, academic support is provided for ESL students through the IELC Language Center, conversation groups, and language enrichment courses.

### English Department Credit Courses

After reviewing placement test results, undergraduates may be required to take ENGL 003 and ENGL 005 (Composition and Literature for International Writers I and II) in substitution for required ENGL 001 and ENGL 002 or ENGL 015 (Speech Communication for Intl. Speakers). Native English speaking or near native-speaking upperclass and graduate students who are interested in the ESL field as a career can get an introduction to teaching ESL/EFL in ENGL 310 and ENGL 314. (Refer to the English department course offerings.)

### ESL Program Credit Courses

Both undergraduate and graduate students may select from a variety of supplemental ESL credit courses in conversation, listening, accent reduction, reading, and writing offered throughout the year. (Refer to the English as a Second Language course offerings.)

### StepUp Intensive English Non-credit Program

The StepUp Program provides an intensive academic English experience for both enrolled Lehigh students and for other students preparing to enter a U.S. university or who need professional English skills for the workplace. StepUp enhances English skills in academic reading and writing and formal academic language, and provides an orientation to American university culture. For more information, view our website at [www.lehigh.edu/~inesl/StepUp](http://www.lehigh.edu/~inesl/StepUp)

### International English Language Center (IELC)

The Language Center offers English language study through the use of interactive ESL software and private tutoring. Call the ESL Office or view the IELC program on our website.

### Credit by Examination

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Upon petition and presentation of evidence that he or she has qualified for it, a student already enrolled at Lehigh may be permitted by the standing of students committee to take a special examination for credit towards graduation. Special examinations are granted only for extraordinary reasons and upon petition. There must be adequate supporting evidence of sufficient cause accompanying each petition. There is a fee for all special examinations.

Students taking a special exam after matriculation at Lehigh will have the grade and credits assigned to their permanent Lehigh record. Special exam credit will be counted as in residence credit and the grade will be used in all grade point average calculations. No special exam will be granted in a course that the student has already taken (except senior reexaminations) for credit or on an audit basis, or in a course in which the student has already completed more advanced work at Lehigh.

### Preparation for Graduate Work

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Students planning to continue in graduate programs should take advantage of the flexibility in many undergraduate programs to design an upper-division curriculum that meets requirements in the anticipated graduate program.

The policies of the colleges provides as much flexibility as possible for students who wish to change to new but related fields of study after the baccalaureate degree. Students should consult with their previous program adviser and the department representative of the new field to establish an academic program that will remedy any deficiencies in background.

### Graduate Courses

Qualified undergraduates may petition the graduate committee to register for 400-level courses if they are certified by the course instructor and the department chairperson concerned.

### Guidelines for Undergraduates to Take Graduate Level Courses

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1. No undergraduate student may take 400-level courses during a term where the student's total credits are greater than 18 (including audits).
2. All students receiving a graduate degree must be enrolled one full semester or summer as a regular student prior to the awarding of a graduate degree.
3. An undergraduate student may use no more than 12 credits taken as an undergraduate toward a graduate degree. These courses must be at the 300 and 400 level and beyond all undergraduate degree requirements.
4. Students should have achieved junior standing and a grade point average of 3.0 to take 400 level courses.
5. Students must petition the Standing of Graduate Students and the Standing of Students for permission.
6. Students requesting a second graduate level course in a given term must petition the Standing of Graduate students committee. (Students should not expect to take a second graduate level course if enrolled for more than 15 credits.)

### Curricular Flexibility

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Choice is a regular part of university life, and encompasses the determination of a college and major, the selection of courses each term, and the development of life goals and career options.

Many of these choices are academic in nature. The undergraduate curricula are flexible, designed to accommodate the changing interests and needs of students. Boundaries between colleges are as fluid as possible to provide many options in an educational program. For instance, students may take a bachelor of science (B.S.) degree in the College of Business and Economics or the College of Engineering and Applied Science with a minor in journalism in the College of Arts and Sciences. There are five-year programs for which degrees are awarded in two colleges.

Transfers between undergraduate colleges is permitted but only after the freshman year. Students considering such a transfer must confer with their advisers to begin the process.

To provide additional flexibility and encourage student initiative and depth of investigation, the university has developed academic alternatives including the following:

### Provisional Courses

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Departments may introduce provisional courses temporarily within a semester, either experimentally or as a response to a contemporary social or scientific issue. If successful, a course may become part of the regular curriculum. Such courses, identified with a 95, 96, 97 or 98 number (preceded by a 1, 2, or 3 indicating level) may sometimes take provisional courses numbered above 100 on a pass/fail basis.

### Pass/Fail Option

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Undergraduate students have the opportunity to study in areas without concern for possible poor grades by electing a pass/fail option. Intended to encourage exploration at the upper division level outside the major field, this option is open to those who are sophomores and above, in good standing, who have declared a major. Courses numbered below 100 will not be eligible for pass/fail. The pass/fail option may not be used for major or minor subject credit toward graduation or for distribution requirements. Consultation with the adviser is required.

### LVAIC Cross-Registration

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Currently enrolled full-time degree seeking undergraduate students in good academic standing who have achieved sophomore status



may register for up to two courses per term at any one of the member institutions (DeSales University, Cedar Crest College, Lafayette College, Moravian College, and Muhlenberg College). The student must obtain the appropriate approvals of his or her own adviser and the host institution registrar. The courses must not be available at the home institution and must be in the normal academic load and not produce an overload. Graduate students and courses (courses numbered 400 and above) are not eligible for cross registration.

All grades of courses taken through the LVAIC cross registration process will be accepted by the home institution and entered on the permanent record, and such grades will be used in computing the grade point average. Credits taken through the cross-registration process will be calculated as in-residence. The number of credit hours assigned to a course is the responsibility of the home institution registrar.

Students may not repeat a course at another LVAIC institution in which they expect to have a Lehigh cumulative grade point average adjustment.

Lehigh University students are not permitted to cross-register for courses in all January intersession programs, the evening program at Muhlenberg College, all weekend courses at Cedar Crest College, or the Access program at DeSales University. All independent study, tutorial, music lessons or groups, correspondence, and on line courses are prohibited from cross-registration without prior approval of the Lehigh University Standing of Students Committee.

#### **Summer Cross-Registration**

Lehigh students must have been registered full time in the prior spring semester to be eligible to cross-register for a summer term. A maximum of two courses per session, and 12 credit hours over the course of the entire summer may be rostered. Students may not cross-register for a course being offered at Lehigh during the summer term.

Additional information on cross-registration can be found on the LVAIC website at the following link: <http://www.lvaic.org/default.aspx?pageid=464>

### **The General College Division**

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The General College Division supplements the mission of the established undergraduate curricula. The division provides an opportunity for persons not planning to qualify for a degree to pursue work of a general or specialized nature that their preparation and interests make desirable; provides a trial period for those who wish to become candidates for baccalaureate or graduate degrees, but whose preparation does not satisfy the entrance requirements for the established curricula; and provides an opportunity for qualified students to continue their education without being committed to a restricted or specialized program of studies. Courses taken in the General College Division may not be submitted to meet the requirements for a graduate degree.

For admission to the General College Division, the student must submit a special, simplified application to the undergraduate admissions office; the application must be submitted at least *one month prior* to the start of the semester in which the student hopes to enroll. The applicant must show maturity, seriousness of purpose and evidence of ability to pursue with profit the program of studies he or she desires. The student must have the established prerequisites for courses in which he or she wishes to enroll, and may register for courses up to and including those at the 300-level.

There is no established curriculum for the General College Division. Each student works on a program outlined to meet his or her special needs. Each program must be approved by the registrar, director of the division. Students must obtain permission of the instructor for courses in which they want to enroll. Students in the division are not permitted to take courses using the optional pass/fail grading system, or cross register for courses in LVAIC.

Students in the division, as non-degree candidates, do not meet the eligibility criteria for federal student aid, under Title IV, including Federal Pell Grants and Federal Stafford Student Loans. Similarly, institutional financial aid also is limited to degree candidates.

Students in the division are not candidates for degrees and must maintain a minimum 2.00 grade point average. A student may transfer to regular matriculated undergraduate status in any of the colleges only upon petition to, and with the approval of, the Committee on the Standing of Students. Transfer to the graduate school is possible only through the normal graduate admission process.

With the exception above, students in the General College Division are subject to the same rules and regulations as students of the university. They pay the tuition and fees established for regularly matriculated students.

## Graduate Study and Research

Lehigh began awarding graduate degrees in 1882. The first recipient, T.H. Hardcastle, of the Class of 1880, wrote his thesis on Alexander Pope, entitled it *The Rights of Man*, and read it aloud at commencement in June 1882.

The first Ph.D. was granted in 1893 to Joseph W. Richards, Class of 1886. Richards, who had a background in metallurgy and electrochemistry, taught at Lehigh until his death in 1921.

Women were admitted to the graduate program in 1918 when the faculty and the board of trustees agreed to grant the degrees of M.A. and M.S. to women, provided they attended classes in the late afternoon and on Saturdays "so that the general character of campus life shall not be affected." Three women received graduate degrees in 1921, the first women to complete graduate work at Lehigh. In 1929, the rule was changed, and women were admitted on much the same basis as men.

In 1936, the Graduate School was established to administer the graduate program. The Ph.D., which was temporarily discontinued in 1894, was reinstated in nine departments: chemistry, chemical engineering, civil engineering, geology, history, mathematics, mechanical engineering, metallurgical engineering, and physics. Tomlinson Fort, professor of mathematics, was selected in 1938 as the first dean of the Graduate School.

In 1995, graduate programs were decentralized and are now administered by the four colleges of the university, as described below.

### College of Arts and Sciences

Donald Hall, dean

Garth Isaak, associate dean for research and graduate programs

The College of Arts and Sciences offers graduate degrees in the humanities, social sciences, mathematics, and natural sciences. The master of arts, master of science, and the doctor of philosophy degrees are given in most of the traditional academic departments and in some interdisciplinary programs. Advanced degrees may be obtained in the departments of biological sciences, chemistry, earth and environmental sciences, English, history, mathematics, physics, political science, psychology, and sociology. In addition, interdisciplinary degrees are available in American studies, environmental policy design, photonics, and polymer science and engineering.

Although degree requirements vary from department to department, most require a combination of formal coursework and independent research. Students work closely with a faculty adviser in formulating and carrying out their research programs. Students admitted to a traditional department who are interested in an interdisciplinary approach may design a program of study and research which draws on faculty and facilities in other areas of the college or university.

For the most up to date information, interested students should check the CAS graduate website (<http://cas.lehigh.edu/grad>) or write to Office of Research and Graduate Programs, College of Arts and Sciences, 9 West Packer Ave., Bethlehem, PA. 18015

### College of Business and Economics

Thomas J. Hyclak, interim dean

Andrew J. Ward, associate dean

The College of Business and Economics offers the master of science degree in accounting and information analysis; master of science degree in economics; master of business administration with concentrations in corporate entrepreneurship, finance, marketing, international business, project management and supply chain management; and the doctor of philosophy degree in business and economics. In addition, the College of Business and Economics and the P.C. Rossin College of Engineering and Applied Science offer the MBA and Engineering. Students in this program will have the opportunity to concentrate in both a business area and an engineering area during their studies. The College of Education and the College of Business and Economics offer a joint masters degree in MBA and Educational Leadership, which will develop skills in business disciplines and prepare educators for roles in school administration. The College of Business and Economics, the P.C. Rossin College of Engineering and Applied Science, and the College of Arts and Sciences

offer a master of science degree in analytical finance, which provides a strong education in advanced finance and quantitative financial analysis tools. Students will be prepared to create innovative solutions for real financial problems using state of the art analytical techniques and computing technology.

There are five departments in the college: Accounting, Economics, Perella Department of Finance, Management, and Marketing. More information about the various degree programs appears below. Information on the college's graduate programs may be obtained at [www.lehigh.edu/business](http://www.lehigh.edu/business) or by contacting the College of Business and Economics, Graduate Programs Office, Rauch Business Center, 621 Taylor Street, Bethlehem, Pa. 18015, 610-758-4450.

### College of Education

Gary M. Sasso, Ph.D., Dean

Ward M. Cates, Ed.D., Associate Dean

The College of Education is a nationally recognized graduate college. Our distinction resides in our ability to function as a community of scholars and teachers. The diversity of our partnerships, the quality of our research and teaching, and the invigorating and supportive learning environment distinguish us as leaders among graduate colleges of education.

The College of Education offers a master of arts in education, a master of education, a master of science in education, the educational specialist, a joint master in business administration/master of education, post-baccalaureate certificates in various concentrations, the doctor of education, and the doctor of philosophy. There are six academic programs within the college including: Comparative and International Education, Counseling Psychology, Educational Leadership, School Psychology, Special Education, and Teaching, Learning and Technology. The focus of these programs is to prepare students for leadership roles in groundbreaking, cross-disciplinary inquiry that shapes educational practices nationally and internationally. While the College of Education does prepare individuals for leadership roles in school systems, we also prepare individuals for a variety of positions in business and industry, healthcare, private practice, and community-based organizations. We embrace the philosophy that a top quality education should provide the instruction, resources, and experience necessary to create a new type of educator; one who understands the nature of learning, social equity and cultural diversity; values collaboration and teamwork; and embraces societal challenges.

In addition to these six core academic programs, there are four other units within the College of Education:

### Centennial School

The College of Education operates the Centennial School, a laboratory facility for children with emotional/behavior disorders that has both an elementary and a secondary component. Centennial School provides research opportunities, as well as practical experience, for advanced students in our counseling psychology, educational leadership, school psychology, and teacher-preparation programs. <http://www.lehigh.edu/centennial/>

### The Center for Developing Urban Educational Leaders (CDUEL)

The mission of the CDUEL is to cultivate transformational educational leadership in urban communities by conducting research, developing leadership competencies, and improving leadership practice that enhance student learning and development. The center is committed to leaders who support education at all levels of a community, including teachers, principals, parents and human service workers. Special emphasis is placed on work involving small to midsized urban communities. [www.lehigh.edu/education/cduel/](http://www.lehigh.edu/education/cduel/)

### The Center for Promoting Research to Practice

The center's mission is to generate new knowledge that will truly impact the lives of individuals with disabilities. The primary objective of the center is to create a living laboratory that establishes partnerships with schools, parents and families, and community service providers to enhance the use of best practices for individuals with disabilities. [www.lehigh.edu/education/cprp/](http://www.lehigh.edu/education/cprp/)

### **Global Online Graduate Degrees and Training Office (formerly The Office of International Programs)**

Online Graduate Degrees and Training Office provides online graduate education and training to students within Lehigh University's College of Education. The College of Education's International Program initiatives are designed specifically to reach the global community. We offer graduate degree programs, principal certification, professional education certificates, summer professional institutes, and online academic courses throughout the academic year. [www.lehigh.edu/lbl](http://www.lehigh.edu/lbl)

Information on the various degree programs can be obtained by contacting the College of Education, 111 Research Dr., Bethlehem, PA 18015, 610-758-3231 or visiting our website: [www.lehigh.edu/~ineduc/](http://www.lehigh.edu/~ineduc/).

### **P.C. Rossin College of Engineering and Applied Science**

David Wu, Iacocca Professor and dean

John P. Coulter, associate dean of graduate studies and research

There are seven academic departments within the P.C. Rossin College of Engineering and Applied Science: chemical engineering, civil and environmental engineering, computer science and engineering, electrical and computer engineering, industrial and systems engineering, materials science and engineering, and mechanical engineering and mechanics. Master of science and doctor of philosophy degrees are available in each of these departments, as well as in bioengineering, computational and engineering mechanics, environmental engineering, computer engineering, structural engineering, and polymer science and engineering. In addition, master of science programs are provided in analytical finance, management science and engineering, manufacturing systems engineering, photonics, and wireless and networking engineering. Master of engineering degrees are offered in biological chemical engineering, chemical engineering, civil engineering, computer engineering, computer science, electrical engineering, energy systems engineering, environmental engineering, healthcare systems engineering, industrial and systems engineering, management science and engineering, materials science and engineering, mechanical engineering, polymer science and engineering, structural engineering and technical entrepreneurship. In Cooperation with the College of Business and Economics, students can also pursue a Master of Business Administration and Engineering (MBA&E) degree. Certificate programs are available in the area of nanotechnology, manufacturing systems engineering, polymer science and engineering and quality engineering.

Graduate study in the P.C. Rossin College of Engineering and Applied Science is most often related to the college's extensive research activity, and graduate students are expected to engage in analytical or experimental research as part of their programs of study. This activity involves students in the process of creating new knowledge under the direction of the college's distinguished faculty and brings them into contact with some of the most modern and advanced experimental techniques. Many college research programs are supported by contracts, fellowships, and grants from industry and from federal, state, and local governments. This funding not only provides financial support for outstanding students but also allows them to deal with some of the more complex and pressing problems facing our society in the 21st century.

Many faculty members and graduate students in the P.C. Rossin College of Engineering and Applied Science are associated with interdisciplinary research centers and institutes as well as with their own departments. The opportunity for interdisciplinary study allows them to cross departmental lines in specific technological areas and to work with faculty and graduate students from other departments. Centers and institutes currently perform research in the areas of biotechnology, health sciences, thermofluids, materials, energy, environmental sciences, surfaces and coatings, solid-state studies, optical technologies, structural and geotechnical studies, high-rise habitats, emulsion polymers, metal forming, robotics, computer-integrated manufacturing, value chain science, nanotechnology, and design and management innovation. Extensive research in many of these areas is also conducted within academic departments.

Further information on the graduate programs may be obtained through the Office of Graduate Studies and Research, P.C. Rossin College of

Engineering and Applied Science, 19 Memorial Drive West, Bethlehem, PA 18015.

### **Admission to Graduate Study**

A graduate of an accredited college or university may be considered for admission to graduate study. The decision to admit a student rests with the applicant's major department and stands for one year following the first semester for which admission was offered. If more than one year elapses, the prospective student's department reserves the right to reconsider the original offer. Students wishing to pursue an interdisciplinary degree may, in some cases, apply to the program directly.

Applications for admission may be completed online. Links to the application can be found at the university's graduate admissions website as well as the individual college websites.

An applicant may enter the graduate program as a student in the following categories: regular, associate, or non-degree. Except for qualified Lehigh undergraduates, only those who have been admitted officially by the graduate program office of an appropriate college or by a department in one of the categories above may register for graduate courses or take them for credit.

#### **Regular Graduate Students**

Only regular graduate students are candidates for graduate degrees. Application for admission as a regular graduate student must be filed by July 15 for the following fall semester or by Dec. 1 for the spring semester. Regular graduate students wishing to begin in the summer must apply before April 30. Certain departments or programs have earlier deadlines. Applicants should consult their respective departments or their dean's office. In order to be considered for admission as a regular graduate student, the applicant must satisfy at least one of the following conditions: have an undergraduate GPA of at least 2.75 out of 4.00 (note: College of Education GPA minimum is 3.0); have an average of at least 3.00 for the last two semesters of undergraduate study; have a graduate grade point average of at least 3.00 for a minimum of twelve credit hours of graduate work completed at other institutions; or have successfully satisfied the probationary conditions as an associate graduate student (discussed below). Satisfying one of these conditions is necessary for admission as a regular graduate student but may not be the only condition required. Graduate students who are non-native speakers of English are required to take the Test of English as a Foreign Language (TOEFL) Internet-Based Test (iBT). Please contact your department or program of choice for the required acceptance scores. Note: For any student who has taken the TOEFL Paper-Based Test (PBT), please contact your department or program of choice to be sure that this score is acceptable. The TOEFL Computer-Based Test (CBT) has been discontinued and is no longer valid for admissions. The TOEFL test may be waived if a student has obtained a degree from an English-only university in an English speaking country and demonstrates effective English language skills. Applicant's should consult with their respective departments or college dean's office to determine if they are eligible for a waiver.

Individual departments may evaluate their candidates for admission according to higher standards and additional criteria. Students seeking admission to Professional Certification Programs may have to meet additional requirements to comply with Pennsylvania Department of Education Regulations. Departments should be consulted for information regarding required examinations for admission. For example, candidates for the MBA program are required to take the Graduate Management Admissions Test (GMAT) or the Graduate Record Exam. In some cases the GRE subject tests are required.

Admission of a student to graduate standing is executed through the Office of Graduate Studies in each college or the respective dean's office. Credentials for admission to counseling psychology and school psychology programs and to all College of Education doctoral programs are acted upon only once a year.

Completed applications accompanied by requests for financial aid must be submitted by January 15 for admission in the following fall semester. (Some departments have earlier deadlines.) Applications received after the deadline will be considered on a space-available basis.

### Associate Graduate Students

Associate graduate student status may be offered to applicants who apply but fail to qualify for regular graduate student status. Only associate student applications will be considered during the late admissions period between the end of the regular admission period and the first day of classes. Applicants for associate status may submit unofficial rather than official transcripts; letters of recommendation are not required at that time. However, the registrar will require an official final transcript before grades are released. Certain departments or programs have earlier deadlines and more stringent requirements. Applicants should consult their respective departments.

Associate graduate students who are admitted during the late admission period and who clearly qualify for admission as regular graduate students may petition for regular status after classes begin if all credentials are in order. There is no late application fee. Individual departments may have more stringent requirements.

Associate graduate students are allowed to take up to nine credits of coursework numbered 300 or higher before they must petition for regular student status. In order to be granted regular student status, they must have completed those nine credits with at most one final course mark below B-. Associate graduate students receiving a final course mark lower than a C- will be dropped from the program. Students should note that individual departments may impose more rigorous probationary standards. For example, the College of Education has more stringent probationary standards; please see the handbook for details.

When the probationary period of nine credit hours is completed, associate graduate students must petition for regular student status in order to enroll for additional coursework. Such a petition requires the submission of any regular admission documents not already on file. Courses completed during a successful probationary period may count toward a graduate degree if they are part of an approved program.

### Non-Degree Students

Students who do not wish to enter a degree program may seek admission with non-degree status. In this case, the prospective student completes an abbreviated application form (available from the appropriate college). The admissions criteria for non-degree graduate students are: 1) a bachelor's degree from an approved institution with an overall grade point average of at least 3.0; (applicants with undergraduate GPAs below 3.0 may be admitted with the approval of the department in which they wish to take courses; or 2) evidence that the applicant is presently a student in good standing in an appropriate graduate program at an approved institution; or 3) evidence that the applicant has received an appropriate graduate or other advanced degree from an approved institution. In addition, international students are required to demonstrate English language skills equal to those required of degree-seeking students and are held to the same TOEFL standards.

Admission decisions for non-degree students are made by the dean of the appropriate college or other responsible official designated by him/her for this purpose. The signature of the designated official on the application and registration forms confers admission to the non-degree graduate student status. Informal transcripts will be accepted for initial admission, but formal transcripts must be on record before the student can receive any transcript or grade report from the university or enroll for additional courses.

### Non-degree Options

In addition to degree programs, there are two non-degree options: 1) Regular non-degree and 2) Non-degree for external certification. Regular non-degree admission is for students who wish to take up to 12 credits of graduate coursework without seeking a degree. Non-degree for external certification students are admitted to pursue coursework for the purpose of obtaining certification through an external accrediting agency. These students complete coursework for the appropriate certification, with the number of credits being dictated by the external accrediting agency. Given this external control of credit requirements, the number of credits will vary and will typically exceed the 12-credit limit for regular non-degree students. A student admitted as non-degree may subsequently be admitted to a degree program, but would need to submit all components required for admissions consideration by

that degree program. Students should consult their respective college dean's office for proper procedure.

### Graduate Course Auditing

With the permission of the departmental chair, graduate students can be admitted to a course as auditors. This course will not count for credit towards any graduate degree, and may not subsequently be taken for credit. In no case shall a student who has attended a course as an auditor be given an anticipatory examination for credit or register for the same course in the future. A student completing a course in this manner will have the course and the notation "AU" indicated on the permanent record. A student rostered on an audit basis may be withdrawn from the course with a grade of "W" for poor attendance.

### Lehigh University Undergraduates

A Lehigh undergraduate with a 3.0 cumulative grade point average who has achieved Junior standing may take any 400-level course for which he or she is qualified. The qualifications are defined by the department and are certified by the course instructor and department chairperson through petition to the Graduate and Research Committee. For additional information on constraints on undergraduates taking graduate level courses please see Section III Curricular Flexibility.

Undergraduates at Lehigh who are within a few hours of meeting the requirements for a baccalaureate degree may, with the special approval of the Graduate and Research Committee, enroll for up to 12 credit hours of study for graduate credit (6 in the P.C. Rossin College of Engineering and Applied Science). Lehigh undergraduates may apply course credits taken in the undergraduate program toward a graduate degree under the following conditions: 1) the course credits are not submitted as part of the requirement for an undergraduate degree; and 2) courses for possible graduate credit are approved in advance by the course instructor, department chairperson, and the dean of the college. The student must receive a final course mark of B- or better.

### Readmission

A student who has not been registered in a Lehigh graduate program for one year must petition for readmission. Petitions approved by the student's major department must be forwarded to the registrar's office.

### International Students and Scholars

International applicants must hold an American bachelor's degree or an equivalent foreign degree requiring at least 16 years of primary, secondary, and university education. International applicants applying for regular graduate student status must submit all documents required for that status (see above).

## Registration

### Requirements

All graduate students using Lehigh University resources must be registered. No graduate student may register for more than 16 credits per semester. University employees may register for, at most, two courses per semester with appropriate approval. The maximum registration in a summer session is two concurrent courses and no more than 14 summer credits across all summer sessions.

### Full-time Status

In order to maintain full-time enrollment status, a graduate student must ordinarily register for a minimum of nine credits each semester. Full-time students may not be employed full-time. Identification as a full-time student is important for three purposes:

1. eligibility for financial aid,
2. compliance with visa requirements for international students, and
3. for university and national graduate enrollment data.

Full-time status may be maintained with fewer than nine credits of registration after fulfillment of degree credit-hour requirements and under some other selected circumstances, provided that the student is, in fact, continuing a program of full-time study and research. In such cases, the status must be certified each semester on the Graduate Full Time Certification request form, first by the department and then by the appropriate college.

### Registration Procedure

Registration is scheduled for a two-week period at a time designated on the university calendar. Graduate registration for new students is held during the week preceding the start of classes. Students should check with their departments for registration and semester class schedules. Graduate students may register using the online system after consultation with their adviser, or complete paper registration forms available in their departments. A course adviser will discuss course selections with students and provide the registration PIN or sign registration forms upon approval.

### Late Registration Penalties

Registration after the designated period during the prior term for continuing full-time graduate students or between the second and tenth day of class during the fall and spring semesters, and the second and fifth day of class during the summer sessions will require a late registration fee. Students who have not completed the registration process by the tenth day of the regular academic semester or by the fifth day of the summer session will not be permitted to attend class.

### Graduate Credit and Grades

Course grades are defined as for undergraduates (p. 27) except that, at a minimum, no final course mark lower than C- may be counted toward a graduate degree and pass-fail registration is not allowed for graduate students. No regularly admitted student who receives more than four final course marks below a B- in courses numbered 200 or higher is allowed to continue registration as a graduate student. Individual degree programs may have higher standards.

The N grade is defined as for undergraduates (p. 27) except that, parenthetical grades are not required for thesis or research courses and graduate students have a calendar year to remove course incomplete grades unless an earlier deadline is specified by the instructor. Graduate student incomplete course grades that are not removed remain as N or N (grade) on the student record for one year. After one year, the N grade will be converted to an F and the N (grade) will be converted to the parenthetical letter grade. Incomplete grades may be extended an additional year with approval of the course instructor and the graduate coordinator. After two years, outstanding incomplete grades will be converted to an F or the parenthetical mark. After two years, students may appeal to the Committee on Standing of Graduate Students (SOGS) with a timeline and plan for completion. Thesis or research project N grades may remain beyond one year until the work is completed.

The X grade is defined as for undergraduates (p. 27) except that to be eligible for a make-up examination a graduate student must file a petition and the petition must be approved by the Graduate and Research Committee.

The Z grade is defined as for undergraduates (p. 27) except that graduate students have a calendar year to complete coursework following a Z grade unless an earlier completion deadline is specified by the instructor. The X portion of the grade is removed as described for undergraduates. Z grades which are not removed remain on the record of graduate students. All petitions for exceptions are sent to the Committee on Standing of Graduate Students (SOGS).

A student's grade that was originally assigned an N, X or Z grade when converted or computed will be noted with an "\*" asterisk prefix.

### Withdrawal from a Course

When a student drops a course within the first ten days of the semester (five days for summer sessions) no indication of this action is recorded on the academic transcript. A student that drops all courses for which he or she is registered is considered to be withdrawing from the university.

A student who withdraws from a course after the tenth day of instruction and before the end of the eleventh week of instruction will have a final course mark of "W" assigned to the course. This is a non-punitive grade.

A student who withdraws from a course after the eleventh week of instruction and before the end of classes receives a "WP" or "WF" at the discretion of the instructor. A "WF" is considered to be a failing grade and is calculated as such in the term and cumulative grade point

average. An Add/Drop form signed by the student's adviser must be submitted to the registrar's office before the deadlines noted to be official.

### University Withdrawal

A student withdrawing from the university (dropping all courses during a given term) must submit the Drop/Add form signed by the adviser to the registrar's office. Withdrawal after registration day and during the first eleven weeks of instruction will be noted on the academic transcript by assigning a final course mark of "W" to all courses. A withdrawal after the eleventh week of instruction and before the end of classes will have the grade of "WP" or "WF" assigned for each course at the discretion of the instructor. The date of the withdrawal will be noted on the academic transcript for a withdrawal at any time during the term.

### Graduate Student Scholastic Requirements

The following guidelines state the minimum requirements for all graduate students. Individual degree programs may have higher standards.

#### Associate and Non-Degree Students

Associate and Non-Degree Students: will be placed on probation when they receive their first final course mark below a "B-" and will be dropped for poor scholarship at the end of a term when the student has accumulated either two "C", "C-" or "C+" final course marks or one final course mark below "C-".

If an associate student is assigned two grades below a "B-" in the same term the student is eligible to be dropped without any term on probation.

Once on probation, students remain on probation until they are granted regular status or receive degree. Students who are eligible to be granted regular status but fail to apply by the regular student deadline will be evaluated according to the regular student criteria.

#### Regular Students

Regular Students: will be placed on probation at the end of the term in which they are assigned their fourth final course mark below a "B-" in courses numbered 200 or above and will be dropped for poor scholarship at the end of any term in which they are assigned their fifth final course mark below a "B-".

Once regular students are placed on probation they will remain on probation until they receive their degrees.

#### Readmission

Readmission: Graduate students who have been dropped for poor scholarship are ineligible to enroll for the next regular term. After one term away they may petition for readmission. The department and the dean's office must review the petition. If approved, the student will be readmitted on probation and may be dropped again with any additional final course marks below a "B-".

### Graduation

#### Degree Registration

A student must be registered in the semester in which the degree is conferred. If a student is not registered for a course, he/she must register for maintenance of candidacy. Candidates for September degrees do not need to be enrolled the summer preceding the degree if they were enrolled both fall and spring of the previous academic year.

#### Application for Degree

Candidates for degrees to be conferred on University Day in May must file an application for degree with the registrar by March 1. Candidates for degrees to be conferred in January must file by November 1. Candidates for degrees to be conferred in September must file by July 1. Late application for a degree will incur a penalty fee of \$40.

#### Clearance

Graduate students must receive clearance from the university prior to the awarding of the degree. The following obligations must be satisfied:

- Students must complete all coursework for incompletes they may have received.
- Theses must be cleared by the registrar's Office.
- Dissertations must be cleared by the appropriate dean's office.

- All financial obligations must be cleared with the bursar. Tuition fees, bookstore charges, library fines, and motor or vehicle fines must be paid before graduation.
- All library books on loan must be returned.
- Students must turn in their student identification cards at the I.D. card office.

The interdepartmental clearance sheet must be completed. This form requires the signature of the student's department chairperson (except for the College of Education), and the facilities services office before it is submitted to the registrar at least three days prior to graduation.

## Tuition and Fees

### Tuition Payment

Graduate students who register at least six weeks prior to the start of classes will receive an email notification to their Lehigh email account that their tuition bill is ready to view online at the Student Account Suite. Students that register less than six weeks prior to the start of classes will most likely not have a tuition bill generated prior to the start of classes. To remain in good standing, tuition charges must be paid prior to the start of classes even if the student has not received a tuition bill because of his/her late registration for classes. Students can review their current account balance online 24/7 by logging into the Student Account Suite or the Campus Portal. Information about the various payment options is available at the Bursar's Office web site at [www.lehigh.edu/inburs/](http://www.lehigh.edu/inburs/) or by calling the Bursar's Office.

### Tuition Refunds

A student in good standing who formally withdraws or drops a course(s) before 60% of the semester has been completed is eligible for a tuition refund. Academic fees are non-refundable after the first day of classes. **The "first day of classes" is considered the first day of the semester, not the first day a particular class meets.** Courses not following standard semester dates will have percent-of-semester-completed refunds based on dates for that specific course. Online courses percent-of-semester-completed are based on access availability, not if/when student first accessed course material. No tuition refunds will be made for courses of one week or less after the first day of class.

### Tuition and Fees for 2013-2014 per credit hour

College of Arts & Sciences	\$1300
College of Business & Economics	\$1050
College of Education, and for fulltime elementary and secondary teachers and administrators enrolled in the other three colleges	\$565
College of Engineering & Applied Science	\$1300
Special Programs MBA & Engineering	\$1300
MBA/Educational Leadership	\$810
MS/Analytical Finance	\$1300
Audit charge per course – same as credit charge in the appropriate college	
Maintenance of candidacy – same as a one-credit charge in the appropriate college	
Master's candidate registration fee – same as a onecredit charge in the appropriate college	

### Living Accommodations

The university maintains a graduate student housing complex in the Saucon Valley that has 135 living units. This complex, Saucon Village Apartments, provides units generally on a yearly lease basis. For the 2013-2014 period beginning in September, the following are the monthly rents exclusive of utilities:

Efficiency apartment	\$545
One-bedroom apartment	\$645
Small two-bedroom apartment	\$695

Two-bedroom apartment w/o AC	\$695
Two-bedroom apartment w/AC	\$710
Three-bedroom apartment	\$720

### Other Fees

Application fee	Consult with individual college (for graduate admission consideration)
Late pre-registration <sup>1</sup>	\$100
Late application for degree	\$40
Late payment (after announced date)	\$200
Returned check fine	\$35
Identification card (replacement)	\$15
Thesis distribution	\$55
Dissertation distribution	\$90
MBA Orientation Fee	\$250
Supervision fee <sup>2</sup>	\$100 to \$250

<sup>1</sup> Assigned to full-time graduate students who do not select their full class load during the designated period each term.

<sup>2</sup> College of Education (per 3 credits) Intern courses require a special supervision fee which varies from \$100 to \$250. Inquire in your department.

## Financial Aid

Financial aid is ordinarily available only for regular, full-time graduate students. Teaching assistantships, research assistantships, graduate assistantships, fellowships, and scholarships are academic awards made by individual academic departments. Several graduate assistantships unrelated to a particular area of study can be obtained by applying to administrative offices. International students are also encouraged to apply for funding to outside sponsoring agencies and/or home governments. Finally, please note that all student loan programs, and the Federal Work-Study program, are administered by the Office of Financial Aid located at 218 W. Packer Avenue. (Please read the section below regarding loans and work-study.)

### Academic Awards

Requests for fellowships, scholarships, research assistantships, teaching assistantships, and graduate assistantships to begin in the fall semester must be filed with academic departments no later than January 15. (Some departments have earlier deadlines.) Generally, a special committee formed by department faculty selects the recipients of these awards based upon merit; students are not required to submit a financial statement.

In addition to their stipends, graduate students holding half-time teaching appointments generally receive tuition remission. Fellowship holders also receive a stipend and tuition award. Scholarship recipients are awarded tuition. Research assistants receive a stipend for research services, but their tuition is commonly paid directly by research projects.

### Teaching Assistants and Graduate Assistants

Teaching assistant and graduate assistant (TA/GA) are technical terms used to describe specific types of Lehigh University graduate students. The duties of TAs and GAs are generally set by the departments or offices that appoint them, but certain conditions must be satisfied before a student can be classified as a teaching assistant or a graduate assistant. These include:

- Each TA/GA must be a regular full-time resident Lehigh graduate student, which normally requires registration for at least nine credit hours per semester.
- A TA/GA is a half-time position and each TA/GA provides services to Lehigh University of up to twenty hours per week. Quarter-time and eighth-time TA/GA appointments are possible for full-time resident graduate students, with stipends and tuition remission appropriately reduced.
- Each TA/GA must be paid a specific stipend, which is set for the academic year by the dean of the appropriate college after consultation with the Director of Budget.

- Qualified TAs/GAs receive tuition remission for at most ten credit hours in a regular semester. No TA/GA may register for more than ten credit hours. A student who is a TA/GA during the preceding academic year is entitled to at most three hours of thesis, research, or dissertation registration (not course credit) in the following summer without payment of tuition (except in the College of Education).
- Each TA/GA is appointed by a process which begins with a formal letter of appointment issued by the appropriate department chairperson. The appointment letter specifies standard university conditions including stipend level, time of arrival, length of service, and the requirement of satisfactory academic progress and performance of duties. Each department chairperson submits written notification of TA/GA appointments to the appropriate college dean or vice president.

The Graduate and Research Committee endorsed academic guidelines for new teaching assistants which exceed minimum admission requirements. Each TA should satisfy one of the following: have a GPA of 3.0 or better in the undergraduate major field of study; have a GPA of 3.5 in the senior year major field; rank in the 85th percentile or higher on the Graduate Record Exam or other standardized test; or have a GPA of 3.5 in at least twelve hours of graduate work in the major field. Exceptions to these guidelines shall be made only with the approval of the appropriate dean.

In addition, each teaching assistant must make normal progress toward a graduate degree. The definition of normal progress may vary among departments, but the criteria for satisfactory progress are established by the department faculty and the Graduate and Research Committee. Teaching assistants who fail to satisfy these criteria are ineligible for reappointment.

In addition to a minimum passing TOEFL score, Teaching Assistants whose native language is not English must have on record with the ESL Program and their academic department a SPEAK score of 230+ (Test of Spoken English or TSE score of 55+) in order to work with Lehigh undergraduates in academic settings (i.e., classrooms, recitations, labs, office hours, etc.).

Those whose SPEAK score is between 200 and 225 (or TSE 50) may also be appointed as TAs, but they are required to attend ESL courses at Lehigh until their SPEAK score is at least 230 or until they no longer have a TA position. A comprehensibility score of 195 (or TSE 45) or below eliminates an international graduate student from being appointed as a TA. Note: The TSE Test has been discontinued as of March 31, 2010. TSE scores are valid for two years from the test date.

Tuition remission for qualified TAs/GAs is authorized by the appropriate dean or vice president as part of the registration process. Each college dean or appropriate vice president will be provided tuition remission accounts against which TA/GA remissions will be charged. The accounts will be budgeted at an amount equal to the nine-hour TA/GA tuition rate times the approved number of TA/GA positions and will be included in the annual operating budget. The budgets shall not be exceeded. If additional TA/GA positions are desired on a temporary basis, the account executive must provide for the transfer of budget support to the remission account. These budgets are to be used exclusively for tuition remission for authorized TA/GA positions.

There are a limited number of summer TA/GA appointments. These TA/GAs must receive the same monthly stipend as academic year TAs/GAs and devote up to twenty hours per week to the GA/TA responsibilities. A summer TA/GA registers for a maximum of three credit hours in each summer session of appointment and receives tuition remission for that registration.

#### Other Graduate Assistantships

Graduate students may apply directly to administrative offices for graduate assistantships unrelated to their areas of study. The availability of these assistantships is based upon the needs of the individual departments. GAs are appointed regularly by the office of the vice provost for student affairs, the dean of students office, the university counseling service, and by career services.

#### Loans and Work-Study Awards

Graduate students may apply for Federally funded loans (Direct Unsubsidized Loan or Graduate PLUS Loan) through the Office of

Financial Aid. In addition, there may be very limited availability of Federal Perkins loans and Work-Study funds available for Graduate students. Federal funds are awarded using the Free Application for Federal Student Aid (FAFSA). The FAFSA can be completed on the web at [www.fafsa.ed.gov](http://www.fafsa.ed.gov). In addition to the FAFSA, Lehigh University requires a university application (Graduate Student Financial Aid Application). Applications for Federal loans cannot be processed and funds cannot be disbursed, until the FAFSA and Graduate Student Financial Aid Application are received and reviewed.

Eligibility for student loans is based on the number of credits to be taken and the total amount of assistance received. Any change to the number of credits to be taken or the amount of aid received may affect loan eligibility. To avoid problems with your loan application, it is important that you notify the Office of Financial Aid of any changes in your enrollment or in the amount of aid received. Unfortunately, students frequently change the number of rostered credit hours, or receive Graduate School aid, after their loan application has already been processed. When either of these circumstances occur, a student's eligibility may change dramatically. It is the student's responsibility to notify the Office of Financial Aid of any changes.

Literature on student loan programs is available through the Financial Aid office or the website ([www.lehigh.edu/financialaid](http://www.lehigh.edu/financialaid)).

### Degree Information

The following degrees are offered by the university: the master's degree, the doctor of philosophy, the doctor of education, and the doctor of arts.

Students pursuing multiple graduate level degrees must meet minimum unique degree credit-hour requirement for courses taken at Lehigh. A single master's degree requires a minimum of 30 credits (see transfer credit policy for any exceptions); a single doctoral degree requires a minimum of 72 credits, or 48 for a student with a prior master's degree. A student seeking two master's degrees will be required to take at least 60 credits at Lehigh, but may petition to transfer in credits towards the first master's degree. No credit used for a master's degree may be counted towards reducing the minimum requirement of 48 Lehigh credit hours for a doctoral degree. No graduate credit may be counted towards two graduate level degrees.

Candidates for the master's degree have six years in which to complete their programs. Students should confer with their advisers to be certain that specific department and program course requirements are met. The following requirements must be satisfied by master's candidates in all departments.

#### Program for the Master's Degree

A student's program must include: not less than 30 credit hours of graduate work; not less than 18 credits of 400-level coursework (research or thesis registration counts as part of the 400-level coursework requirement); and not less than 18 credits of coursework in the major, of which 15 credits must be at the 400 level. Coursework for the master's degree must be taken under at least two instructors and must be approved by Lehigh University. With the approval of the department chair, between nine and 15 credits of graduate coursework taken elsewhere may be transferred to a Lehigh master's program. The number of credits that may be transferred depends on the number of credits in the master's program: Up to nine credits for programs of 36 credits or less; up to 12 credits for programs of 37 to 48 credits; and up to 15 credits for programs of 49 to 60 credits.

A petition is submitted, with course descriptions and transcript, as well as departmental recommendation. Final course marks of B or better are required, such courses may not have been applied toward any prior degree, the courses must have been completed at an institution accredited by one of the six regional accrediting associations, and those courses must have been completed within four years of the first enrollment in the Lehigh master's program.

A student must complete the form, "Program for Master's Degree," setting forth the courses proposed to satisfy the degree requirements. This form should be approved by the department and then submitted to the registrar as soon as possible after 15 credit hours toward the degree have been completed. Approval of the program by the registrar

signifies that the student has formally been admitted to candidacy for the master's degree.

### **Thesis and Comprehensive Exam**

Candidates may be required to submit a thesis or a report based on a research course of at least three credit hours, or to pass a comprehensive examination given by the major department. The department will specify which of these requirements apply and may require both. If required, the thesis or report shall not count for more than six credit hours, and thesis registration is limited to a maximum of six credit hours. If the thesis or research project involves human subjects, the student must complete the university human subjects review packet and receive written approval from the Institutional Review Board. All approved thesis/dissertations copies must be submitted by the appropriate deadlines in electronic form by following the procedures and guidelines found on the LTS Web site URL: <http://libraryguides.lehigh.edu/etdadmin>. Please contact your college dean's office for further clarification.

A non-thesis option exists for certain programs in the Colleges. Students should check with their departments regarding that option.

### **Time and Registration Requirements**

A candidate for the doctor of philosophy degree ordinarily is expected to devote at least three academic years to graduate work. In no case is the degree awarded to someone who has completed fewer than two full academic years of graduate work. All post-baccalaureate work toward the doctorate must be completed within ten years. A student beginning doctoral coursework after an elapsed period of at least one semester after the master's degree has been conferred is granted seven years in which to complete the doctoral program.

Doctoral students whose graduate study is carried out entirely at Lehigh University must register for a minimum of 72 credits beyond the bachelor's degree. However, students who during their entire doctoral program, including the semester of graduation, have paid full tuition continuously (normally a minimum of 9 credits per academic semester) have also satisfied the tuition requirements for the doctoral degree once they have completed all other requirements. Students who have earned a master's degree at another university must register for a minimum of 48 credits. These requirements include registration for research or dissertation credits. Students participating in approved dual-degree doctoral programs involving external institutions may transfer up to 25% of their total required doctoral program research credits to Lehigh for work that was performed at the external partner institution. Approval of such programs is required by the dean of the relevant Lehigh college.

Full-time students working toward the doctorate normally register for a minimum of nine credits each semester. If the minimum degree registration requirement of 72 or 48 credits is attained prior to formal admission to doctoral candidacy, continued registration of at least three credits per semester is necessary. Such registration does not automatically grant full-time student status, however. Full-time student status must be certified on the graduate registration form.

Students seeking to receive both a master's degree and a doctoral degree must complete a minimum of 72 graduate credits at Lehigh and must meet all requirements of both degrees.

After admission to doctoral candidacy, a student must maintain candidacy by registering at least two times each calendar year (in each academic semester or in one academic semester and one summer session). After completion of the minimum registration requirement plus any additional requirements of the student's department or program, students are permitted to register for 'Maintenance of Candidacy' and be charged a single credit hour of graduate tuition at the appropriate rate for the degree program in which they are enrolled. Full-time status must be certified on the graduate registration form each semester.

### **Concentrated Learning Requirement**

Each doctoral degree candidate must satisfy Lehigh's concentrated learning requirement. This requirement is intended to ensure that doctoral students spend a period of concentrated study and intellectual association with other scholars. Two semesters of full-time Lehigh graduate study or 18 credit hours of Lehigh graduate study, either on or off campus, within a fifteen-month period must be completed.

Individual departments may impose additional stipulations. Candidates should check with their advisers to be certain that they have satisfied their concentrated learning requirements.

### **Language Requirements**

Language requirements for the Ph.D. are the option of, and in the jurisdiction of, the candidate's department. Since proficiency in a language is not a university requirement, each department decides which languages, if any, constitute part of the doctoral program.

### **Qualifiers**

Many departments require students who wish to enroll in doctoral programs to pass qualifying examinations. Since these examinations vary among departments, students should ask their advisers or department chairpersons for more detailed information. If a qualifying examination is not used, students should find out how and when eligibility to pursue doctoral studies is determined.

### **Admission to Candidacy**

With the help of an academic adviser, the student names the faculty members of the doctoral committee, a special committee formed to guide the student through the doctoral program. The committee is responsible for assisting the student in formulating a course of study, satisfying specific departmental requirements, submitting a suitable dissertation proposal and for overseeing progress in research, and evaluating the completed dissertation. At least four faculty are appointed to the committee; one must be a member of an outside department. Committee membership must be approved by the university's Graduate and Research Committee.

A doctoral student should apply for candidacy no later than two years after completion of the master's degree or its equivalent and after passing qualifying examinations, if they are required by the major department. The prospective doctoral candidate must submit to the doctoral committee a written program proposal that includes a discussion of proposed dissertation research. Upon receiving committee approval of the proposal, the candidate submits the proposal, signed by the committee members, to the appropriate dean for action by the Graduate and Research Committee. The dean will advise the student of the committee's decision.

If the dissertation research involves human subjects, all research procedures and instruments must be approved by Lehigh University's Institutional Review Board (IRB) prior to the involvement of the subjects.

### **General Examinations**

Examinations composed and administered by the members of the student's doctoral committee are designed to test the candidate's proficiency in a particular field of study. These examinations, which may be either written or oral, should be passed at least seven months before the degree is to be conferred. If a student fails the general examination, a second examination may be scheduled not earlier than five months after the first. If the results of the second examination are unsatisfactory, no additional examination is scheduled.

### **Dissertation and Defense**

The doctoral candidate is required to write a dissertation prepared under the direction of a Lehigh University professor. The dissertation must treat a topic related to the candidate's specialty in the major subject, show the results of original research, provide evidence of high scholarship, and make a significant contribution to knowledge in the field.

Upon approval of the advising professor and, if required by the departmental secondary readers, the final draft of the dissertation is submitted to the appropriate dean for inspection by the date posted in the academic calendar. Upon its return, the student should distribute copies of the draft to the members of the doctoral committee for review and for suggestions for revision. The candidate then schedules a dissertation defense before the doctoral committee, additional faculty members the department may add to the examining committee, and the general public. After the dissertation has been defended and revised accordingly, the student must submit the finished dissertation to the appropriate dean for review by the university's Graduate and Research Committee no later than the date specified in the academic calendar for completion of all degree requirements. All approved thesis/dissertations copies must be submitted by the appropriate deadlines in electronic form by following the procedures and guidelines found on the LTS Web



site URL: <http://libraryguides.lehigh.edu/etdadmin>. Please contact your college dean's office for further clarification. Guidelines stipulating the standard form of the dissertation are available in the dean's office.

## Graduate Studies Organizations

### The Graduate and Research Committee

The Graduate and Research Committee consists of twelve members representing the faculties of Lehigh's colleges: four from the College of Arts and Sciences; two from the College of Business and Economics; four from the P.C. Rossin College of Engineering and Applied Science; and two from the College of Education; plus the college deans, the registrar, the vice provost for research, the director of the office of research, two non-voting graduate student members, and a member of the student senate.

The committee formulates policies and regulations on graduate education and it recommends policies and procedures for research-related activities. The committee interprets and applies faculty rules governing graduate students and degrees, including questions concerning student petitions and appeals.

### Graduate Student Senate

The Graduate Student Senate is comprised of graduate student representatives from each academic unit. The general assembly meets bi-monthly during the academic year. This body represents the graduate student community regarding graduate programs and graduate student life at Lehigh. Graduate students selected by the Graduate Student Senate are non-voting members of the Graduate and Research Committee and other university committees.

The Senate provides a forum for discussion with university officials and committees, advocates for policy change, disseminates information, and plans social events in order to facilitate communication and community building among graduate students.

## Research Centers and Institutes

Lehigh has developed a number of centers and institutes to provide greater research and academic opportunities for primarily graduate students and faculty. Centers and institutes are generally interdisciplinary and complement the scholarly activities of academic departments and represent scholarship and research based on the expertise and capabilities of a group of faculty members. Frequently, centers relate to the broad-based research needs of government, industry, and the social community.

### Research Organizations/ Directors and Staff

Directors and staff members of the university's research centers and institutes are listed. Complete degree information may be found in the faculty and staff alphabetical listings. In some cases, areas of research interest are given.

All addresses are Bethlehem, Pa. 18015, and the area code is (610).

## Advanced Materials and Nanotechnology (CAMN) (Center for)

5 E. Packer Ave; 610-758-3850

Martin Harmer, Director (Mat Sci); Chris Kiely, Nanocharacterization Laboratory Director (Mat Sci/Chem Eng); Richard Aronson (Econ); Filbert Bartoli (ECE); Ricky Blum (ECE); Alec Bodzin (Ed); Hugo Caram (Chem Eng); Helen Chan (Mat Sci); Xuanhong Cheng (Mat Sci); John Coulter (Mech Eng); Stephen Cutcliffe (STS); Volkmar Dierolf (Phys); Yujie Ding (ECE); John DuPont (Mat Sci); Sharon Friedman (Journ and Comm); James Gilchrist (Chem Eng); Joachim Grenestedt (Mech Eng); Miltiadis Hatalis (ECE); James Hwang (ECE); Anand Jagota (Chem Eng); Himanshu Jain (Mat Sci); Sabrina Jedlicka (Mat Sci); Kai Landskron (Chem); Charles Lyman (Mat Sci); Anthony McHugh (Chem Eng); Steven McIntosh (Chem Eng); Wojciech Misiolek (Mat Sci/Mech Eng); Herman Nied (Mech Eng); Daniel Ou-Yang (Phys); Raymond Pearson (Mat Sci); Jeffrey Rickman (Mat Sci); James Roberts (Chem); Donald Rockwell (Mech Eng); Slava Rotkin (Phys); Richard Sause (Civil & Env Eng); Mark Snyder (Chem Eng); Michael Stavola (Phys); Nicholas Strandwitz (Mat Sci); Svetlana Tatic-Lucic (ECE); Jean Toulouse (Phys); Dmitri Vezenov (Chem); Richard Vinci (Mat Sci);

Israel Wachs (Chem Eng); Masashi Watanabe (Mat Sci); Edmund Webb (Mech Eng); Zhiyuan Yan (ECE); Xiaohui Zhang (Mech Eng)

**Staff:** Andrea Harmer, Director of Web-based Instruction; Robert Keyse, TEM/FIB Manager; Katrina Kraft, Financial Manager; Gene Lucadamo, Industrial Liaison Officer; Laura Moyer, Laboratory Manager; William Mushock, SEM Manager; Susan Stetler, Coordinator.

The CAMN, which evolved from the Materials Research Center established in 1964, was formed in 2003 to demonstrate Lehigh University's commitment to the emerging field of nanotechnology and to expand and apply established strengths in advanced materials research. The CAMN's mission is to promote and engage in strategic areas of research and education in advanced materials and nanotechnology that meet the needs of students and industry. Areas of current research include nanoparticle synthesis, catalysis, biomaterials and biotechnology, interfacial kinetic engineering, polymer, ceramic, and metal nanocomposites, micro-electromechanical systems (MEMS), metals and alloys, microfabricated devices for clinical diagnostics, bio-sensors, materials for energy and electronics, and materials modeling.

### Innovative Interdisciplinary Research Programs with State and Federal Government

The CAMN is engaged in a variety of government supported research activities. One example is a multiyear University Research Commercialization Grant funded by the Pennsylvania Ben Franklin Technology Development Authority to study the control of behavior and properties of materials interfaces at the nanoscale, in order to engineer and optimize bulk properties. This program supports student research at Carnegie Mellon University and at Lehigh, equipment for CAMN user facilities, R&D assistance for PA companies, and translation of university R&D innovations to commercial applications. CAMN is also leading five universities in a five-year Multidisciplinary University Research Initiative (MURI) for the Office of Naval Research on engineering better materials through the understanding of interphase behavior at the atomic scale. Beyond these examples, CAMN seeks and participates in research projects funded by a number of other state and federal agencies.

### Projects, Programs and Relationships with Industry

The CAMN Industrial Liaison Program (ILP) facilitates interactions with industry to support R&D needs and create opportunities for innovation. The ILP connects with a range of technology based companies in need of expertise or laboratory resources, and manages company collaborations with faculty and students. It also helps companies obtain funding, develop products, solve problems, and stay competitive. These connections provide student exposure to industry challenges and practices, and can lead to internship and employment opportunities.

The Lehigh Nanotech Network (LNN) was founded by Lehigh in 2004. The LNN is an organization of over 180 business, education, and government members that facilitates the understanding and commercialization of nanotechnology. The LNN sponsors events for members to learn about nanotechnology applications and research programs, funding opportunities, and educational initiatives. It provides a way for companies to connect to the latest technologies and initiatives in the government sector, and to other members that are active in teaching, developing, applying, and commercializing nanotechnology. The LNN supports education and outreach to foster student interest and opportunities to learn about nanotechnology at many levels. The LNN currently includes over 180 organizations including regional economic drivers such as the PA Department of Community and Economic Development, Ben Franklin Technology Partners of Northeast PA, the Lehigh Valley Economic Development Corporation, the Manufacturers Resource Center, and the Lehigh Valley Workforce Investment Board.

### Multi-user State-of-the-Art Facilities

The CAMN Nanocharacterization Laboratory is a leading center for electron microscopy, with a diverse collection of characterization equipment. The laboratory houses one of the largest collections of electron microscopes of any university in the United States, and is managed and utilized by highly skilled scientists and engineers for cutting edge research. The facility currently houses transmission (TEM), scanning (SEM), and scanning transmission (STEM) electron microscopes, a focused ion beam instrument, an electron microprobe, e-beam lithography, and several scanning probe microscopes. A state-

of-the-art aberration corrected STEM can resolve images on a sub-nanometer scale (atomic level). Lehigh's Scienta ESCA, one of the best instruments for surface composition analysis via XPS, is the only one in the United States. Since 1970 Lehigh has trained over 5,800 scientists and engineers in electron microscopy through its world renowned annual Microscopy School.

#### **Innovative Educational Courses and Programs**

The CAMN facilitates programs of study and research that cross the traditional boundaries of science and engineering curricula, providing a fundamental, broad approach to the field of materials science and nanotechnology. Graduate students participating in research supported by CAMN usually receive a Master of Science or Ph.D. in the science or engineering discipline of their choice, or in an interdisciplinary program such as polymer science and engineering. Financial support for graduate students is available through the CAMN by means of research assistantships.

The CAMN Graduate Certificate Program in Nanomaterials enables students to gain a working knowledge of a broad range of materials, instrumentation, and techniques. Credits earned towards this certificate may be accepted as part of a Masters or Ph.D. in Materials Science and Engineering, or a Masters in Nanomaterials. A Minor in Nanotechnology can also be attained in connection with most engineering and science Bachelor degrees. Some examples of nanotechnology courses offered include Materials for Nanotechnology, Strategies for Nanocharacterization, Materials Structure at the Nanoscale, Electron Microscopy and Microanalysis, Advanced Transmission Electron Microscopy, Advanced Scanning Electron Microscopy, Thin Film Processing and Mechanical Behavior, and Crystallography and Diffraction.

The CAMN coordinates a statewide cooperative graduate course program called the Materials Pennsylvania Coalition (MatPAC), through which the six major Pennsylvania research universities (Lehigh, Carnegie Mellon, Penn State, University of Pennsylvania, University of Pittsburgh, and Drexel) can share specialized materials science and nanotechnology courses via video conferencing. Through the MatPAC, the CAMN also connects students with job opportunities.

For more information, contact Martin P. Harmer, Director, CAMN, Lehigh University, 5 E. Packer Avenue, Bethlehem, PA 18015-3194; mph2@lehigh.edu; website [www.lehigh.edu/nano](http://www.lehigh.edu/nano).

#### **Advanced Technology For Large Structural Systems (ATLSS) Research Center**

117 ATLSS Drive, Imbt Laboratories, Mountain Campus  
610-758-3525; Fax 758-5902; [www.atlss.lehigh.edu](http://www.atlss.lehigh.edu)

**Administration:** Richard Sause, Ph.D., Director, Manager, Infrastructure Monitoring Program; James M. Ricles, Ph.D., Deputy Director; Chad Kusko, Ph.D., Administrative Director; Ian Hodgson, P.E., Manager, Industrial Testing Program; Peter Y. Bryan, B.S., Manager computer systems; Doris Oravec, B.S., financial services; Geraldine Kery, research coordinator; Elizabeth MacAdam, research coordinator; Richard Sause, Ph.D., Codirector Pennsylvania Infrastructure Technology Alliance (PITA) and Research for Advanced Manufacturing in Pennsylvania (RAMP); James M. Ricles, Ph.D., Director RealTime MultiDirectional Testing Facility, (RTMD); Gary Novak, Operations Manager, RealTime MultiDirectional Testing Facility (RTMD)

**Faculty Associates:** Helen M. Chan, Ph.D., Materials Science & Engineering; John N. DuPont, Ph.D., Materials Science & Engineering; Dan Frangopol, Ph.D., Structural Engineering; Joachim L. Grenestedt, Ph.D., Mechanical Engineering & Mechanics; Wojciech Z. Misiolek, Ph.D., Materials Science & Engineering; Clay J. Naito, Ph.D., Structural Engineering; Herman F. Nied, Ph.D., Mechanical Engineering & Mechanics; Sibel Pamukcu, Ph.D., Civil & Environmental Engineering; Raymond A. Pearson, Ph.D., Materials Science & Engineering; Stephen P. Pessiki, Ph.D., Structural Engineering; James M. Ricles, Ph.D., Structural Engineering; Richard Sause, Ph.D., Structural Engineering; John L. Wilson, Ph.D., Structural Engineering; Shamim Pakzad, Ph.D., Structural Engineering; Muhannad T. Suleiman, Ph.D., Geotechnical Engineering; Paolo Bocchini, Ph.D., Structural Engineering

**Faculty Emeritus Associates:** John W. Fisher, Ph.D., emeritus, Structural Engineering; John H. Gross, Ph.D., emeritus, Materials Science & Engineering; Le-Wu Lu, Ph.D., emeritus, Structural Engineering; Alan W. Pense, Ph.D., emeritus, Materials Science & Engineering; Robert Stout, Ph.D., emeritus, Materials Science & Engineering; Ben T. Yen, Ph.D., emeritus, Structural Engineering;

**Research/Staff Associates:** Ian C. Hodgson, M.S., Infrastructure Monitoring; Thomas M. Marullo, M.S., Software Development/System Administration – RTMD; Sougata Roy, Ph.D., Infrastructure Monitoring/Fatigue; Robin Hendricks, Structural Testing

The ATLSS Research Center is a national center for research and education on structures and materials of the infrastructure. Established in May 1986 with a grant from the National Science Foundation (NSF), the Center now addresses the research goals of the NSF, the U.S. Department of Transportation, the Commonwealth of Pennsylvania, the U. S. Department of Defense, and numerous national, state, and local industry and government organizations and agencies. Approximately 80 people, including graduate and undergraduate students, research associates, faculty and staff members representing the disciplines important to large structural systems are active at the Center.

ATLSS research areas include: Advanced Structural Systems and Materials; Measurement, Simulation, and Evaluation of Structural Systems; Infrastructure Reliability, Maintenance, and Life-Cycle Performance; Intelligent Structural Systems; and Infrastructure Hazard Mitigation with particular emphasis on Earthquake-Resistant Structures. The research is conducted in close association with engineers and scientists from several Lehigh departments, industry, government, design and professional groups and other universities.

ATLSS has excellent research facilities and equipment, including two world-class structural testing facilities; the Fritz Engineering Laboratory and the ATLSS Multi- Directional Testing Laboratory, in which researchers study large-scale structural subassemblies under static, dynamic, and/or cyclic multidirectional loading with complete computer-controlled experimentation. A recent grant from the NSF created the real-time multi-directional (RTMD) equipment site for large-scale simulation of earthquake effects on structures as part of NSF's George E. Brown, Jr. Network for Earthquake Engineering Simulation (NEES). ATLSS also has outstanding resources for computing, mechanical testing, welding, metallography, and non-destructive evaluation.

#### **Research Activities**

##### **Advanced Structural Systems and Materials**

Research is conducted on new structural forms and structural systems to promote efficiency through innovation and to promote the competitive use of high-performance steel, concrete, fiber-composites, and mixed systems for bridge, building, and ship-hull applications.

##### **Measurement, Simulation, and Evaluation of Structural Systems**

Techniques for measuring and simulating the behavior of structural systems under realistic loading conditions are being developed and implemented in the laboratory and in the field. Lab and field assessments are made on bridge, highway, railway and ship structures for evaluating their behavior under load, and evaluating the effects of corrosion, fatigue, and other damage.

##### **Infrastructure Reliability, Maintenance, and Life-Cycle Performance**

Research is conducted on optimal design, maintenance, monitoring and management of infrastructure systems, and on structural health monitoring, structural damage models and assessment, and predicting the remaining life of structures considering uncertainty.

##### **Infrastructure Hazard Mitigation**

Research is conducted on engineering processes and structural systems and materials technology to predict and reduce economic losses and injuries from hazard events, such as earthquake, blast, fire, and vehicular impact.

##### **Intelligent Infrastructure Systems**

Research is conducted on materials, components, and systems for sensing, processing and utilizing sensor information, and adaptively controlling the behavior of the large-scale structures of the infrastructure.

### Educational Opportunities

The ATLSS Center facilitates broad programs of study and research in the fields of structures and materials. Graduate students in the Center's programs receive master of science, master of engineering, or doctor of philosophy degrees, usually in structural engineering, materials science and engineering, or mechanical engineering. Financial support for graduate students is available through the ATLSS Center by means of fellowships and research assistantships related to sponsored research programs.

Undergraduates participate in the Center's research through summer internships and academic-year special projects.

For more information, write to Dr. Richard Sause, Director, [rsaue@lehigh.edu](mailto:rsaue@lehigh.edu); Chad Kusko, Administrative Director, [chk205@lehigh.edu](mailto:chk205@lehigh.edu); or Elizabeth MacAdam, Research Coordinator, [es00@lehigh.edu](mailto:es00@lehigh.edu); ATLSS Research Center, Lehigh University, 117 ATLSS Drive, Bethlehem, PA 18015-4728; web-site address [www.atlss.lehigh.edu](http://www.atlss.lehigh.edu).

### Baker Institute for Entrepreneurship, Creativity and Innovation

11 East Packer Avenue, Bethlehem, PA 18015-3123, (610) 758-5626  
[www.lehigh.edu/entrepreneurship](http://www.lehigh.edu/entrepreneurship)

Todd A. Watkins, Ph.D., Executive Director and Arthur F. Searing Professor of Economics; Lisa Getzler-Linn, Director of Administration and Programs

Pasquale J. Costa; Dale F. Falcinelli; William Forster, Ph.D.; William R. Haller; Sandra F. Holsonback, Ph.D.; Michael Lehman, M.D.; Holona L. Ochs, Ph.D.; John B. Ochs, Ph.D.; Mark Orrs; Neal G. Simon, Ph.D.; Marc de Vinck; Silagh White, Ph.D.

The Baker Institute for Entrepreneurship, Creativity and Innovation actively fosters and champions the entrepreneurial culture at Lehigh to advance creativity and innovation for economic, cultural and social development. The Baker Institute is designed to create a culture of entrepreneurship across the university, promote innovative thinking and the realization of entrepreneurial ideas in any field. To that end, the principal goals of the Institute are to:

- Nurture the creative entrepreneurial mindset and skills—in any discipline—among students, faculty, staff and the community to develop a culture committed and able to bring about transformative change;
- Provide opportunities for Lehigh students of all disciplines and levels to graduate with the skills, experience and attitudes necessary to move creative ideas and new solutions for social problems successfully into sustainable practice;
- Provide supporting infrastructure that enables and significantly increases the likelihood of practical scaling up of innovative ideas and technologies to implementation and launch of new organizations.

Based squarely on a cross-university approach, the Baker Institute aims to expand the creative pipeline of innovation-related curricular and extra-curricular opportunities for students, faculty and the broader community. The Baker Institute serves as an umbrella organization to support and help coordinate, deepen and improve synergies among the substantial network of entrepreneurship-related programs on campus. By expanding resources for that network, and serving as a visible central portal, the Institute champions, highlights and promotes entrepreneurship opportunities on campus and throughout the community.

Institute operations include

- Strategic oversight for enhancing internal and external exposure and competitively differentiating Lehigh's overall entrepreneurship activities as a whole greater than its parts;
- Managing the Lehigh Entrepreneurs Network of Alumni for outreach and engagement of community and alumni, for students and faculty start-ups;
- Offering workshops, seminars and bootcamps to augment curriculum, together with youth and enhanced executive education programs;

- Managing and expanding entrepreneurship-related competitions and clubs;
- Leveraging opportunities for partnerships with government agencies and economic development organizations (national, state and local).

The Baker Institute also supports the entrepreneurship-related activities of academic departments and programs by:

- Funding curricular innovation and materials for
- Modifying existing courses to incorporate entrepreneurial thinking;
- Piloting new courses in disciplines across the entire university;
- Exploring alternative structures for courses and course delivery, such as scheduling outside conventional calendar, short courses, modular courses, and Web delivery;
- Organizing cross-college curricular coordination, synergies, and continuous improvement;
- Championing the development of new models of faculty, staff and student incentives to reward and promote entrepreneurial pursuits across many fields;
- Assisting faculty and student start-ups through
- Fostering mentoring relationships,
- Proof-of-concept and early stage venture funding, and
- Facilitating technology transfer, spin-outs, and other forms of commercial and social venture creation;
- Cost-sharing to attract entrepreneurial faculty, researchers, and visiting entrepreneurs for departments across a wide range of disciplines.

The overall objective of the Institute is to cultivate the ability of our students, faculty, staff and community members to develop new ideas that produce innovations and sustainable organizations with economic, technical and social benefit.

### Chemical Process Modeling and Control Research Center

Iacocca Hall, 111 Research Drive; 610-758-6654

Mayuresh V. Kothare, Ph.D., codirector; William L. Luyben, Ph.D., codirector; Hugo S. Caram, Ph.D.; William E. Schiesser, Ph.D.; Eugenio Schuster Ph.D.; James T. Hsu, Ph.D.

The mission of the Chemical Process Modeling and Control Research Center at Lehigh University is to advance the theory and application of feedback control techniques, dynamic modeling, optimization and automation, and to apply these tools to a range of chemical and biological systems. A key execution strategy involves close collaboration with industrial partners to identify and solve technological relevant automation problems.

The Center was established in January 1985 through the efforts of faculty members of the chemical engineering department at Lehigh University, leading industrial processing companies, the Ben Franklin Partnership Program of the Commonwealth of Pennsylvania, coupled with the organizational and financial support of the National Science Foundation (NSF).

The center provides a unique atmosphere for fundamental research, development of specific techniques, application to real industrial processes, and opportunities for advanced education (M.S. and Ph.D.) in chemical process modeling and control for academics and industrial practitioners. Facilities are available for real time testing of new algorithms in experimental process units, development of dynamic simulations of real processes, and the close collaboration with researchers in several other fields of chemical processing.

Interdisciplinary collaboration is encouraged with other research groups, centers, or institutes engaged in biotechnology, polymer processing, environmental science, applied statistics, signal processing, chemical reaction engineering, and process design.

### Education

An integral part of the center is the commitment to conduct an outstanding program dedicated to the education of undergraduate and graduate students. The center has and continues to attract top quality students from a large group of well recognized international universities.

In addition, each year several industrial companies send employees to receive advanced training and engage in research efforts for particular company technical requirements.

#### Faculty

The center brings together several faculty members from different engineering disciplines in the university engaged in the research and educational efforts of the center. Visiting faculty from other well recognized universities supplement these researchers and provide opportunities for diversity of thinking and innovative research. All of the associated faculty members are recognized around the world as leaders in their respective fields of specialization. They also serve as consultants to a variety of industries.

#### Facilities

The Center is located in Iacocca Hall on the Mountaintop Campus of Lehigh University. This building represents a unique facility available to the center as well as the chemical engineering department and the Emulsion Polymers and Bioprocessing Institutes. The center has the use of several dedicated computer facilities with numerous workstation computers continuously available to the students, faculty, and staff. In addition to the local computing network, the center's researchers have access to the Lehigh University central computing facilities and its outside links to other worldwide computing systems and data networks. The center has several laboratories with sophisticated equipment dedicated to process control research work.

#### Areas of Research

The research activities of the Center span a wide spectrum of problems in large complex chemical process design, dynamical analysis and control, as well micro and nanoscale complex process development, evaluation, dynamical analysis and control. A recently added area of research studies the role of feedback control in biological systems with particular emphasis on neuronal systems encountered in neuroscience and neurology. The research themes emphasize a combination of new theoretical developments, new applications and translation of new theoretical developments to practical problems.

##### 1. Synthesis and PlantWide Control

During the last decade Center faculty have done pioneering work in the area of plantwide control, which has resulted in the only textbook that covers this important area. There continue to be a number of projects in this area.

a. On Demand Control of Processes with Multiple Products: This project studies the design and control of processes in which consecutive reversible reactions produce multiple products. The demand for these products can vary, so the process and its control system must be able to produce exactly the desired amount of each individual product. An ideal system has been studied first in which the effect of equilibrium constants and volatilities can be explored. A real chemical system is also being studied (the production of methyl amines).

b. Design and Control of Tubular Reactors Systems: Adiabatic gasphase exothermic reactions are often carried out in tubular reactors. There are several types of systems: a single adiabatic reactor, multiple adiabatic reactors in series with either intermediate cooling or "cold shot" cooling (mixing some cold feed with the hot reactor effluent) and a cooled tubular reactor. These alternatives are being studied in terms of both steadystate design (which has the lowest total annual cost) and dynamic controllability (which provides the tightest temperature control in the face of disturbances).

##### 2. Dynamics and Control of Distillation

Reactive distillation is an emerging area in chemical engineering because it offers potential savings in capital and energy costs in some systems, particularly for reversible reactions. A recent project explored several reactive distillation systems: ETBE, methyl acetate, TAME, ethylene glycol and metathesis of pentene. The steadystate economic designs of these systems were studied. Then their dynamics and control were explored. Different types of chemical systems require types of control structures. These columns are sometimes operated using of an excess of one of the

reactants and sometimes using exact stoichiometric amounts of the two fresh reactant feeds. Both the process design and the control scheme are different with these two scenarios.

##### 3. Convex Optimization Techniques in Linear and Nonlinear Process Control

The last few years have seen the emergence of a new class of optimization problems that have been variously referred to as a Linear Matrix Inequalities (LMIs), semidefinite programming (SDP) problems and convex problems. We were one of the first groups to explicitly show the applicability of LMIs in process control by reformulating the modelbased predictive control (MPC) algorithms as LMI problems. There are several classes of problems involving control of systems subject to constraints that are amenable to LMI formulation. These include efficient offline MPC for fast sampling time processes, observerbased nonlinear, MPC, multimodel transition control using MPC, antiwindup, moving horizon estimation and evaluation of robustness, i.e., the impact of model uncertainty on controller performance. These new control algorithms are being tested on numerous application platforms.

##### 4. Multi-Model and Hybrid Systems Analysis and Control

Hybrid and multimodel systems are a class of systems in which there is interaction between continuous dynamical behavior of systems with discrete switching behavior. For example, systems described by piecewise linear multiple models are continuous and linear within a prescribed region and switch to a different linear model description in a different prescribed region of the statespace. Other examples include switches and overrides that switch one of a family of controllers into the closedloop, based on the operating space and control objective.

Our research in this area has focused on two broad problems (1) control of systems described by multiple piecewise linear models; (2) formulation of saturated systems as switched/piecewise linear models and subsequent antiwindup controller design using piecewise quadratic functions. We demonstrated, through a case study, the control of a highly nonlinear solution copolymerization reactor using multimodel switching MPC. We have also shown how an appropriate antiwindup controller synthesis problem can be formulated using piecewise quadratic Lyapunov functions.

##### 5. Dynamics and Control of Micro and Nanochemical Systems

Microchemical systems are a new generation of miniature chemical systems that carry out chemical reactions and separations in precisely fabricated three dimensional microreactor configurations in the size range of a few microns to a few hundred microns. Typical microchemical systems combine fluid handling and reaction capabilities with electronic sensing and actuation, are fabricated using integrated circuit (IC) manufacturing techniques and use silicon and related IC industry materials, polymers, ceramics, glass or quartz as their material of construction.

The goal of this integrated research and education program is to study the unique dynamical properties of such integrated microchemical systems and to develop a framework for designing implementable feedback control techniques for this class of microsystems. Concepts for distributed and boundary control theory will be employed to study the modelbased feedback control formulation of microchemical systems and to develop a technical framework for microsystem controller design. The Integrated Microchemical Systems Laboratory (under the direction of Professor M.V. Kothare) conducts this research as part of the Center.

##### 6. Control of Biomedical Systems: We are currently working on applying control techniques to emerging problems in biomedical engineering, in particular, in neuroengineering. This involves developing models of ensembles of neurons in the human brain and use of such models in optimizing closed loop neuroprosthetic rehabilitation strategies.

For more information, contact Mayuresh V. Kothare (coDirector) or William L. Luyben (coDirector), Center for Chemical Process Modeling and Control, Iacocca Hall, Lehigh University, 111 Research Drive, Bethlehem, PA 180154791, (610) 758- 6654, fax (610) 758- 5297, email: mayuresh.kothare@lehigh.edu, wl10@lehigh.edu.

## Developing Urban Educational Leaders (CDUEL) (The Center for)

111 Research Drive; 610-758-6093

[www.lehigh.edu/education/cduel/](http://www.lehigh.edu/education/cduel/)

George White, Ed.D., Director; Floyd Beachum, Ph.D., Bennett Professor of Urban School Leadership; Jon Drescher, Professor of Practice; Liza Robinson, M.Ed., Projects Director

The mission of CDUEL is to cultivate transformational educational leadership in urban communities by conducting research, developing leadership competencies, and improving leadership practice that enhances student learning and development. The center is committed to leaders who support education at all levels of a community, including teachers, principals, parents and human service workers. Special emphasis is placed on work involving small to midsized urban communities.

## Emulsion Polymers Institute

111 Research Drive; 610-758-3602

H. Daniel Ou-Yang, Ph.D., director; Eric S. Daniels, Ph.D., executive director; Bryan W. Berger, Ph.D.; Xuanhong Cheng, Ph.D.; Mohamed S. El-Aasser, Ph.D.; James F. Gilchrist, Ph.D.; Andrew Klein, Ph.D.; Tianbo Liu, Ph.D.; Jeetain Mittal, Ph.D.; Raymond A. Pearson, Ph.D.; James E. Roberts, Ph.D.; Cesar A. Silebi, Ph.D.; Mark A. Snyder, Ph.D.; Dmitri Vezenov, Ph.D.

Originally established in 1975, the Emulsion Polymers Institute (EPI), provides a focus for graduate education and research in polymer colloids. Formation of the institute constituted formal recognition of an activity that had grown steadily since the late 1960s. Recently, the research thrust of the Institute has been broadened to include **engineered particles**. The new focus is rooted in fundamental scientific-based particle design, but guided by identified applications, while still maintaining a core competency in emulsion polymerization. The rapidly broadening applications for particle technologies in fields such as biotechnology (e.g., drug delivery, imaging, assembly of biocompatible scaffolds), nanotechnology (e.g., directed assembly of hierarchically ordered, functional structures), and others demand a concomitant *diversification of the institute to include a broader class of particles*: polymeric, inorganic, hybrid, macroionic, metallic, as well as novel particulate composites designed at the nanoscale that will span all industrially-relevant scales.

The institute has close ties with polymer and surface scientists in the Center for Polymer Science and Engineering (CPSE), Center for Advanced Materials and Nanotechnology (CAMN), and the departments of chemical engineering, chemistry, physics, and materials science and engineering. These ties reflect the interdisciplinary nature of research that is carried out in the Institute.

### Research Activities

Fundamental particle research in the institute spans particle synthesis, particle functionalization, and directed assembly of particles into higher order, functional structures. Continuing emulsion polymers research is a blend of theoretical and experimental problems related to the preparation, characterization, and applications of polymer latexes and are aimed at understanding the kinetics, mechanisms, morphology, and the colloidal, surface and bulk of the latexes. Applications of this fundamental technology, resulting from interdisciplinary research among the faculty associated with the institute, stand to align well with the strategic university and college-level nanotechnology, biotechnology, and energy/environment initiatives. Many projects within EPI achieve what has been the largest obstacle to commercialization of nanotechnology: scalable process design of nanoscale functioning materials. Materials fabricated by EPI researchers are designed to function either as nano- or microscale sensors, material modifiers, or to self-assemble into advanced materials that depend on the nanoscale features of its constituents. In addition, engineered particle technologies developed at EPI and other institutions have allowed for the validation of soft condensed matter theories at scales available to experimentalists. In the biotechnology area, research focuses on diagnostic and therapeutic technology to prepare particles that are biocompatible, biologically

specific, easily detectable, and responsive to external controls. In the area of energy, work focuses on a variety of different unique particle technologies that may be used in applications such as catalysis and photocatalysts for the hydrogen economy, photovoltaics and solar cells, and membrane separations. In the environmental area, in addition to seeking novel particle technology for contaminant remediation in water, tailor-made colloidal particles with desirable surface properties, should provide model systems for fundamental insight into surface phenomena, relationships between bacterial adhesion to a surface and cellular bioenergetics, and bacterial transport through unsaturated porous media. Similarly, model porous media constructed by engineered particles could benefit research on the sources, fate and transport of bacteria in the environment, new water treatment technologies for developing countries, and alternative water disinfection technologies.

Research support for institute activities is obtained from industrial organizations through their membership in the Emulsion Polymers Industrial Liaison Program as well as government agencies. Hence some considerable effort is made to relate the research results to industrial needs. Consequently, graduates can find excellent opportunities for employment.

### Educational Opportunities

Graduate students in the Institute undertake dissertation research leading to the master of science or doctor of philosophy degree in existing science and engineering curricula or in the Center for Polymer Science and Engineering. Programs of study are tailored to meet the individual needs of each student and considerable flexibility is permitted in the selection of courses and a research topic. Educational and research opportunities exist for postdoctoral scholars and visiting scientists as well as resident graduate students. In addition, the institute holds a short course each June, "Advances in Emulsion Polymerization and Latex Technology" that typically attracts a number of industrial participants as well as EPI students and is an excellent opportunity to interact with industrial scientists and engineers.

For more information, write to H. Daniel Ou-Yang, Emulsion Polymers Institute, Iacocca Hall, Lehigh University, 111 Research Drive, Bethlehem, PA 18015. Please visit our web site at [http://fp2.cc.lehigh.edu/inemuls/epi/epi\\_home\\_page.htm](http://fp2.cc.lehigh.edu/inemuls/epi/epi_home_page.htm) for further details.

## Energy Research Center

117 ATLSS Drive; 610-758-4090

Edward K. Levy, Sc.D.; Harun Bilirgen, Ph.D.; Derek Brown, Ph.D.; Hugo S. Caram, Ph.D.; Joshua M. Charles, M.S.; Vladimir Dobric, Ph.D.; John N. DuPont, Ph.D.; Sharon Friedman, M.A.; Christopher Kiely, Ph.D.; Mayuresh Kothare, Ph.D.; Arnold H. Kritz, Ph.D.; Gerard P. Lennon, Ph.D.; Ursula S. Levy, M.B.A., C.M.A.; Charles E. Lyman, Ph.D.; Vincent Magnotta, M.S., M.B.A.; Sudhakar Neti, Ph.D.; Herman F. Nied, Ph.D.; Sibel Pamukcu, Ph.D.; Donald O. Rockwell, Ph.D.; Carlos E. Romero, Ph.D.; Eugenio Schuster, Ph.D.; Arup Sengupta, Ph.D.; Shivaji Sircar, Ph.D.; Arkady Voloshin, Ph.D.; Edmund B. Webb, Ph.D.; Zheng Yao, M.S.

Energy research at Lehigh involves faculty and students from a wide range of disciplines. The Energy Research Center coordinates the University's energy research, helping the faculty respond to research opportunities and developments in energy and providing the main point of contact between the university, industry and government for matters dealing with energy research. Originally founded in 1972 as the Task Force for Energy Research, the Center was organized into its present form in 1978.

### Energy Research

Research within the Center falls into five major categories. Projects of interest include:

#### Energy Conversion/Power Generation

This research program area has several components. The largest focuses on the equipment and processes used in large fossil-fired electric power plants, with research on methods of improving power plant conversion efficiency, of reducing emissions of carbon dioxide and of other gaseous pollutants, and of reducing the cost of generating electricity. A second group of projects deals with fusion energy, with an emphasis on the physics of magnetic plasma containment in fusion

reactors. Other projects deal with topics such as fuel cell conversion systems, hydrogen production, capture of carbon dioxide, and reduction of fresh water requirements for power plant cooling.

#### **Energy-Related Environmental Research**

The Center's environmental research program deals with air pollution, solid waste, and ground water contamination issues resulting from power generation and energy conversion activities; and reduction of amounts of fresh water required for power plant cooling.

#### **Energy-Related Materials Research**

This focus area considers materials issues in the energy field. Examples include high temperature coatings for boiler tubes, welding processes for new alloys, containment vessels for nuclear waste materials, component life prediction, and development of catalysts for pollution control. Energy Conservation and Renewable Energy. The Center's research program in energy conservation deals with reducing energy use in manufacturing and with the development of high efficiency electric motors. Renewable energy research focuses on utilization of biomass materials as fuels.

#### **Basic Energy Sciences**

Faculty and students in engineering and science also carry out research to improve our understanding of the basic phenomena that underlie the knowledge base required for developing new and improved energy technologies.

#### **Educational Opportunities**

The Center's research programs provide opportunities for graduate students interested in working in the energy area. Most of the departments in the College of Engineering and Applied Science, as well as several departments within the College of Arts and Sciences, are active in energy research and offer both masters and doctoral degree programs suitable for studies of energy-related topics.

All degrees are granted by the academic departments and graduate students interested in energy enroll in traditional graduate degree programs in departments of their choice. These students specialize in energy by complementing their programs with a selection of energy-related courses. They pursue their graduate research in energy areas under the supervision of faculty from the Energy Research Center or from other research centers or academic departments.

Financial support for graduate students is available through fellowships and research assistantships.

#### **Outreach and Industrial Liaison Activities**

The Center's Energy Liaison Program is a mechanism for providing consulting and problem-solving to member companies. The Liaison Program also provides opportunities for involving industry in sponsored research projects.

#### **Additional Information**

For more information, write to Edward K. Levy, Director, Energy Research Center, Lehigh University, 117 ATLSS Drive, Bethlehem, PA 18015, or e-mail at [ekl0@lehigh.edu](mailto:ekl0@lehigh.edu). Please visit our website at [www.lehigh.edu/energy](http://www.lehigh.edu/energy)

### **Enterprise Systems Center (ESC)**

The Enterprise Systems Center (ESC) was established in 1995. This multidisciplinary center is committed to providing student experiential learning and leadership development through industry value creation. ESC maintains a wide network of regional industry partner relationships to serve as a platform for course projects, summer and co-op projects and leadership immersion activities. Partnership and teaming on projects and programs is important and occurs frequently with the Department of Industrial and Systems Engineering as well as other departments and centers. The center seeks to advance interdisciplinary research and scholarship relating to analytics, information technology, new process development, sustainable manufacturing and enabling businesses to maintain global competitiveness. Additional research initiatives focus on discovering new methods for collaboration among academic, industry and government partners through the use of advanced technology. Emphasis is given to innovative systems approaches to problem-solving. Operating as one of the centers in the P.C. Rossin College of Engineering and Applied Science, the ESC is housed in Mohler Laboratory. The Enterprise Systems Center provides undergraduate

and graduate students from all four colleges with the opportunity to work on teams with faculty and industry professionals to solve a variety of real world problems. Participation in these work teams, with ESC's unique layered mentoring, provides students with a level of work experience representative of what they will encounter following graduation. This is often a critical factor in winning highly competitive employment positions. Since its inception, ESC has completed more than 1000 projects with industry and government partners. Over 3000 undergraduate and graduate students have benefited from experiential learning and leadership development through involvement with the Enterprise systems Center.

#### **Research Activities**

The ESC conducts research into the development and implementation of enterprise strategies to improve the effectiveness of organizations. This research involves the utilization of systems thinking, information technology, and leadership approaches that add value to engineering education. In its applied research efforts, the Center focuses on analytics techniques, operational improvements, enterprise resource optimization, sustainable manufacturing and product development or enhancement. Operational improvement research with partner companies has included the development of decision support systems, processes for workflow analysis and facility reorganization, analysis of constraints and throughput improvement, evaluating sustainable manufacturing opportunities, agile business practices, utilization of analytics tools and creating new solutions for supply chain management. Work in enterprise resource optimization has included methodologies for business process reengineering and for the analysis and selection of Enterprise Resource Planning (ERP) systems. Applied research in product development and enhancement has included the use of computer modeling and simulation along with analysis and evaluation of existing products, and design for manufacturability and assembly support.

Involvement in these applied research activities with industry partners provides Lehigh students with hands on learning experiences built on progressive responsibility and contribution to high impact company projects. From these activities, students gain leadership skills and valuable industry experience.

The creation of technology-enabled educational resources augments traditional learning models. Coupled with knowledge management technology, these resources create integrated learning experiences and materials to support engineering courses. The ultimate objective is to identify key components of innovative behavior and develop the educational methods necessary to transfer to students the skills and experiences that will prepare them for leadership roles in society.

The Enterprise Systems Center houses laboratories and initiatives that enhance the overall center mission stated as follows: "The ESC is committed to helping students learn, while simultaneously providing value for our clients. We believe that our research should be driven by industry needs and enabled by close partnerships and collaboration."

The newly established ESC Advanced Analytics Laboratory provides increased workspace and resources for industry projects and research programs. The laboratory supports a program structure designed to increase awareness, understanding and implementation skill development of a broad spectrum of analytics tools and techniques.

Within the ESC is the Learning Collaboratory, an innovative educational environment designed to promote inquiry-based and competency-driven experiential learning. It enriches the classroom lectures with practical experience through industry partner interactions. The Collaboratory supports team learning, action learning, and the application of technology to augment traditional educational resources.

#### **Educational Opportunities**

The ESC provides support for courses in the analysis and design of manufacturing systems, decision support systems (DSS), computer graphics (CAD), computer integrated manufacturing (CIM), industrial engineering techniques, analytics, experimental projects in industrial engineering, and leadership development. These courses are offered through the Industrial and Systems Engineering department. The ISE senior project class utilizes ESC facilities and a video teleconferencing

system to step beyond the traditional classroom experience in the preparation and presentation of its culminating presentation.

The ESC is continuously developing new programs as part of its Leadership Initiative. ESC has founded and is home to the engineering leadership minor, the leadership development course (IE382) was recently named as one of the top curriculum innovations by the Institute of Industrial Engineers. The Lehigh Chapter of the National Society of Leadership and Success and the Innovation and Leadership Residency Club are also managed as part of the Enterprise Systems Center operation.

Participation in industry partner projects is open to all Lehigh students, both undergraduate and graduate, regardless of academic major, based on an interview process.

For more information, contact Dr. Emory W. Zimmers, Jr., Director, Enterprise Systems Center, Lehigh University, Mohler Lab, Second Floor, 200 West Packer Avenue, Bethlehem, PA 18015 (ewz0@lehigh.edu) or visit our website <http://www.lehigh.edu/~inesc/>

## Global Islamic Studies, Center for

*Supported by the Office of Interdisciplinary Programs, Maginnes Hall, 9 W. Packer Avenue; 610-758-3996; incasip@lehigh.edu*

Website: <http://cgis.cas2.lehigh.edu/>

The Center for Global Islamic Studies (CGIS) is an intellectual community committed to the interdisciplinary study of Islamic civilization funded with the generous support of the Andrew W. Mellon Foundation. Cutting across numerous academic disciplines and departments, the Center supports the academic exploration of the diverse cultures and rich historical legacy of the Muslim world—from its roots in Abrahamic prophecy and Greek philosophy, to its long interaction with the West and profound impact on global culture, trade, art and architecture, literature, politics, philosophy, science and religious life, from Morocco to Malaysia to Bethlehem, Pennsylvania.

CGIS promotes teaching and research designed to take Islamic Studies into and beyond the classroom by offering students, faculty and the broader community a variety of forums for dialogue, debate and experiential learning. The Center's intellectual core is distinguished by three distinct signatures:

- an integrated undergraduate academic program that provides Lehigh students with multiple outlets to encounter the diversity and dynamism of global Islam
- a comparative, interdisciplinary approach to Islamic studies that goes beyond narrow geographic areas and political issues to explore the broader landscape of Islamic civilization, both past and present
- the translation of theory into practice, linking rigorous scholarship on the Muslim world to direct, practical, hands-on learning beyond the boundaries of the Lehigh campus

### Research Activities

Through the Mellon Foundation, the CGIS provides grants to Lehigh faculty to promote research in interdisciplinary, comparative Islamic Studies.

### Educational Opportunities

The launch of the Center for Global Islamic Studies is a pivotal component in the continued expansion of the undergraduate educational experience at Lehigh University. Drawing on the university's experience in building interdisciplinary programs, its institutional commitment to developing the necessary resources, and its substantive relationships with numerous Muslim partners both in the Lehigh Valley and internationally, the Center for Global Islamic Studies plays a central role in the university's mission to provide our students with transformative learning experiences that cross academic disciplines and broaden horizons on today's globalized world.

## Humanities Center

Eccentral Committee: M. Edurne Portela, Ph.D. (North Carolina), MLL – Spanish and Director Humanities Center; Seth Moglen, Ph.D. (California at Berkeley), English; Suzanne M. Edwards, Ph.D. (Chicago), English;

Mary Foltz, Ph.D. (University of Buffalo, SUNY), English; Khurram Hussain, Ph.D. (Yale), Religion; Nitzan Lebovic, Ph.D. (UCLA), History; John Pettegrew, Ph.D. (Wisconsin at Madison), History; Michael L. Raposa, Ph.D. (Pennsylvania), Religion; Nicholas Sawicki, Ph.D. (Pennsylvania), Art, Architecture and Design; Vera S. Stegmann, Ph.D. (Indiana), MLL – German

The Humanities Center provides a physical home as well as intellectual, financial, and organizational support for students, faculty, and staff who wish to come together to participate in humanistic inquiry, understood in the broadest possible terms. We seek to enrich the work of existing academic departments and programs in the humanities, by stimulating a wide range of activities that move beyond and across disciplines, urging members of the community to consider in the freest and fullest ways what humans are or have been, what humans have produced and are producing. We seek to break down the division between work and play, between the classroom and the rest of life. We aim to foster vibrant intellectual inquiry, and to diffuse the energies of such inquiry into the broader culture of the Lehigh campus. Each year, the Humanities Center's advisory board chooses a particular theme for interdisciplinary exploration. "Waste," "Just Globalization," "Contagion," "New Bethlehem," "Speaking Bodies" and "Excess" are recent examples and the center brings a series of distinguished scholars, intellectuals, artists and writers to address related issues.

### Research Activities

The Humanities Center fosters interdisciplinary research activity in several ways. Faculty, graduate students, and undergraduates may apply for funding to support reading groups, colloquia, conferences and visiting speakers. Graduate students may apply for modest financial support to enable them to travel to present research at academic conferences. The center sponsors a worksinprogress series, which fosters dialogue about ongoing research projects in the humanities. Summer, Individual and Collaborative Research Grants are available for faculty and graduate students. The objective of the grant is twofold:

1. to strengthen the intellectual community of Lehigh's scholars in the Humanities and
2. to provide support for faculty to pursue a humanistic research project or creative activity and for graduate students to finish their dissertations.

### Educational Opportunities

The Humanities Center hosts and sponsors the production of the Lehigh Review, an undergraduate research journal founded in 1992 by the Lehigh humanities faculty. Original articles range in topic and subject across the spectrum of undergraduate study, from English to Economics and Physics. Published annually, the entire publication process—from reviewing submissions to editing to design and illustration—is handled almost exclusively by undergraduate students and supervised by a graduate student instructor. The Humanities Center also hosts a wide range of informal activities to create a lively, unstructured humanistic community.

For more information visit the website <http://www.lehigh.edu/~inhum/index.html> or contact the Director, M. Edurne Portela at the Humanities Center, 224 West Packer Avenue, Bethlehem, PA 18015 or by email at [mep8@lehigh.edu](mailto:mep8@lehigh.edu).

## Institute for Interactivist Studies

Interactivism is a philosophical and theoretical approach to modeling multiple biological, mental, and social phenomena. It is attracting interest from scholars and researchers around the world. For a general description, see: <http://www.lehigh.edu/~mhb0/InteractivismManifesto.pdf>

The primary functions of the Institute for Interactivist Studies are:

1. to build on the growing interest in the model,
2. to promote interactivist research,
3. to give Lehigh greater visibility within this wider community of people involved in the interactivist research program.

The primary focus of the Institute is the sponsoring of Summer Institutes on Interactivism. These are being held biennially, and the tradition is to alternate between North America and Europe for location. We

have organized six International Summer Institutes: 2001 at Lehigh; 2003 in Copenhagen; 2005 at Clemson University; 2007 in Paris; 2009 in Vancouver; and 2011 in Syros, Greece. These have attracted philosophers, psychologists, biologists, roboticists, and linguists from more than twenty countries. ISI 2013 is planned for Tampa, Florida.

The Institute also:

1. sponsors the Interactivist Forum, an email discussion group which currently has about 140 members from some 25 countries,
2. sponsors an institute web site — <http://www.lehigh.edu/~interact/index.html>,
3. encourages and sponsors visiting scholars,
4. participates in contributing to the journal *New Ideas in Psychology*, published by Elsevier, and
5. encourages collaborative work — we currently have about half a dozen publications co-authored by institute affiliates, and special issues on Interactivism in two journals are in press or planned.

For more information, contact Mark Bickhard, Director, [mhb0@lehigh.edu](mailto:mhb0@lehigh.edu).

### **Institute for Metal Forming**

5 E. Packer Avenue; 758-4252

Wojciech Z. Misiolek Sc.D., director, John C. Chen, Ph.D., Xuanhong Cheng, Ph.D., John P. Coulter, Ph.D., John DuPont, Ph.D., Edwin W. Force II, Sabrina Jedlicka Ph.D., Christopher Kiely Ph.D., Samuel Lawrence, Alparlslan Oztekin, Ph.D., Sudhakar Neti, Ph.D., Herman F. Nied, Ph.D., Michael Rex, Jean Toulouse, Ph.D., Kemal Tuzla Ph.D., Masashi Watanabe Ph.D.

The Institute for Metal Forming was established in 1970 to teach the principles and applications of metal forming technology to graduate and undergraduate students, to provide instructions and equipment for graduate research in metal forming processes, and to assist industry with solutions to problems in metal forming.

The main objective of the institute's research is to conduct cross-disciplinary process engineering studies to better understand and control manufacturing processes and their impact on the microstructural response of a material. The material microstructure developed during processing is responsible for physical properties of the material. Recently, classical metal forming research has been expanded to include projects in powder processing, microstructure characterization and analysis, as well as forming processes for polymers, glasses, and ceramics.

The study of the forming processes encompasses physical and numerical modeling; simulation of microstructure response to process parameters. Computer enhanced analysis of material flow also allows us to optimize tooling design in many manufacturing processes. The combined quantitative results of these techniques may then be compared with experimental data obtained from instrumented metal forming laboratories (such as those maintained at the institute), or from our research partners in industry.

#### **Research Activities**

Current research areas include: extrusion of metals, metal and ceramic powders, glasses, polymers, sheet material formability, rolling, wire drawing, forging, semi-solid forming, light-optical and electron-optical micro-texture characterization, tooling design and tooling materials, thermo-mechanical processing of metals, rapid prototyping, rapid tooling, and machinability of the sintered powder materials. Additionally new research projects have been initiated in development of materials for medical and energy applications.

#### **Educational Opportunities**

Students interested in metal forming should refer to course offerings in the departments of materials science and engineering, mechanical engineering and mechanics, and industrial and manufacturing systems engineering.

For more information contact Wojciech Z. Misiolek, Director, Institute for Metal Forming, 242 Whitaker Laboratory, Lehigh University, 5 East Packer Avenue, Bethlehem, PA 18015

### **International Materials Institute for New Functionality in Glass**

7 Asa Drive. 758-1112. [www.lehigh.edu/imi](http://www.lehigh.edu/imi)

Himanshu Jain, Eng.Sc.D., Director; Carlo G. Pantano, Ph.D. (Penn State University), Co-Director; William R. Heffner, Ph.D., Associate Director; Sarah Wing, Program Coordinator

Lehigh's International Materials Institute for New Functionality in Glass (IMI-NFG) was founded in 2004 on a program by the same name and sponsored by the National Science Foundation under an initiative to advance materials research globally by enhancing coordinated international collaboration between U.S. researchers and educators and their counterparts worldwide. The Institute's long term goal is the creation of a worldwide network in glass research for new applications, and the development of a new generation of scientists and engineers with enhanced international leadership capabilities. Among all the IMI's established in the country, IMI-NFG is the only one dedicated to a single class of materials. Specifically on campus, it promotes new activities in glass research through international and national collaborations, and the development of new approaches to the education of glass. Faculty and students from various Departments of Rossin College of Engineering and Applied Science, and College of Arts and Sciences participate in its activities listed below.

Half of the 20 most significant inventions of the 20th century, as identified by the National Academy of Engineering, would not have materialized without glass. The solutions to 12 of the 14 grand engineering challenges of this century depend on the availability of glass either as a support material or as an active component for sensing, information storage, treatment delivery, etc. The discovery of new phenomena, along with continually improving properties and processing methods, will keep glass at the cutting-edge of technology. Unfortunately, in recent decades glass education has fragmented with the result that a larger number of students is exposed to glassy materials, but with relatively shallow, cursory knowledge that does not prepare them to become a professional glass scientist or engineer. To meet these challenges IMI-NFG is pooling together resources of educational institutions, leading glass companies, national laboratories and professional organizations from across the globe. Thus, it is promoting research through synergistic collaborations and international exchange of researchers at undergraduate to faculty level as well as training glass professionals through internet and other education technology to create a new generation of scientists and engineers with enhanced leadership capabilities.

The programs of IMI-NFG are carried out with the guidance of a US Board of 11 Advisers from as many US institutions, and an International Board of 8 Advisers from as many countries, who also act as ambassadors of the Institute to various technical communities and geographical regions. In addition, 7 senior executives of the world's leading glass companies help identify the technical areas in greatest need of research and development. To keep the scope of its activities focused, currently IMI-NFG is supporting collaborative research within four thrust areas, viz. active glass, strength of glass, biomedical glass and low-Tg glass. To avoid duplication, the various activities are coordinated with existing glass organizations such as the Glass Manufacturing Industry Council, International Commission on Glass, and Center for Glass Research.

To promote international research collaborations for new uses of glass, and to make glass education available without geographical boundaries, IMI-NFG sponsors and provides support for several programs as summarized below:

#### **International Research Exchange Program**

International Research Exchange Program, which is available to the faculty, postdocs, graduate students or industry researchers from any institution in the world to establish collaborations with colleagues in USA. This opportunity can be catalytic to building new international teams of complimentary expertise. It has supported numerous short and long term visitors to Lehigh campus, including sabbatical stay of professors from abroad who have taught courses and lectured at Lehigh, and developed new multinational research teams.



### Development of Educational Material

Development of Educational Material such as video DVDs and hands-on demonstrations by the leading international glass experts to promote the understanding of glass at all levels. A variety of over 200 video tutorial lectures and overviews of the latest progress is available via Internet to interested students without charge. For example, a full semester course on Optical and Photonic Glasses consisting of 39 lectures is accessible from IMI-NFG's web site. The teachers at Lehigh and other universities and colleges will find this collection a useful resource for their lectures. Professionals in industry can learn the subject by studying these lectures.

### Research Experience for Undergraduates (REU)

This program provides support for the involvement at an early stage of US undergraduates in active glass research during summer at Lehigh / Penn State University or at an overseas institution. Stipends are available for the Lehigh students to participate in glass research during the regular semester as well.

### International Conference Travel Scholarship

International Conference Travel Scholarship for undergraduate, graduate and postdoctoral researchers at US universities to present their work on new functionality in glass at an international meeting. Through this program IMI-NFG hopes to give the new generation of researchers a perspective of current challenges from an international point of view, simultaneously encouraging discussions and collaborations among glass scientists from different parts of the world.

### Research Experience for Teachers (RET)

This program is for middle and high school teachers, who will then introduce glass knowledge to pre-college students through the popular glass art – glass science interface.

For more information, contact Prof. Himanshu Jain, Director, International Materials Institute for New Functionality in Glass, Lehigh University, Sinclair Lab 120, 7 Asa Drive, Bethlehem, PA 18015. (Tel: 610-758-4217); Dr. Bill Heffner, Associate Director (610-758-6677); Sarah Wing in the IMI Office (610-758-1112). Web site: [www.lehigh.edu/imi](http://www.lehigh.edu/imi) or e-mail [imi@lehigh.edu](mailto:imi@lehigh.edu).

### Lawrence Henry Gipson Institute for Eighteenth-Century Studies

9 W. Packer Avenue; 610-758-4424

Scott Paul Gordon, Ph.D., co-director; Monica Najar, Ph.D., co-director; William Bullman, Ph.D.; Marie Helene Chabut, Ph.D.; Stephen H. Cutcliffe, Ph.D.; Elizabeth Dolan, Ph.D.; Lyndon Dominique, Ph.D.; Edward J. Gallagher, Ph.D.; Michelle LeMaster, Ph.D.; James S. Saeger, Ph.D.; John Savage, Ph.D.; Jean R. Soderlund, Ph.D.

The Lawrence Henry Gipson Institute for Eighteenth-Century Studies was established in 1971, to honor one of America's most distinguished scholars, who served as a long-time member of the faculty at Lehigh. Gipson's monumental life work, *The British Empire Before the American Revolution* (15 volumes) was written between 1936 and 1970. Gipson received the Pulitzer Prize in History in 1962 for Volume 10, subtitled, *The Great War For Empire*. When he died in 1971, Professor Gipson left his entire estate to Lehigh and provided the original endowment for the institute.

### Research Activities

The income from the endowment of the institute is used to encourage faculty and student research in the eighteenth century by providing grants to defray travel costs, copying, and other expenses to permit scholars to visit necessary libraries and depositories. The Gipson Institute normally awards one fellowship annually to a Ph.D. candidate enrolled at Lehigh University for dissertation research and writing in any field of eighteenth-century studies. The institute also helps provide additional resources to build the university library's research collections in eighteenth-century studies.

### Educational Opportunities

The institute invites leading scholars to give lectures and supports relevant programs such as interdisciplinary seminars and visiting scholars interested in the eighteenth century. Occasional symposia honor Professor Gipson by bringing to campus distinguished scholars

to lecture and discuss various topics. The essays generated at the symposia have been published and the institute maintains a continuing close relationship with Lehigh University Press for publishing original manuscripts on the eighteenth century.

For more information, write to either of the co-directors, Monica Najar, Department of History, Maginnes Hall, 9 W. Packer Ave., or Scott Paul Gordon, Department of English, Drown Hall, Lehigh University, 35 Sayre Drive, Bethlehem, PA 18015.

### Martindale Center for the Study of Private Enterprise

Rauch Business Center, 621 Taylor Street, Room 350; 758-4771

J. Richard Aronson, Ph.D., director; Robert J. Thornton, Ph.D., associate director; Todd Watkins, Ph.D., associate director and director of the Microfinance Program; Judith McDonald, Ph.D., associate director and director, Canadian Studies Institute; Anne M. Anderson, Ph.D.; Henri Barkey, Ph.D.; Paul A. Brockman, Ph.D.; Stephen H. Cutcliffe, Ph.D.; James Dearden, Ph.D.; Thomas Hyclak, Ph.D.; Janet M. Laible, Ph.D.; Vincent Munley, Ph.D.; David H. Myers, Ph.D.; Paul Salerni, Ph.D.; Roger Simon, Ph.D.; Richard Weisman, Ph.D.

**Faculty Emeriti:** Richard W. Barsness, Ph.D.; Carl R. Beidleman, Ph.D.; Raymond Bell, Ph.D.; James Saeger, Ph.D.; Oles M. Smolansky, Ph.D.; Howard R. Whitcomb, Ph.D.

**Staff:** Sharon P. Bernstein, Program Director; Rosemary H. Krauss, Coordinator; Robert Kuchta, assistant director for marketing.

The Martindale Center for the Study of Private Enterprise, part of the College of Business and Economics, was established in 1980 with a gift from Harry and Elizabeth Martindale. The primary purpose of the center is to contribute through scholarship to the advancement of public understanding of the structure and performance of our economic system.

Attention is focused on the private sector of the economy and on public policies as they influence the private sector. To achieve this end, the center activities include the sponsorship of lectures and conferences, support of faculty research, and administration of the visiting scholar and executive-in-residence programs. The center sponsors and administers the Martindale Student Associates Program (for undergraduates) and the publication of their journal, *Perspectives on Business and Economics*. The center has established: the Canadian Studies Institute which encourages scholarship dealing with the business and economic environment of Canada and with U.S./Canadian business and economic relations; the Microfinance Program; and along with the Department of International Relations, partners with the U.S. Department of State to offer a lecture series on the Global Political Economy. Started in 2009, along with the College of Business and Economics Graduate Programs Office, the center sponsors Martindale MBA Fellows, an educational exchange with the University of Nottingham (UK).

For more information, write to Dr. J. Richard Aronson, Director, Martindale Center for the Study of Private Enterprise, Rauch Business Center, Lehigh University, 621 Taylor Street, Bethlehem, PA 18015. [www.lehigh.edu/martindale](http://www.lehigh.edu/martindale)

### Murray H. Goodman Center for Real Estate Studies

621 Taylor Street; 610-758-4786

Stephen F. Thode, DBA, director

The Murray H. Goodman Center for Real Estate Studies was established in 1988 through a major gift from Murray H. Goodman, '48. The center is a self-supporting, interdisciplinary unit of the College of Business and Economics. The center provides financial support and other assistance for courses in real estate and real estate finance, supports scholarly research in real estate, and sponsors joint activities with practitioners in the real estate field.

### Educational Opportunities

The center provides resources for the teaching of graduate and undergraduate courses in real estate, real estate finance, and ire@I (Integrated Real Estate at Lehigh). ire@I is a three- to four-year course of study open to all undergraduate students at Lehigh.

The ire@I curriculum consists of:

**Core Courses**

IPRE 001	Introductory Seminar in Real Estate	3
IPRE 002	Field Laboratory	2
IPRE 301	Case Studies in Real Estate Value Creation	3
IPRE 347	Practicum in Real Estate I	2
IPRE 348	Practicum in Real Estate II	2
IPRE 302	IPRE Internship (mandatory summer internship)	1

**Optional Courses**

IPRE 101	Real Estate Practicum Clerkship I	1
IPRE 102	Real Estate Practicum Clerkship II	1

**Additional Courses**

FIN 336	Real Estate Finance	3
GBUS 425	Real Estate Financing and Investing	3

In addition, the center sponsors a continuing series of seminars and presentations by real estate executives and practitioners through the ire@l program. As part of the ire@l program, the center also serves as a clearinghouse for students seeking internships with real estate firms and related companies.

**Research Activities**

Consistent with the university's encouragement of scholarly research, the center provides funding for faculty research in the real estate area. Funding possibilities include: summer faculty research grants; travel, telephone and administrative support; and grants for part-time graduate assistants. The center also maintains a file of sponsored research opportunities available through private foundations, government agencies and practitioner organizations and provides administrative support to faculty applying for such funding.

**Practitioner Interaction**

The third aspect of the center's activities is its interaction with practitioners in the real estate field. The increased emphasis on continuing education and research among real estate practitioner organizations, as well as Lehigh's proximity to major real estate markets, enable the center to engage the practitioner community in a variety of joint projects. These joint projects include:

1. sponsored research projects;
2. continuing education programs and short courses;
3. special conferences and events of national and/or regional interest; and,
4. center-sponsored databases and continuing activities of interest to the practitioner community.

For more information, write to Dr. Stephen F. Thode, Director, Murray H. Goodman Center for Real Estate Studies, Rauch Business Center, Lehigh University, 621 Taylor Street, Bethlehem, PA 18015, or call (610) 758-4786 or email [sft0@lehigh.edu](mailto:sft0@lehigh.edu).

**Philip and Muriel Berman Center for Jewish Studies**

9 W. Packer Avenue, Bethlehem, PA 18015; 610-758-4869

Berman Center Web Site (<http://catalog.lehigh.edu/graduatestudyandresearch/researchcentersandinstitutes/philipandmurielbermancenterforjewishstudies/%20http://www.lehigh.edu/~inber/inber.html>)

Martin Kavka, Ph.D., Director; Chava Weissler, Ph.D.; Robert L. Cohn, Ph.D. (Lafayette College); Nitzan Lebovic, Ph.D., the Helene and Allen Apter Chair of Holocaust Studies and Ethical Values. Associated faculty: Bunnie Piltch, M.A.; Ruth K. Setton, Ph.D.; Roslyn Weiss, Ph.D.; Benjamin G. Wright III, Ph.D.; Laurence J. Silberstein, Ph.D., emeritus.

The Philip and Muriel Berman Center for Jewish Studies, established in 1984, develops, administers, and coordinates a comprehensive program in Jewish studies at Lehigh University. The center is directed by Martin Kavka, Philip and Muriel Berman professor of Jewish Studies.

Eight faculty members, including three Philip and Muriel Berman professors, teach Jewish studies classes at Lehigh. In 2001, as the result of a gift from Susan Ballenzweig Beckerman, the center

established the position of Writer-in-Residence in cooperation with the department of English. In 2007, the Helene and Allen Apter Chair of Holocaust Studies and Ethical Values was created with the generous support of Helene and Allen Apter '61 and Lehigh's College of Arts & Sciences.

Other activities of the center include designing and implementing new courses and seminars, an annual lecture series, scholarly colloquia, and academic conferences. Conditions permitting, the center organizes the "Lehigh in Israel" summer program taught by Lehigh faculty and provides financial awards to Lehigh undergraduates for study in Israel through the Howard Ballenzweig Memorial Fund. In addition, the center publishes a book series with New York University Press titled *New Perspectives on Jewish Studies*.

For more information on the Berman Center and its programs, write to Dr. Martin Kavka, Director, Philip and Muriel Berman Center for Jewish Studies, Lehigh University, 9 W. Packer Avenue, Bethlehem, PA 18015, or call 610 758-4869 ([inber@lehigh.edu](mailto:inber@lehigh.edu)).

**Polymer Science and Engineering (Center for)**

111 Research Drive; 610-758-3590

M.S. El-Aasser, Ph.D.; Ivan Biaggio, Ph.D.; Manoj K. Chaudhury, Ph.D.; John Coulter, Ph.D.; Gregory Ferguson, Ph.D.; J. Gilchrist, Ph.D.; J. Grenestedt, Ph.D.; Ned Heindel, Ph.D.; A. Jagota, Ph.D.; Andrew Klein, Ph.D.; Tianbo Liu, Ph.D.; A.J. McHugh, Ph.D.; H.F. Nied, Ph.D.; H. Daniel Ou-Yang, Ph.D.; Ray Pearson, Ph.D., director; Steven L. Regen, Ph.D.; James Roberts, Ph.D.; Cesar A. Silebi, Ph.D.; Arkady S. Voloshin, Ph.D.

The Center for Polymer Science and Engineering (CPSE) was formally established at Lehigh University in July 1988. The center provides a unique opportunity for faculty and students from the traditional departments of chemistry, chemical engineering, materials science and engineering, mechanical engineering and mechanics, and physics to perform interdisciplinary research in polymers. The center is an umbrella organization encompassing polymers research and graduate studies at Lehigh University. The center's primary missions are preparation of first rate scientists and engineers with proficiency in polymers, fostering cross disciplinary polymer research, organizing and teaching continuing education short courses in areas of interest to the polymer industry; and organizing campus wide seminars.

The center's Polymer Education Committee graduate studies through the academic departments leads to the Master of Science, Master of Engineering, and Doctor of Philosophy in Polymer Science and Engineering. Students may also elect to pursue studies towards a classical degree in their respective departments with an emphasis in polymer courses and research. Both advanced undergraduate and graduate courses in polymer science and engineering are offered through the participating departments. Current course offerings include polymer synthesis and characterization laboratory, physical polymer science, organic polymer science, engineering behavior of polymers, rheology, polymer processing, emulsion polymers, polymer blends and composites, colloid science, and polymer interfaces.

**Research Activities**

The center has a wide range of research activities covering the field of polymers. The following are the major research themes: emulsion polymerization and latex characterization, surface/interfacial aspects of polymer colloids, adhesion, polymer blends and composites, polymerization mechanisms and kinetics, polymerization reactors modeling and control, structure/property relationships of interpenetrating polymer networks, macromolecular chemistry of biopolymers and coal, polymer coatings for corrosion protection, and microelectronic packaging.

**Research Facilities**

The following research instrumentation is available for the Center for Polymer Science and Engineering: X-Ray Photoelectric Spectroscopy (ESCA), Scanning Auger Electron Spectroscopy, Laser Raman Spectroscopy, Mossbauer Spectroscopy, Nuclear Magnetic Resonance Spectroscopy of both solids and solutions (NMR) (3 instruments; 90 MHz, 300 MHz and 500 MHz), Fourier Transform Infrared Spectroscopy (FTIR) (both conventional and photo-acoustic), a variety of advanced

transmission and scanning electron microscopes, modulated differential scanning calorimetry, hi-res-thermogravimetric analysis, instruments for rheological studies (including a Rheometrics ARES system), particle sizing instruments (Coulter N4M, Joyce-Loebl Disc Centrifuge, Capillary Hydrodynamic Fractionation, and Hydrodynamic Chromatography), Gel Permeation and Gas Chromatography units, Electrophoretic Mobility apparatus, mechanical testing devices such as the screw-driven Instrons, several computer-controlled servohydraulic fatigue test machines, and Polymerization Reactors, including Bottle Polymerizer, Tubular Reactor, Stirred Tank Reactors with on-line sample analysis for residual monomer and inter faced with computer for control operations.

#### **Educational Opportunities**

Programs of study for individual students are designed to meet the student's interests, the requirements of the academic department, and the student's dissertation committee. Considerable flexibility is permitted in the selection of courses and a research topic. Lehigh University has been awarding interdisciplinary M.S. and Ph.D. degrees in Polymer Science and Engineering since 1975. Graduate students conducting polymer research may also earn the M.S. and Ph.D. degrees in the classical fields of chemistry, chemical engineering, materials science and engineering, physics, or mechanical engineering and mechanics. For further information please refer to the Polymer Science and Engineering Program in the section: Interdisciplinary Graduate Programs.

For more information about the center activities, admission to graduate school, or financial aid, contact; Dr. Raymond A. Pearson, Director, Center for Polymer Science and Engineering, 5 East Packer Avenue, Bethlehem, PA 18015; (610) 758-3857. Dr. James E. Roberts, Chairman, Polymer Education Committee, Lehigh University, 6 East Packer Avenue, Bethlehem, PA 18015; (610) 758-4841, or Anne Marie Lobley, Coordinator, Lehigh University, 5 East Packer Avenue, Bethlehem, PA 18015; (610) 758-4222. Please address applications to one of the participating departments. Please visit the web site: [http://fp2.cc.lehigh.edu/inpolctr/cpse\\_home\\_page.htm](http://fp2.cc.lehigh.edu/inpolctr/cpse_home_page.htm) or e-mail [rp02@lehigh.edu](mailto:rp02@lehigh.edu), [jer1@lehigh.edu](mailto:jer1@lehigh.edu), [amme@lehigh.edu](mailto:amme@lehigh.edu).

#### **Promoting Research to Practice - Schools, Families, Communities (Center for)**

L111 Iacocca Hall, 111 Research Drive 610-758-3258

Edward S. Shapiro, Ph.D., Director, Linda Bambara, Ph.D.; Mary Beth Calhoun, Ph.D., George J. DuPaul, Ph.D.; Lee Kern, Ph.D.; Patricia Manz, Ph.D.; Ageliki Nicolopoulou, Ph.D.; Brook Sawyer, Ph.D.; George White, Ph.D.; Perry A. Zirkel, Ph.D.

The Center for Promoting Research to Practice seeks to develop practical solutions to real problems for those individuals at risk or who have disabilities. All too often research that is created for these individuals remains at the development level and is not disseminated into best practices. Using an interdisciplinary approach and establishing a living laboratory through partnerships with schools, parent and families, and community service and support providers, the Center aspires to distinguish itself as a leader at state, regional, and national levels in addressing the need for the production of research to reach the users and consumers of research. The mission of the Center for Promoting Research to Practice (CPRP) is to generate new knowledge that will favorably impact the lives of individuals with or at risk for disabilities and promote the use of evidence based best practices by schools, families, and community service providers. The Center emphasizes the conducting of applied research, partnership, and dissemination.

#### **Applied Research Opportunities**

The CPRP focuses on securing research projects that emphasize bringing research findings from the field and moving them into effective practice with evaluation of outcomes. The projects secured by the CPRP faculty focus on individuals who have identified areas of disability or are considered at risk for developing disabilities. Currently, the Center has research projects examining the most effective intervention strategies for improving behavioral and academic outcomes for students with behavior disorders. One project focuses on understanding effective, scientifically based interventions in educating students who present severe challenges to the schools. Another, focuses on the teaching of

reading to middle school students who are severely reading disabled. Recently completed projects include the implementation and evaluation of progress monitoring within a Response to Intervention model of school-wide change in six high need elementary schools in two diverse school districts, evaluation of the Philadelphia home-school visitor model for infants and toddlers, and a project focused on the evaluation of the Early Reading First initiative to improve early literacy in Head Start preschool children.

#### **Partnership**

The Center forms and maintains partnerships at national, regional, and local levels. Several objectives are established to accomplish this goal. The CPRP assists with the development and implementation of research projects designed in local school districts and intermediate units. Many school districts, particularly small and rural districts, do not have the capacity to engage in widescale research efforts. Yet, these districts often have very significant needs for empirically based decision making. The CPRP provides a cost effective vehicle for these districts to engage in such research efforts. Another level of partnership for the CPRP is interdisciplinary research within the University community. This objective is met through facilitating cross-college and cross-program proposals. Continuous efforts are made to invite colleagues from across departments and colleges in the University to join with faculty in the College of Education in pursuing research interests that are within the mission of the Center. Efforts also continue to conduct research with colleagues across institutions. Past projects have included partner institutions such as University of California Riverside, University of Missouri, University of Pittsburgh, and the James Madison University, the Institute for Learning and Literacy in Allentown, as well as the Pennsylvania Training and Technical Assistance Network.

#### **Dissemination**

The CPRP is a resource for distilling and bringing research findings to the field. Investigators conducting research have published the outcomes of findings in professional journals and outlets. In addition, the CPRP initiates dissemination to parents, teachers, and other practitioners in a format that more easily affects practice.

The Center's mission, goals, current accomplishments, as well as its future initiatives are disseminated to groups both on- and off-campus. Included in its objectives are the development of publicity about the Center itself and outcomes of Center projects through varied forms of communication across campus as well as institutions of higher education, local/state educational agencies, community agencies, and parent groups.

For more information, contact Dr. Ed Shapiro, Director, Center for Promoting Research to Practice, Lehigh University, Room L111 Iacocca Hall, 111 Research Drive, Bethlehem, PA 18015; (610-758-3258) or email [ed.shapiro@lehigh.edu](mailto:ed.shapiro@lehigh.edu); Web site: [www.coe.lehigh.edu/cprp](http://www.coe.lehigh.edu/cprp).

#### **Sherman Fairchild Center for Solid-State Studies**

16A Memorial Drive, East

Miltiadis Hatalis, Ph.D., Interim Director; Filbert Bartoli, Ph.D.; Ivan Biaggio, Ph.D.; Slade Cargill, Ph.D. (Emeritus) Sherman Fairchild Professor of Solid State Studies; Volkmar Dierolf, Ph.D.; W. Beall Fowler, Ph.D. (Emeritus); James Hwang, Ph.D.; Ralph Jaccodine, Ph.D. (Emeritus) Sherman Fairchild Professor of Solid State Studies; H. Daniel OuYang, Ph.D.; Slavav V. Rotkin, Ph.D.; Michael Stavola, Ph.D., Sherman Fairchild Professor of Solid State Studies; Svetlana Tatic-Lucic, Ph.D.; Jean Toulouse, Ph.D.; George D. Watkins, Ph.D. (Emeritus), Sherman Fairchild Professor of Solid State Studies; Marvin H. White, Ph.D. (Emeritus), Sherman Fairchild Professor of Solid State Studies.

The Sherman Fairchild Center (SFC) is an endowed Center, which was established through a major grant from the Sherman Fairchild Foundation and opened in the fall of 1976. The goal of the SFC is to strengthen and further develop a program of excellence in nanoscience and engineering through the integration of research and education for both undergraduate and graduate students – a partnership program between engineering, the physical sciences, and the life sciences. The laboratory houses an interdisciplinary staff consisting of faculty and students from the departments of electrical and computer engineering,

materials science and physics. While work on various aspects of solid state science is carried out at many locations on the Lehigh campus, the Sherman Fairchild Center provides the focal point for studies of electronic materials and devices with an emphasis on nanoscience and engineering. The SFC has broadened its research scope in recent years to include emerging areas, such as bioelectronics, biophotonics, and flexible electronics. The SFC, since its inception, has graduated over 180 Ph.Ds.

#### Research Activities

The Sherman Fairchild Center's faculty and students have a wide range of interests that include experimental and theoretical studies of the physics of defects in nonmetallic solids and of disordered materials; advanced semiconductor processing technology, and semiconductor device, sensor and circuit design, fabrication, and characterization; theoretical modeling of nanoscale devices. The materials systems of interest are equally diverse and include silicon, silicon dioxide, silicon nitride, compound semiconductors, wide bandgap semiconductors (SiC, ZnSe, and GaN), ferroelectrics, glasses, thin film semiconductors as well as non-conventional nanomaterials, such as nanotubes/graphene.

The Sherman Fairchild Center houses several experimental laboratories. The Nanoelectronics Research Laboratory provides processing facilities for the fabrication of advanced CMOS, SONOS nonvolatile memory devices, sensors, and integrated circuits. Available technology includes low pressure chemical vapor deposition, RF, DC and electron beam metallization, plasma chemistry, ebeam nanolithography, photolithography, oxidation, diffusion, and Deep Reactive Ion Etching. The Flexible Electronics and Display Research Laboratory provides research on polysilicon and metal oxide thin film transistors and thin film materials for flexible electronics, sensors and flat panel displays. The Microelectromechanical Systems (MEMS) Research Laboratory, in collaboration with the Nanoelectronics and Flexible Electronics and Display Research Laboratories, carries out research on sensors and transducers with a focus on biomedical, biometric and other applications. The Compound Semiconductor Research Laboratory has facilities for characterizing high speed devices and microwave integrated circuits.

Individual laboratories, within the Sherman Fairchild Center, provide instrumentation for optical excitation and luminescence, deep level transient spectroscopy (DLTS), and Fourier transform infrared spectroscopy (FTIR) for the study of defects in semiconductors. There are also facilities for the study of Raman spectroscopy ultrasonic attenuation. Theoretical work is facilitated by the university's high-performance computing facilities, including several clusters and dedicated SM and GPU workstations.

Current research programs include work on

1. nanoelectronics, a study of the characterization of small geometry solid state devices with emphasis on high k dielectrics for CMOS transistors;
2. SONOS nonvolatile semiconductor memories for a "semiconductor disk";
3. active matrix displays;
4. flexible electronics and sensors for applications in health care, homeland security and infrastructure monitoring;
5. MEMS sensors for biological cell stiffness for the study of osteoporosis;
6. the fundamental properties of impurities and simple lattice defects in silicon and wide bandgap compound semiconductors; a variety of methods (crystal growth, diffusion, electron irradiation) are used to introduce defects which can then be studied by spectroscopic techniques;
7. quantum mechanical calculations of the structural, vibrational, and electronic properties of defects in various semiconductors and conducting oxides;
8. the fabrication and characterization of high speed, compound semiconductor integrated circuits;
9. the collective dynamics of partially ordered and disordered ferroelectrics and glasses;
10. photoluminescence and electroluminescence with optical excitation of defects and site selective spectroscopy of defects in solids;

11. nonlinear optics and carrier transport in photoconductors, organic thin films and crystals with research into improving the nonlinear optical response in small organic molecules;
12. biophysics with optical tweezers for trapping and manipulation of biological cells to study intracellular mechanical properties;
13. device physics of nano-carbon materials, theoretical study of nanotube parallel array transistors and diodes, their transport, optical and thermal properties;
14. optical characterization of rare-earths complexes with nanotubes.

#### Educational Opportunities

Graduate students associated with the Sherman Fairchild Center usually enroll for the master of science or doctor of philosophy degree in the traditional discipline of their choice, such as electrical engineering, materials science, physics, etc., with specific course requirements and research participation coordinated through their advisor and the appropriate department chairperson. Students are financially supported by graduate fellowships provided by the Sherman Fairchild Foundation, government and industrial grants obtained by researchers in the SFC, and/or by university resources, which provides teaching assistantships and research assistantships. These arrangements typically permit graduate students in the general area of solid state studies to take 3 courses per semester in addition to their teaching or research activities. There are numerous opportunities for undergraduate students to participate in the research activities of the center with the support during the summer through the Fairchild Summer Scholars Program.

For more information write to Miltiadis K. Hatalis, Interim Director of the Sherman Fairchild Center for Solid State Studies, Lehigh University, 16A Memorial Drive E, Bethlehem, PA 18015-3184.

#### Social Science Research Center (SSRC)

The multidisciplinary Social Science Research Center assists university faculty, community groups, government agencies, and businesses with conducting empirical research. The center is unique in its support for the collection and rigorous analysis of both qualitative and quantitative data. Recent past projects range from federally-funded and collaborative scholarly studies to small on-campus studies by undergraduates. Our involvement in projects varies from one-time consulting on specific aspects of a research program to contracts for fully conducting a project from start to finish.

The goals of the SSRC are to expand and support scholarly research in the social sciences by Lehigh faculty; enrich undergraduate and graduate education by providing research training and opportunities for students and course projects; and partner with community-based organizations for program evaluations and needs assessments. Support for the SSRC comes from the Dean of the College of Arts and Sciences and from the university's Vice-Provost for Research.

Faculty and students affiliated with the SSRC are drawn from across the university and trained in a variety of methodological techniques, including telephone and face-to-face surveys, in-depth and life history interviewing, focus groups, document analysis, analysis of audio and video recordings, geographic information systems (GIS) analysis, and advanced statistical analysis.

SSRC facilities include 6 computer lab work-stations, computer-assisted telephone survey software, computer-assisted qualitative analysis software, GIS and statistics software, professional transcription equipment, and meeting space for collaborative research teams.

For more information, go to the SSRC's website at <http://www.lehigh.edu/ssrc> or contact Ageliki Nocolopoulou, Director, Social Science Research Center, 337 Chanler-Ullman Hall, Bethlehem PA 18015, [agn3@lehigh.edu](mailto:agn3@lehigh.edu).

#### Value Chain Research (Center for)

Rauch Business Center, 621 Taylor St.

#### Center Mission

The Center for Value Chain Research (CVCR) is committed to supporting and sharing research and information through the integration of emerging theory and best practices. The center's research focuses

primarily on, but is not limited to, value chain planning and development activities, which connects corporate strategy with value chain execution.

#### What the Center Does

- Provides a unique, multidisciplinary approach to research, offering exciting new opportunities for innovation by integrating analytical and quantitative engineering approaches with process-driven and field-based business research.
- Conducts professional development seminars and symposiums, APICS certification courses, and executive round tables.
- Disseminates research findings through professional conferences, scholarly publications, and curriculum development.

#### Affiliated Faculty

Robert Trent, Ph.D., Director; Liuba Belkin, Ph.D.; William Forster, Ph.D.; Doug Mahony, Ph.D.; Corinne Post, Ph.D.; Catherine Ridings, Ph.D.; Nada Sanders, Ph.D.; Michael D. Santoro, Ph.D.; Susan Sherer, Ph.D.; Oliver Yao, Ph.D.; Zach Zacharia, Ph.D.

For more information, contact Prof. Robert Trent, Director, (rjt2@lehigh.edu), Center for Value Chain Research, Lehigh University, Rauch Business Center, 621 Taylor Street, Bethlehem, PA 18015; (610-758-5157). Web site: [www.lehigh.edu/cvcr](http://www.lehigh.edu/cvcr)

#### Other-University Related Centers

##### Ben Franklin Technology Partners of Northeastern Pennsylvania

The Ben Franklin Technology Partners of Northeastern Pennsylvania (BFTP/NEP) is headquartered in Ben Franklin TechVentures® on the Mountaintop campus and is a wholly-owned subsidiary of Lehigh. Serving a 21-county region, the Center is part of a four-member, state-funded economic development program that is an initiative of the PA Department of Community and Economic Development and is funded by The Ben Franklin Technology Development Authority. Ben Franklin frequently utilizes the faculty, students, and resources of Lehigh to accomplish its tasks.

BFTP/NEP fosters innovation to stimulate economic growth. By providing knowledge and investment resources, Ben Franklin facilitates the creation of new products, sophisticated technologies, and novel processes among entrepreneurs and established companies to help them prosper. The result: the creation and retention of highly paid, sustainable regional jobs and a strong economic climate.

The goals of BFTP/NEP include helping early-stage technology-oriented firms to form and grow, helping established manufacturers to improve productivity through the application of new technologies and practices, and promoting an innovative community-wide infrastructure that fosters a favorable business environment for high-growth companies. Founded in 1983, the Ben Franklin Technology Partners of Northeastern Pennsylvania has:

- Created and retained 37,465 jobs.
- Established 442 new companies.
- Commercialized and developed 1,189 new products and processes.

The Ben Franklin program is structured to help companies achieve sustainable competitive advantage. Statewide, new tax revenue generated because of Ben Franklin represents a 3.6-to-1 payback to the Commonwealth.

Assistance includes expertise, largely contributed in the northeast by the center's association with Lehigh and other leading research universities, and funding, with investments ranging from \$30,000 to \$150,000 per year for up to three years. Faculty and students involved with Ben Franklin gain experience in solving real issues for working companies. Technical and business assistance services are provided on a year-round basis.

BFTP/NEP owns and operates Ben Franklin TechVentures, an award-winning business incubator and post-incubator facility. Fifty-five successful companies have graduated from the BFTP/NEP incubator, grossing more than \$984 million in annual revenue last year and

creating more than 5,400 jobs. Ben Franklin TechVentures is LEED Gold certified.

For more information, contact the Ben Franklin Technology Partners of Northeastern Pennsylvania, Lehigh University, Ben Franklin TechVentures, 116 Research Drive, Bethlehem, PA 18015-4731; 610-758-5200; [www.nep.benfranklin.org](http://www.nep.benfranklin.org) (<http://www.nep.benfranklin.org>). E-mail: [info@nep.benfranklin.org](mailto:info@nep.benfranklin.org).

##### Manufacturers Resource Center (MRC)

Founded in 1988, MRC is one of seven statewide Industrial Resource Centers (IRCs) established to help small and mid-size manufacturers grow and remain competitive. In 1994, MRC joined the National Institute of Standards and Technology (NIST) Manufacturing Extension Partnership (MEP) which is comprised of 59 nationwide centers. MRC works with manufacturing companies by leveraging its own staff of experienced Business Development Managers with public and private sector resources. Through our assistance and work with manufacturers, we help raise the economic level of the region by creating high impact, cost-competitive manufacturers.

With its main office located on Lehigh's Goodman Campus, MRC serves all of Lehigh, Northampton, Berks, Carbon and Schuylkill counties. MRC offers services in four broad areas:

- Strategic Business Growth Services to help companies grow through strategic development, sales, marketing and product development;
- Operational Excellence services that include Lean, Six Sigma, Quality and Hoshin Deployment programs. We incorporated sustainability and coaching components into our Lean training and now apply a Green lens for greater profitability and cost savings;
- Business Performance and Technology Services to help mentor companies in financial analysis and strategies, capital sourcing and management, mergers and acquisitions, establishing visual business intelligence systems, technology and innovation strategies, "Green" and Sustainability transformations, tax credit opportunities, and other related services.

For further information or assistance, please contact Jack Pfunder, MRC President and CEO at 610-758-5596 or 800-343-6732. Please visit our website at [www.mrcpa.org](http://www.mrcpa.org) (<http://www.mrcpa.org>).

##### Manufacturing Systems Engineering (Center for)

200 W. Packer Avenue; (610) 758-5157

Keith M. Gardiner, Ph.D., director; Hisham Abu-Nabaa; John P. Coulter, Ph.D.; Steven L. Goldman, Ph.D.; Parveen P. Gupta, Ph.D.; David J. Hinrichs; Jacob Y. Kazakia, Ph.D.; John B. Ochs, Ph.D.; Lawrence V. Snyder, Ph.D.; Robert J. Trent, Ph.D.; George R. Wilson, Ph.D.

The Center for Manufacturing Systems Engineering was created in response to the expressed needs of industry for educational and research services which were distinctively cross-disciplinary. A primary responsibility of the center is the administration of an award winning educational program leading to a Master of Science degree in Manufacturing Systems Engineering. This world renowned program started in January of 1984 as a result of a major initiation grant from the IBM Corporation. It now has 396 alumni who are working as managers and technical leaders in industry around the world. The center has four major thrusts:

1. A graduate program which offers a curriculum leading to the Master of Science degree in MSE.
2. Research directed at solving problems of manufacturing; this also serves to maintain faculty currency and provides a vehicle for student project and thesis studies.
3. Technology transfer to sustain the free flow of knowledge from the research laboratories to industrial applications, and from leading edge member industries back into the classrooms.

4. The provision of services by supporting conferences, clinics, workshops and other means for communicating and disseminating the advantages of sound manufacturing systems engineering practice.

#### **Graduate Education**

The 30-credit master's degree MSE program is cross-disciplinary, administered through the College of Engineering and Applied Science, with additional courses provided by the College of Business and Economics. Four core courses, 4-5 graduate level elective courses (at least one elective must be an MSE-numbered course) and a 3 or 6 credit research project or thesis are requirements of all candidates for the M.S. degree. Courses are offered on campus and scheduled so that part-time students can complete the degree in two years. It is possible for distance students to earn the MS in MSE degree remotely. Special activities in the program are team intensive and include in depth studies of companies, tours of industry, industry-related research and internships. Additionally, an MSE option is available in the MBA&E program.

#### **Research Activities**

Students in the MS in MSE program undertake research of interest either to their employers, or to industry in general. Research activities range from microelectronics packaging, the use of lead free solders, welding specifications, pharmaceutical industry processes and equipment development qualification, design management, and process development for surgical products. There are investigations into activity-based costing, design management, application of financial information systems, and injection molding. There is collaboration with other centers, departments and laboratories in the preparation and planning of research proposals and programs which aim to improve the understanding of manufacturing.

For more information, contact: Keith M. Gardiner, kg03@lehigh.edu, Director, Center for Manufacturing Systems Engineering, H. S. Mohler Laboratory, Lehigh University, 200 W. Packer Avenue, Bethlehem, PA 18015, or call (610) 758-5157 or visit our website at [www.lehigh.edu/mse](http://www.lehigh.edu/mse)

#### **Philip Rauch Center for Business Communications (The)**

621 Taylor Street; 758-4863

Joseph M. Manzo, MBA, director

The Rauch Center for Business Communications supports the business curriculum for both undergraduate and graduate programs.

Courses/programs administered through the center include BUS 005 and the Excel Competency program. BUS 005 is a one credit required course in the undergraduate program which addresses the foundations of business integrity. The Excel Competency program addresses the analysis and presentation of data in the context of business. This program is a prerequisite for 3 core courses in the undergraduate curriculum.

The center also partners with the faculty to develop methods for improving students' writing and presentation skills. Programs are developed with the faculty and are integrated into the syllabus for the faculty member's course where writing and/or presentations are required.

For more information, write to Anne Nierer, Coordinator, The Philip Rauch Center for Business Communications, Lehigh University, 621 Taylor Street, Bethlehem, PA 18015-3117, or email [JMM6@lehigh.edu](mailto:JMM6@lehigh.edu) or phone 610-758-4863.

#### **Small Business Development Center**

Sandra F. Holsonback, Ph.D., director; Mary Beth Zingone, associate director; Kim Edwards, B.S.Ed., program director, Financing Assistance Program; David Dunn, B.S., program director, Government Marketing Assistance Program; Cora Landis, program director, Lexnet; Christine Cleaver, B.S., program director, South Bethlehem Assistance Program. ([www.lehigh.edu/sbdc](http://www.lehigh.edu/sbdc))

Established in 1978, the SBDC provides general management assistance to over 1,000 entrepreneurs and small businesses per year in the Lehigh Valley and surrounding areas. Primary funding for

this program comes from major grants from the U.S. Small Business Administration and the Commonwealth of Pennsylvania.

#### **Specialized Programs**

The Management Assistance Program delivers general management consulting to existing small firms and startup ventures. Services are offered to retail, service, wholesale, construction and manufacturing firms. Research is offered through electronic data base research. Seminars are offered on many topics of interest to start-up and growing firms.

#### **International Trade Development Program (ITDP)**

The International Trade Development Program (ITDP) is a specialized outreach effort of the Small Business Development Center. The ITDP helps companies with exportable products to develop export marketing plans and establish direct contacts with international markets. Seminars, trade missions and research projects support the efforts of this program.

#### **Government Marketing Assistance Program**

The Government Marketing Assistance Program assists potential suppliers to government sales in identifying and developing procedures. Clients are handled on a one to one basis. Trade fairs and seminars are also offered.

#### **Financing Assistance Program**

The Financing Assistance Program provides assistance in loan packaging and financial planning and helps clients identify appropriate financing sources. The program administers the Lehigh Valley Small Business Loan Pool and the Lehigh Valley Chapter of the Northeastern Pennsylvania Angel Network, a partnership program with the Ben Franklin Technology Partners of Northeastern PA. Contracts with the Lehigh/Northampton Revolving Loan Fund, the Lehigh Valley Economic Development Corporation and other funding agencies provide resources for this assistance.

#### **Lehigh Valley Export Network (LEXNET)**

The Lehigh Valley Export Network (LEXNET) is the regional office of the Team Pennsylvania Export Network. Throughout the year LEXNET brings PA foreign office representatives to the Lehigh Valley to meet with SBDC clients and discuss in country export assistance needs. LEXNET also assists with export finance programs such as Market Access Grants allowing small and mid-sized manufacturing or service companies to participate in international trade events. Specialized training events and seminars are also held throughout the year.

#### **South Bethlehem Assistance Program (SBAP)**

The South Bethlehem Assistance Program (SBAP) is a specialized outreach effort of the SBDC that provides technical assistance to businesses located in the South Bethlehem Area.

#### **Technology Business Development Program (TBDP)**

The TBDP provides assistance to companies in the areas of technology, product development, patent searches, trademarks, copyright, Internet strategies, commercial potential, business socioeconomic certifications and defense conversion. Special assistance with SBIR/STTR research funding opportunities is available. Clients are handled on a one to one basis. Seminars and workshops are also available.

#### **Business Education and Training Program (BETP)**

The Business Education and Training Program of the Small Business Development Center provides specialized workshops, seminars and customized training for the small business community.

#### **Small Business Consulting (formerly LUMAC)**

The Lehigh University Small Business Consulting Program (a graded three-credit course) was established in 1972 on the initiative of undergraduate students. Through support from the SBDC, approximately 150 students per year gain practical experience by providing counseling to sixty businesses.

For more information, write to Sandra Holsonback, Director, Small Business Development Center, 125 Goodman Drive, Bethlehem, PA 18015

## Courses, Programs and Curricula

For more information about specific academic programs and opportunities, see the following pages.

College of Arts and Sciences (p. 55)

College of Business and Economics (p. 245)

College of Education (p. 279)

P.C. Rossin College of Engineering and Applied Science (p. 293)

Interdisciplinary Undergraduate Study (p. 369)

Interdisciplinary Graduate Study and Research (p. 380)

### College of Arts and Sciences

Donald E. Hall, *dean*; Garth Isaak, *associate dean*; Frank Davis, *associate dean*; Diane T. Hyland, *associate dean*.

The College of Arts and Sciences is the heart of Lehigh University offering a wide variety of academic majors, minors and programs, while also providing essential liberal arts access to all Lehigh students. Arts and Science faculty are engaged as active scholars, are highly accessible, and are committed to the teaching mission of our undergraduate programs. A hallmark of our college is the faculty's ability to engage students interactively and experientially in research and scholarship.

Students in the College develop new habits of mind that characterize the liberal arts education, such as testing assumptions, respecting evidence, and probing the unknown with curiosity and an open mind. Those habits prepare our graduates to thrive in an uncertain world. Through a combination of college-wide distribution requirements and major field requirements, Lehigh Arts and Sciences students investigate and acquire knowledge of human cultures and the physical and natural world by studying arts and humanities, mathematics, natural sciences, and social sciences.

Studying broadly in the areas above and concentrating deeply in a major field will help develop intellectual traits and skills needed to create the lifelong learning habits necessary to confront constantly changing social conditions, emerging technologies, careers and lives.

The College of Arts and Sciences offers several curricular options:

- A four-year arts and sciences curriculum leading to a bachelor of arts or bachelor of science degree in designated fields
- A five-year arts-engineering curriculum leading to a bachelor's degree from the College of Arts and Sciences and a bachelor of science degree from the College of Engineering and Applied Science
- Double degree programs within the college and in conjunction with the other two undergraduate colleges.

#### Teacher Preparation

- A five-year program leading to a bachelor's degree from the College of Arts and Sciences and a master's degree in Education from the College of Education

Specific requirements for many of the degree programs described in this section may be found in Section V.

#### Major Degree Programs in the College

##### Bachelor of Arts and Bachelor of Science Degree Programs

Two distinct bachelor-degree programs are offered by the College, each distinguished mainly by the proportion of courses taken in the major field. For the Bachelor of Arts degree the student takes a comparatively smaller number of courses to fulfill the major requirements plus a selection of courses in various fields outside the major. For the more professionally oriented Bachelor of Science degree, offered by the College in designated disciplines, the student takes a more extensive concentration in the major field, along with a proportionally smaller number of courses outside the major. Except for this distinction, the same basic requirements must be met for both degree programs (including the minimum number of 120 hours for graduation and the minimum average in the major of 2.0). No more than six hours of military science may be applied toward either degree.

#### Bachelor of Arts Degree

##### Humanities

Architectural history, architecture, art, art history, Asian studies, classical civilization, classics, design arts, English, modern languages and literature (French, German and Spanish), music, music composition, philosophy, religion studies, theatre

##### Social Sciences

Africana studies, anthropology, cognitive science, economics, environmental studies, global studies, history, international relations, IR/MLL joint major, journalism, journalism/science writing, political science, psychology, STS (science, technology and society), sociology/social psychology, sociology and anthropology, urban studies, women, gender and sexuality studies

##### Mathematics and Natural Science

Astronomy, behavioral neuroscience, biology, chemistry, computer science, earth and environmental science, mathematics, molecular biology, physics

BA degrees in premedical science, premedical science, or preoptometry science are available to students who are admitted to certain combined degree programs (see Health Professions Programs).

#### Bachelor of Science Degree

Astrophysics, behavioral neuroscience, biochemistry, biology, chemistry, computer science, earth and environmental science, mathematics, molecular biology, pharmaceutical chemistry, physics, psychology, statistics

#### General Plan of Undergraduate Study

Students in the College are required to choose - usually by the end of the sophomore year - a major field and to complete a program of courses, selected in consultation with the student's adviser, to provide the breadth that is the mark of a liberal education. For most students, the credits earned for the major and those earned for the distribution requirements are not enough to meet the graduation requirement of 120, and students take free elective courses in areas of interest to earn the remaining credits. Three schemes of courses - one in the student's area of concentration (the major-field requirements), a second set drawn from certain designated disciplines (the distribution requirements representing the minimum set), and a third set without constraints (the free electives) - make up the educational program in the College.

#### Major Field of Concentration

By majoring in a specific discipline, a student establishes a foundation of knowledge in that field, learns to frame its particular kind of questions, and starts to apply its traditional body of knowledge. By submitting to increasingly challenging and complex exercises in a distinct discipline over several semesters under the guidance of mature practitioners, the student can start to feel the rewards of intellectual mastery of a subject. The student thus experiences the gratification of developing expertise and intellectual sophistication.

Along with introductory courses in the discipline, the minimum number of credits for the major is 30. The student must maintain a minimum grade-point average of 2.0 in the major field.

#### Standard major sequences

When a student chooses one of the standard majors, a faculty member from the department or program offering the major becomes a student's major adviser and assists the student in constructing a program of study. In all cases, the final responsibility for meeting both major and non-major requirements rests with the student.

#### Special interdisciplinary majors

In addition to the standard major programs, specially structured interdisciplinary major sequences between majors are possible. For example, a student interested in a professional school of urban or regional planning might wish to structure a special major consisting primarily of courses in political science and economics or in economics and social relations.

Any student may, with the aid of faculty members chosen from the disciplines involved, devise an interdisciplinary major program to include

not less than thirty credits of related course work, of which at least 15 credits must consist of advanced courses. The major advisers and the dean of the college must approve the program.

#### Multiple majors and Double degrees

A student who wishes to fulfill the requirements for more than one major program has two options. A double major is a single BA degree with two majors (some students complete triple majors). A student pursues a double major by declaring both majors. Typically, double majors can be completed in four years, but sequencing of courses and time conflicts with required courses can introduce delays. No more than three courses may overlap two majors. A double degree program is a combined BA and BS program or two Bachelor of Science degrees in one or more of our undergraduate colleges. The BA is in the College of Arts and Sciences, and the BS may be in any one of the three undergraduate colleges. A student pursues a double degree by declaring the first program and then petitioning the standing of students committee for permission to pursue the second degree program. A special balance sheet and a major declaration for the second degree must accompany the petition to pursue a second degree. The double-degree student must satisfy major and distribution requirements for both degrees and earn a minimum of 30 additional credits beyond those required for the first degree. All of the 30 additional credits must be taken at Lehigh or in Lehigh residency programs. The requirement of 30 additional credits typically makes the double degree program a five-year program. There is no limit on the number of overlapping courses between two degrees, but there must be at least 30 credits of non-overlapping coursework in each degree program. For administrative purposes, students who take two degrees or two majors must designate one as the primary major or primary degree.

#### Distribution Requirements

Whatever expertise in a single discipline an undergraduate may achieve, in the course of a lifetime, curiosity lures most of us beyond the confines of a single chosen specialty. Furthermore, in a swiftly changing world, careers are being rapidly redefined, and only a person of broad intellectual orientation can intelligently consider where one may be most useful to our society and find most personal gratification. Many of the basic modes of thought and work in various fields are being reformulated, often producing surprising influences in the public and private spheres. In this world-to devise for oneself a satisfying professional life and to be a responsible citizen-one needs some awareness of the concepts and methods specific not to one field only but to a variety of disciplines.

The distribution requirements are the four domains of learning in which the College faculty requires students to develop an introductory level of expertise through encountering the body of knowledge that each discipline has gathered, the kinds of phenomena it describes and manipulates, and the types of problems it addresses. Specified numbers of credits are required in each of the four domains: the mathematical sciences, the natural sciences, the social sciences, and the arts and humanities.

#### Distribution Requirements for the B.A. and the B.S.

##### College Seminar/First-Year Class

One course during the first year	1-4
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##### English Composition

Two courses during the first year	6
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##### Mathematical Sciences <sup>1</sup>

Chosen from mathematics or designated courses from philosophy or computer science	3
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##### Natural Sciences <sup>1</sup>

Chosen from those designated in: astronomy, biological anthropology, biosciences, chemistry, earth and environmental sciences, physics, and neuroscience.	8
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At least one science course must also include the associated laboratory.

##### Social Sciences <sup>1</sup>

Chosen from those designated in: anthropology, classics, economics, political science, history, international relations, journalism, psychology, social psychology, social relations, sociology, STS, and urban studies.	8
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##### Arts and Humanities <sup>1</sup>

Chosen from those designated in: architecture, art, classics, history, modern languages and literature, English, music, philosophy, religion studies, and theatre.	8
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<b>Total Credits</b>	<b>34-37</b>
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<sup>1</sup> Students and advisers should monitor closely the progress toward completion of requirements. Courses taken to satisfy a major program may be used to satisfy distribution requirements in only one distribution area.

Total required for graduation: 120 credits

A student's program, including the choice of distribution requirements, is not official until approved by the adviser.

#### Eckardt Scholars Program

The Eckardt Scholars Program is a highly selective and unique honors program in the College of Arts and Sciences. The program emphasizes deep intellectual curiosity, independent work, and close mentoring relationships between the very highest achieving students and faculty at Lehigh. Each graduating class at Lehigh includes approximately twenty Eckardt Scholars per year. These students receive unique academic privileges, which propel them to great opportunities at Lehigh and beyond. Students in the program are exempt from the Arts & Sciences distribution requirements and work with their major advisor and the Eckardt Scholars Program Director to create a flexible course of study that best suits their academic interests and ambitions. Although exempt from Arts and Sciences distribution requirements, students will complete the requisite number of credits for their degrees and all correlative requirements for their departmental or interdisciplinary majors. The program includes participation in two Eckardt Scholar Seminars, and completion of a large independent project (in the form of a thesis, artistic creation, or other capstone experience) during the senior year.

Participation in the Eckardt Scholars Program is restricted to only the most especially well-qualified students, some of whom are invited to enroll at the time of admission to the university, and the rest whom are identified and encouraged to apply by faculty members during their first few semesters at Lehigh. Applicants to the program are evaluated for admission to the program on the basis of their academic records, written statements of educational goals, and recommendations from at least two faculty members.

In addition to the academic privileges of the program, Eckardt Scholars are offered an array of special opportunities during their time at Lehigh. They are provided with close advising and mentoring, invitations to special events and to meeting visiting speakers, special opportunities for funding research projects, close mentoring for accomplishing academic and career goals, etc.

#### Junior-Year Writing Certification

The faculty of the College of Arts and Sciences holds that writing is an essential tool for learning and that writing well is indispensable for performing responsibly in a profession and in one's life as a citizen. Beyond the two writing courses required in the first year, students in the College are encouraged to take courses that provide continued practice in writing throughout their years at Lehigh. In particular each student in the College must complete at least one "writing-intensive" course-normally during the junior year-and receive writing certification from the instructor. Some major programs require that the writing-intensive course must be taken in the major field; others, that it be taken in a specific department outside the major; still others, that it may be chosen freely from writing-intensive courses offered by any department in the College. Courses that satisfy the writing-intensive requirement may also be used to fulfill major or distribution requirements.

#### Foreign Language Study

Students planning to pursue graduate study toward a doctorate are reminded that most graduate schools require doctoral candidates to demonstrate a reading knowledge of one or two foreign languages. Proficiency in foreign languages is advantageous for careers in law, government, journalism, commerce, industry and other fields.



### Internships

Many departments and programs offer optional internship courses, and some require an internship as part of a major program. Students should consult with the department offering the internship course for information about how the internships are arranged. The University faculty has established three important criteria that must be met by all internships: 80 hours of work are required for each credit awarded, no credit can be awarded for an internship ex post facto, and the student must register for the internship course during the same term that the internship work is actually conducted. Students should be sure to pre-arrange all internship experiences with the appropriate department. Internship credits cannot be awarded for work experiences without a distinct educational component. A memorandum of understanding circulated among the employer, student, and departmental internship course director helps to promote a common understanding of the educational and work objectives of the internship. Students are advised that not all work experiences advertised as "internships" warrant academic credit, even though they may be otherwise worthwhile.

### Minor Programs in the College

Certain departments, divisions, and programs in the College of Arts and Sciences afford an opportunity to minor in an additional field of concentration other than the major field.

A minor consists of at least 15 credits; the specific content is determined by the department, division, or program concerned. A minor is optional and, if successfully completed, will be shown on the university transcript in the same manner as the major field. A 2.0 minimum grade-point average is required for courses in the minor. Because of this requirement, no course in the minor program may be taken with Pass/Fail grading. No more than one course may be double-counted toward a major and a minor, and no more than one course may overlap between two minors.

It is the responsibility of students desiring a minor to initiate it no later than the beginning of the junior year by filing a minor program with the department, division, or program where it is offered. The student's minor adviser maintains appropriate records.

Minors in the College of Arts and Sciences departments and programs are available for degree candidates in other colleges within the university, with approval of their college adviser.

The following are established minors in the College of Arts and Sciences. Program descriptions may be found in the alphabetical listing of Section V. Some minor-program descriptions are collected within departmental descriptions, or located elsewhere, as indicated by parentheses. Students in the College of Arts and Sciences may also complete a minor in Business through the Business College or an Engineering minor through the College of Engineering.

- Actuarial Science (Mathematics)
- Africana Studies
- American Literature (English)
- Anthropology (Sociology and Anthropology)
- Art (Art and Architecture)
- Art/Architecture History (Art and Architecture)
- Asian Studies
- Astronomy
- Biology (Biological Sciences)
- British Literature (English)
- Business
- Chemistry
- Chinese (Modern Languages and Literature)
- Classical Civilization (Classical Studies)
- Classics (Classical Studies)
- Cognitive Science
- Communication (Journalism and Communication)
- Computer Science
- Design
- Earth and Environmental Sciences
- Economics

- Education (Education Minor, this section)
- Engineering
- English
- Environmental Studies
- French (Modern Languages and Literature)
- German (Modern Languages and Literature)
- Global Studies
- Graphic Communication (Art and Architecture)
- Health, Medicine and Society
- History
- International Environmental Policy
- International Relations
- Japanese
- Jewish Studies
- Journalism (Journalism and Communication)
- Latin (Classical Studies) (minor offered through Classics program)
- Latin American Studies
- Mathematics, Applied (Mathematics)
- Mathematics, Pure (Mathematics)
- Military Science
- Molecular Biology (Biological Sciences)
- Museum Studies (Art and Architecture)
- Music
- Music Industry
- Peace Studies
- Philosophy
- Physics
- Political Science
- Probability and Statistics (Mathematics)
- Psychology
- Public Administration (Political Science)
- Public Relations (Journalism and Communication)
- Religion Studies
- Russian (Modern Languages and Literature)
- Science, Technology and Society
- Science Writing (Journalism and Communication)
- Social Relations (Sociology and Anthropology)
- Sociology (Sociology and Anthropology)
- Social Psychology (Sociology and Anthropology)
- Spanish (Modern Languages and Literature)
- Studio Art (Art and Architecture)
- Sustainable Development
- Theatre
- Women's, Gender, and Sexuality Studies
- Writing (English)

### College Seminar/First-Year Class (FYC) Program

During the first year, every student in the College of Arts and Sciences is required to enroll in a College Seminar or First-Year Class (FYC) taught by a member of the faculty. With small class size, these college seminars and special classes provide an intimate and supportive environment that facilitates the transition to university life. Students begin to develop many of the skills that serve as a framework for their future scholarly work-how to read closely, think critically, write clearly, learn cooperatively, speak persuasively, and solve problems creatively.

Courses in this program are an excellent way to explore a subject that may be new, or to enter more deeply into an area of previous interest. Many of the topics are non-traditional or interdisciplinary subjects of special interest to the professor.

Whatever the topic, FYCs involve considerable effort on the part of students. Some classes emphasize reading assignments, papers, and oral presentations; others include tests, laboratory work, or fieldwork.

### Pre-Law Programs

Lehigh has a strong pre-law tradition. In keeping with the policy of the Association of American Law Schools, the university does not have a prescribed pre-law curriculum. Successful candidates for law school demonstrate skills in critical analysis, logical reasoning, and communication and have pursued rigorous coursework of significant breadth and depth. Lehigh students have attained entrance to law schools from diverse curricula in all three of the undergraduate colleges. Specifically law-related courses are offered in the College of Arts and Sciences (e.g. Constitutional Law, Civil Rights and Civil Liberties, Law and Order) and the College of Business and Economics (e.g., Introduction to Law and Legal Environment of Business).

In addition to formal academic instruction, Lehigh provides other opportunities for learning about the law and legal careers. The annual Tresolini Lecture series brings nationally recognized speakers to campus for extended interactions with faculty and students. Tresolini lecturers have included present and past U.S. and state Supreme Court justices and renowned legal scholars and practitioners. Lehigh also provides opportunities for gaining academic credit in several off-campus programs that provide practical experience in law and public affairs.

Counseling is available to prospective pre-law students on a continuous basis from first-year orientation through the law school application process in the senior year. The pre-professional advisor in Career Services coordinates these pre-law counseling services.

### Health Professional Programs

Schools of medicine, dentistry, optometry, podiatry, and veterinary medicine stress the importance of a strong liberal arts education as well as prescribed studies in the sciences. Although most pre-health students will choose a major in a pure or applied science, as long as candidates have the essential courses in biology, chemistry, physics, and mathematics, they may major in any of the three undergraduate colleges.

A health professions advisory committee, which includes the pre-professional advisor and faculty members from the sciences, provides career and academic counseling and works closely with students from first-year orientation through the entire process of applying to professional schools. Students are urged to consult with the pre-professional advisor in Career Services as early as possible in their academic career. Those students interested in other allied health fields may also consult with the pre-professional advisor to obtain pertinent information to aid them in planning their college careers.

### Combined-Degree Program in Medicine

In cooperation with Drexel University College of Medicine, Lehigh offers an accelerated program that enables selected students to earn both the baccalaureate degree (B.A.) with a major in premedical science and the M.D. degree after seven total years of study at the two institutions. In the first three academic years at Lehigh, credit hours are earned toward the 120 credits required for the baccalaureate degree. The next four years are spent in the regular program of medical education at Drexel University College of Medicine in Philadelphia. By successfully completing their first year at the medical school, students acquire the necessary additional credit hours for the Lehigh baccalaureate degree.

During their pre-professional years at Lehigh, students are expected to make satisfactory progress in academic areas as well as in the more subtle task of personal growth in those attributes ultimately needed as a physician. Drexel University College of Medicine receives student grades and monitors student progress through feedback from Lehigh. Students are expected to attain specified grade point averages and MCAT scores. Students' undergraduate credentials are processed through the Admissions Committee of Drexel University College of Medicine before a final definitive acceptance is offered. The medical college reserves the right to withdraw an offer of acceptance on the grounds of academic or personal maturation concerns.

Application for admission to this program is made through Lehigh's Office of Admissions. Application deadline is November 15.

### Required Science and Math Courses

#### Chemistry

Select one of the following: 8

CHM 030 & CHM 031	Introduction to Chemical Principles and Chemical Equilibria in Aqueous Systems	
CHM 040 & CHM 041	Concepts, Models and Experiments I and Concepts, Models and Experiments II	
CHM 110 & CHM 111	Organic Chemistry I and Organic Chemistry Laboratory I	4
CHM 112 & CHM 113	Organic Chemistry II and Organic Chemistry Laboratory II	4

#### Biology

BIOS 041 & BIOS 042	Biology Core I: Cellular and Molecular and Biology Core I: Cellular and Molecular Lab	4
BIOS 115 & BIOS 116	Biology Core II: Genetics and Biology Core II: Genetics Laboratory	4
BIOS 120	Biology Core III: Integrative and Comparative	4

#### Physics

Select one of the following: 5

PHY 010 & PHY 012	General Physics I and Introductory Physics Laboratory I	
PHY 011 & PHY 012	Introductory Physics I and Introductory Physics Laboratory I	
Select one of the following:		4-5
PHY 013 & PHY 022	General Physics II and Introductory Physics Laboratory II	
PHY 021 & PHY 022	Introductory Physics II and Introductory Physics Laboratory II	

#### Math

Select one of the following: 7-8

MATH 021 & MATH 022	Calculus I and Calculus II	
MATH 051 & MATH 052	Survey of Calculus I and Survey of Calculus II	

Select one Approved Math Elective 3

Total Credits 47-49

#### Required Non-Science Courses

First-Year Seminar	1-4
English Comp & Lit (I and II)	6
Humanities (three courses)	9-12
Social Sciences (three courses)	9-12
Writing Intensive	
Approved Electives	12-16

### Combined-Degree Program in Dentistry

In cooperation with the School of Dental Medicine at the University of Pennsylvania, Lehigh offers an accelerated program that enables selected students to earn both the baccalaureate degree (B.A.) with a major in pre-dental science and the doctor of dental medicine degree (D.M.D.) after seven years of study at the two institutions. In the first three academic years at Lehigh, credit hours are earned toward the 120 credits required for the baccalaureate degree. The next four years are spent in the regular program of dental education at the Penn School of Dental Medicine in Philadelphia. By successfully completing their first year at the dental school, students acquire the necessary additional credit hours for the Lehigh baccalaureate degree.

During their first three years at Lehigh, students are expected to make satisfactory progress in prescribed academic areas as well as in the area of personal growth, developing those attributes ultimately

needed to become a dentist. Penn Dental School receives student grades and monitors student progress through feedback from Lehigh. Students are expected to attain specified grade point averages and DAT scores. Students' undergraduate credentials are processed through the Admissions Committee of Penn Dental School before a final definitive acceptance is offered. The dental college reserves the right to withdraw an acceptance, or require that a student spend additional time on the undergraduate level, on the grounds of academic or personal maturation concerns.

Application for admission to this program is made through Lehigh's Office of Admissions. Application deadline is January 1.

#### Required Science and Math Courses

##### Chemistry

Select one of the following: 4

CHM 030 & CHM 031	Introduction to Chemical Principles and Chemical Equilibria in Aqueous Systems	
CHM 040 & CHM 041	Concepts, Models and Experiments I and Concepts, Models and Experiments II	
CHM 110 & CHM 111	Organic Chemistry I and Organic Chemistry Laboratory I	4
CHM 112 & CHM 113	Organic Chemistry II and Organic Chemistry Laboratory II	4

##### Biology

BIOS 041 & BIOS 042	Biology Core I: Cellular and Molecular and Biology Core I: Cellular and Molecular Lab	4
BIOS 115 & BIOS 116	Biology Core II: Genetics and Biology Core II: Genetics Laboratory	4
BIOS 120	Biology Core III: Integrative and Comparative	4

Select two Approved Electives 6

##### Physics

Select one of the following: 5

PHY 010 & PHY 012	General Physics I and Introductory Physics Laboratory I	
PHY 011 & PHY 012	Introductory Physics I and Introductory Physics Laboratory I	

Select one of the following: 4-5

PHY 013 & PHY 022	General Physics II and Introductory Physics Laboratory II	
PHY 021 & PHY 022	Introductory Physics II and Introductory Physics Laboratory II	

##### Math

Select one of the following: 7-8

MATH 021 & MATH 022	Calculus I and Calculus II	
MATH 051 & MATH 052	Survey of Calculus I and Survey of Calculus II	

Total Credits 46-48

#### Required Non-Science Courses

First-Year Seminar	1-4
English Comp & Lit (I and II)	6
Humanities (three courses)	9-12
Social Sciences (three courses)	9-12
Junior Writing Intensive	
Approved Electives	12-16

#### Combined-Degree Program in Optometry

In cooperation with the State University of New York College of Optometry in New York City, Lehigh offers an accelerated program in

which students may earn both the baccalaureate degree (B.A.) with a major in behavioral neuroscience and the doctor of optometry degree (O.D.) after seven years of study at the two institutions. In the first three academic years at Lehigh, credit hours are earned toward the 120 credits required for the baccalaureate degree. The next four years are spent in the regular program of optometry education at SUNY College of Optometry. By successfully completing their first year at the optometry college, students acquire the necessary additional credit hours for the Lehigh baccalaureate degree.

SUNY College of Optometry receives student grades and monitors student progress through feedback from Lehigh. Students are expected to attain specified grade point averages and OAT scores. Students' undergraduate credentials are processed through the Admissions Committee of SUNY Optometry before a final definitive acceptance is offered. The optometry college reserves the right to withdraw an offer of acceptance on the grounds of academic or personal maturation concerns.

Students may apply to this program either during their initial application or during their enrollment at Lehigh. Application for incoming students is made through Lehigh's Office of Admissions. Application deadline is January 1.

#### Required Science and Math Courses

##### Chemistry

Select one of the following: 8

CHM 030 & CHM 031	Introduction to Chemical Principles and Chemical Equilibria in Aqueous Systems	
CHM 040 & CHM 041	Concepts, Models and Experiments I and Concepts, Models and Experiments II	
CHM 110 & CHM 111	Organic Chemistry I and Organic Chemistry Laboratory I	4
CHM 112 & CHM 113	Organic Chemistry II and Organic Chemistry Laboratory II	4

##### Biology

BIOS 041 & BIOS 042	Biology Core I: Cellular and Molecular and Biology Core I: Cellular and Molecular Lab	4
BIOS 115 & BIOS 116	Biology Core II: Genetics and Biology Core II: Genetics Laboratory	4

BIOS 120 Biology Core III: Integrative and Comparative 4

BIOS 130 Biostatistics 4

BIOS 177 Behavioral Neuroscience I 3

BIOS 276  
& BIOS 277 Central Nervous System and Behavior and Experimental Neuroscience Laboratory 5

BIOS 382 Endocrinology of Behavior 3

##### Physics

Select one of the following: 5

PHY 010 & PHY 012	General Physics I and Introductory Physics Laboratory I	
PHY 011 & PHY 012	Introductory Physics I and Introductory Physics Laboratory I	

Select one of the following: 4-5

PHY 013 & PHY 022	General Physics II and Introductory Physics Laboratory II	
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PHY 021  
& PHY 022 Introductory Physics II and Introductory Physics Laboratory II

##### Math

Select one of the following: 7-8

MATH 021 & MATH 022	Calculus I and Calculus II	
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MATH 051 & MATH 052	Survey of Calculus I and Survey of Calculus II	
Total Credits		59-61
<b>Required Non-Science Courses</b>		
First-Year Seminar		1-4
English Comp & Lit (I and II)		6
PSYC 001	Introduction to Psychology	4
Social Sciences (one course)		4
Humanities (two courses)		8
Writing Intensive		
Approved Electives (two courses)		6-8

#### Education Minor

The education minor helps undergraduates explore career options in school teaching or other professional careers with elementary, secondary, or special education students. The minor may accelerate entry into a teaching career because appropriate credits from undergraduate coursework may be applied to one of Lehigh's graduate-level Teacher Education Programs.

The minor offers a systematic background of professional education experiences, coordinating practicum activities with theory courses designed to provide a foundation for future educational studies. Its focus is exploratory.

The experiences of the minor are intended to enrich an individual's understanding of education as a central intellectual activity of our culture and to provide self-understanding of one's own potential as an educator.

An undergraduate may take these courses with the approval of the adviser and minimum GPA of 2.75. Completion of the minor does not assure admission to one of the Teacher Education Programs to become a certified elementary or secondary teacher.

Fifteen credit hours are required for the education minor.

Completion of the minor does not guarantee subsequent admission into any of the College of Education degree or certification programs.

For more information about our Education Minor, visit [www.lehigh.edu/education/tlt/](http://www.lehigh.edu/education/tlt/) or contact the Teaching, Learning and Technology Program Director at [TLTProgram@Lehigh.edu](mailto:TLTProgram@Lehigh.edu) or 610-758-3230.

#### Five-Year Bachelor's Plus Master's of Education and Secondary Teacher Certification

The College of Education offers a five-year degree program that is designed to allow students to earn both a bachelor's degree and a master's degree in five years instead of the traditional six.

The combined degree program leads to (1) a B.A./B.S. degree in an academic discipline from the College of Arts and Sciences, the P.C. Rossin College of Engineering and Applied Sciences, or the College of Business and Economics, and (2) an M.Ed. degree in elementary education (PreK-4) or an M.Ed. or M.A. degree in secondary education. In addition, students also earn eligibility for an Instructional I teaching certificate from the Pennsylvania Department of Education (PDE). These PDE certification areas are:

- Biology 7-12
- Chemistry 7-12
- Citizenship Education 7-12
- Earth and Space Science K-12
- English 7-12
- Environmental Education K-12
- General Science 7-12
- Mathematics 7-12
- Physics 7-12
- PreK-4th grade
- Social Sciences 7-12
- Social Studies 7-12

Freshmen, sophomores and juniors with a minimum overall GPA of 2.75 may apply to the 5-year teacher education program. Those accepted

typically begin education courses in the second semester of their sophomore year (junior year for those admitted later).

Criteria for admission to the program include:

- A demonstrable commitment to learning and intellectual growth
- An expressed interest in teaching as a career
- Previous experience in working with young people; this can be gained in the summers of freshman and sophomore years.

In the fall semester of their senior year, students must complete an application for admission to the graduate College of Education (elementary or secondary education) in order to continue in the program and complete the master's degree/Instructional Level I teacher certification eligibility portion of the program.

For more information about the 5-year Teacher Education Program, contact the Teaching, Learning, and Technology Program Director at [TLTProgram@Lehigh.edu](mailto:TLTProgram@Lehigh.edu) or 610-758-3230.

#### Africana Studies

**Program Director: James Peterson, Ph. D. (University of Pennsylvania)**

**Email: [jbp211@lehigh.edu](mailto:jbp211@lehigh.edu) Phone: 610-758-5695**

**Website: <http://aas.cas2.lehigh.edu/>**

*Supported by the Office of Interdisciplinary Programs 610-758-3996; [incasip@lehigh.edu](mailto:incasip@lehigh.edu)*

#### Program Faculty:

Kwame Essien, Ph.D. (Texas) Assistant Professor of History; Susan Kart, Ph.D. (Columbia), Assistant Professor of Art, Architecture and Design; Monica Miller (Chicago Theological Seminary), Assistant Professor of Religion Studies; Darius Williams (OSU), Assistant Professor of Theatre.

The purpose of the Africana Studies Program is to engender in Lehigh students an intellectual appreciation of the life and culture of peoples of sub-Saharan Africa and the worldwide diaspora, especially in the Americas (the United States and Canada, the Caribbean, Central and South America), thereby enriching the Lehigh curriculum and increasing its relevance to a culturally diverse society and world. In the best tradition of a liberal arts education, Africana Studies expands Lehigh students' critical understanding of their own heritage in interaction with other cultures.

The major and minor in Africana Studies constitute an interdepartmental and comparative program of study for undergraduates who wish to integrate the insights and methods of several disciplines to understand the history, culture, social, and political experience of people of African descent globally.

#### The Major

The major in Africana Studies consists of a minimum of ten (10) courses, constituting at least 30 credit hours and no less than four (4) upper level courses. It entails training across disciplinary lines as well as concentrated study in a single discipline.

AAS 003	Introduction to Africana Studies	4
Humanities (3 courses)		9-12
Social Sciences (3 courses)		9-12
Disciplinary Concentration (3 courses)		8-12
Total Credits		30-40

In addition, students are encouraged to pursue independent study opportunities to enhance their knowledge of specific aspects of Africana Studies.

#### The Minor

The minor consists of a minimum of five (5) courses, constituting at least 15 hours of study that includes an introductory course and no less than two upper level courses in the field. To declare a minor in Africana Studies, students must complete a minor declaration form

([http://catalog.lehigh.edu/coursesprogramsandcurricula/artsandsciences/africanastudies/Africana\\_Studies\\_Minor\\_Declaration\\_Form.pdf](http://catalog.lehigh.edu/coursesprogramsandcurricula/artsandsciences/africanastudies/Africana_Studies_Minor_Declaration_Form.pdf)).

### Core Courses

Core courses concentrate on subject material directly relevant to the study of past and present experiences of people of African descent.

### Core Courses

AAS 003	Introduction to Africana Studies	4
AAS/HIST 005	African Civilization	4
AAS/ENGL 038	Introduction to African Literature	3
AAS/SSP 103	Race and Ethnicity in the Contemporary U.S.	4
AAS/ANTH 104	Contemporary Issues in African Societies	4
AAS/LAS/SSP 106	Race and Ethnicity in Latin America and the Spanish Speaking Caribbean	4
AAS/PHIL 117	Race and Philosophy	4
AAS/ENGL 120	Literature from Developing Nations	4
AAS/ENGL 121	Topics in African-American Literature	4
AAS/MUS 128	Jazz History I	3
AAS/MUS 129	Jazz History II	3
AAS/HIST 130	African American History	4
AAS/THTR 132	Hip Hop Theatre	4
AAS 133	Lehigh in Martinique: Globalization and Local Identity	4
AAS/ENGL 138	Introduction to African American Literature	4
AAS/THTR 140	African American Theatre	4
AAS/SSP 144	Global Hip Hop and Social Change	4
AAS/WGSS 145	African American Women Writers	4
AAS/SSP/LAS 155	Afro-Latino Social Movements in Latin America & the Caribbean	4
AAS/SSP 166	Wealth and Poverty in the United States	4
AAS/SSP 177	Cuba: Race, Revolution and Culture	4
AAS/HIST 179	Black Political Thought in America	4
AAS/ANTH 183	Peoples and Cultures of Africa	4
AAS/POLS 205	The Political Development of American Race Relations	4
AAS/POLS 230	Social Movements and Legacies of the 1960s	4
AAS 263	Caribbean Artistic and Cultural Traditions	4
AAS/SSP/WGSS 310	Gender, Race and Sexuality: The Social Construction of Differences	4
AAS/FREN 312	Modernity in the Maghreb	4
AAS/SSP 313	Social Movements	4
AAS/ENGL 318	African-American Literature and Culture	3-4
AAS/ANTH/GS 324	Globalization and Development in Africa	4
AAS/HIST 331	United States and Africa	4
AAS/HIST 332	Slavery and the American South	4
AAS/ASIA/GS/POLS 343	Global Politics of Race: Asia and Africa	4
AAS/SSP 345	Colonialism and the Black Radical Tradition	4
AAS 371	Independent Study	1-3
AAS 372	Independent Study	2-3
AAS/SSP 379	Race and Class in America	4
AAS 381	Special Topics	1-3
AAS 382	Seminar on a topic in Africana Studies	1-4

### Collaeral Courses

HIST 334	American City in the Twentieth Century	3-4
MUS 130	Jazz Masters	3

### Courses

#### AAS 003 Introduction to Africana Studies 4 Credits

An interdisciplinary examination of the roots, culture, and politics of the modern black world through study of classic works in Africana Studies with emphasis on the continuities among African peoples worldwide and the social forces that have shaped contemporary black life in Africa and the Americas.

**Attribute/Distribution:** SS

#### AAS 005 African Civilization 4 Credits

Sub-Saharan Africa through the millennia of the ancient world to the present. Human origins, state and non-state systems, the external slave trade; colonialism, resistance to European rule; independence movements; neocolonialism.

**Attribute/Distribution:** SS

#### AAS 038 Introduction to African Literature 3 Credits

Sub-Saharan African literary themes and styles, historical and social contexts, African folk tales, oral poetry, colonial protest literature, postcolonial writing, films on contemporary Africa.

**Attribute/Distribution:** HU

#### AAS 103 Race and Ethnicity in the Contemporary U.S. 4 Credits

Examines race and ethnicity from a sociological perspective. Focus on the role of the major racial and ethnic communities in modern American society. Explores the roles of race and ethnicity in identity, social relations, and social inequality. Topics include racial and ethnic communities, minority/majority groups, assimilation, prejudice/discrimination, identity and the social construction of the concept of "race."

**Attribute/Distribution:** SS

#### AAS 104 Contemporary Issues in African Societies 4 Credits

Using an anthropological lens to engage issues confronting African societies today, we examine local-level ethnographic accounts and analyses on continent-wide trends, and consider a range of topics including famine, political violence, AIDS, poverty, and corruption. Where does Africa fit into the current neoliberal world order and what is the role "African culture" plays in shaping all these issues?.

**Attribute/Distribution:** SS

#### AAS 106 Race and Ethnicity in Latin America and the Spanish Speaking Caribbean 4 Credits

A sociological examination of race and a look at an individual's experience. We consider how concepts like "race" and "ethnicity" have been defined and how they have been institutionalized in law, government, social policy, social thought, and economic structures. We consider the importance of concepts like "race," "cultures," and "mestizaje" to our understanding of citizenship and national identity, and we address contemporary African and indigenous movements against racial inequality.

**Attribute/Distribution:** SS

#### AAS 117 Race and Philosophy 4 Credits

An introduction to the philosophy born of struggle against racism and white supremacy. We will read the work of philosophers, mostly European, who quietly made modern racism possible by inventing the category of race, but we will concentrate on the work of philosophers, mostly of African descent, who for 200 years have struggled to force a philosophical critique of the category of race and the practice of white supremacy.

**Attribute/Distribution:** HU

#### AAS 120 Literature from Developing Nations 4 Credits

Contemporary literature from Africa, Central and South America, and Asia. Must have completed six hours of freshman English. Cannot be taken pass/fail.

**Attribute/Distribution:** HU

**AAS 121 Topics in African-American Literature 4 Credits**

Selected works of African American literature and/or the literatures of the African Diaspora. May be repeated for credit as title varies. Must have completed six hours of first-year English. Cannot be taken pass/fail.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**AAS 128 Jazz History I 3 Credits**

A study of the roots of jazz. Starting in West Africa, the course traces the synthesis of African and European elements to 1945. Musicians covered are Gottshalk, Bolden, Morton, Armstrong, Hawkins, Basie, Ellington, and others.

**Attribute/Distribution:** HU

**AAS 129 Jazz History II 3 Credits**

A survey of modern jazz from 1945 to present. Musicians covered include Parker, Gillespie, Monk, Davis, Coltrane, Hancock, and Coleman. Can be taken independently of Jazz History I, but the first course would be helpful.

**Attribute/Distribution:** HU

**AAS 130 African American History 4 Credits**

Blacks in America from the first importation of Africans to the implementation of civil rights laws. West African origins, slave trade, slavery, free blacks and emancipation and study of Reconstruction, segregation, urbanization, and the struggle for racial equality.

**Attribute/Distribution:** SS

**AAS 132 Hip Hop Theatre 4 Credits**

Introduction to the creation and performance of Hip Hop Theatre. Exploration of the history and culture of Hip Hop through original written material, live performance, music, film, video and web based content. Public Performances. Must have audition. Consent given by instructor.

**Attribute/Distribution:** HU

**AAS 133 Lehigh in Martinique: Globalization and Local Identity 4 Credits**

History, culture and politics of the French Caribbean island of Martinique, from its position as a key site of the 18th century Atlantic World economy to becoming an official French department and outpost of the European Union. Interdisciplinary perspectives on the complex nature of social identity, historical memory and impact of globalization. No French is required. Offered during winter inter-term through Lehigh Study Abroad.

**Attribute/Distribution:** HU

**AAS 138 Introduction to African American Literature 4 Credits**

Survey of African American prose narrative and poetry from the 18th century to the present. Features writers from the Harlem Renaissance, the Black Arts Movement, and the post Black Power era.

**Attribute/Distribution:** HU

**AAS 140 African American Theatre 4 Credits**

Foundations of African theater: historical, literacy, and practical.

**Attribute/Distribution:** HU

**AAS 144 Global Hip Hop and Social Change 4 Credits**

Hip Hop has become a global phenomenon. We will analyze how and why socially Conscious Hip Hop, as a tool for social change, has expanded to Latin America, Africa, and the Middle East.

**Attribute/Distribution:** SS

**AAS 145 African American Women Writers 4 Credits**

Literature by African American women writers with a focus on the experiences and images of black women in the U.S. Explores the written portraits and voices of 20th century black female novelists and poets, including Hurston, Petry, Morrison, Angelou, and Walker.

**Attribute/Distribution:** HU

**AAS 155 Afro-Latino Social Movements in Latin America & the Caribbean 4 Credits**

This course focuses on Afro-Latinos who make up nearly 70% of the population of the Americas. Despite the large amount of people of African descent living in the Americas, Afro-Latinos are an understudied population who face significant amounts of racial discrimination in their countries. Who are Afro-Latinos? Where do they live? How are they challenging the racism that they face? These are questions we will tackle in this course.

**Attribute/Distribution:** SS

**AAS 166 Wealth and Poverty in the United States 4 Credits**

Examines the sociology of wealth and poverty affluence and disadvantage, "rags and riches" in American Society. Focus is a critical analysis of the wealth gap, its causes, consequences and social context. We will consider the roles of wealth and poverty in determining life chances and structuring opportunity, as well as their roles in the perpetuation of social inequality across generations. We will address contemporary debates surrounding public policy, tax laws, antipoverty programs and other reform efforts aimed at decreasing the gap between the "Haves" and the "Have-Nots." H.

**Attribute/Distribution:** SS

**AAS 177 Cuba: Race, Revolution and Culture 4 Credits**

This course analyzes the role of race & "culture" in the Afro Cuban struggle for equality. By focusing on the arts: particularly music, film & literature, this course will analyze the development of race during Cuba's colonial period; the Afro Cuban challenge to the "race blind" political and cultural movements of the Cuban Republic. We will then wrap up the semester by addressing the significance of contemporary cultural movements that challenge the social issues currently facing Afro Cubans.

**Attribute/Distribution:** SS

**AAS 179 Black Political Thought in America 4 Credits**

Black leadership, organizations, and philosophy in America from Reconstruction to the Civil Rights Era; ideas and programs of Booker T. Washington, W.E.B. DuBois, Marcus Garvey, Malcolm X and Martin Luther King, Jr.

**Attribute/Distribution:** SS

**AAS 183 Peoples and Cultures of Africa 4 Credits**

Studies African modernity through a close reading of ethnographies, social stories, novels, and African feature films.

**Attribute/Distribution:** SS

**AAS 205 The Political Development of American Race Relations 4 Credits**

This course examines the distinctive role race has played in shaping the political history of the United States.

**Attribute/Distribution:** SS

**AAS 230 Social Movements and Legacies of the 1960s 4 Credits**

The lessons and legacies of 1960s social and political movements. Students examine civil rights, black power movements, the New Left, campus protests, the Vietnam war and antiwar movement, the counterculture, women's ecology movements and assess their connection to democracy, today's world and their own lives.

**AAS 263 Caribbean Artistic and Cultural Traditions 4 Credits**

Representation of contemporary popular culture in the Caribbean in literature, music, painting and other artistic expressions. Major attention is devoted to the influences on tradition, folklore and religion in modern Caribbean life.

**Attribute/Distribution:** HU

**AAS 310 Gender, Race and Sexuality: The Social Construction of Differences 4 Credits**

This course will provide the student with an opportunity to engage current debates about the meaning and use of racial and sexual classification systems in society. Using a multidisciplinary approach, we will examine the historical and sociological contexts in which specific theories of racial and sexual differences emerged in the U.S. Additionally, we will explore the ways in which change in images have implications for the role racial, gender, and sexual identity plays in our understanding of the relationship between difference and inequality.

**Repeat Status:** Course may be repeated.

**Prerequisites:** WGSS 001

**Attribute/Distribution:** SS

**AAS 312 Modernity in the Maghreb 4 Credits**

Emergence of the modern self through a comparative study of textual as well as visual representations of postcolonial subjects by male and female writers and film makers. Study of the way the sociopolitical context of countries such as Morocco, Algeria and Tunisia informs the constitution of subjectivity within a multicultural and multilingual community. Issues such as patriarchy, nationalism, colonialism, post colonialism, identity, gender, and Islam in North African literature and film from Franco-Arab traditions.

**AAS 313 Social Movements 4 Credits**

Explores the origins, dynamics, and consequences of social movements through both sociological theory and empirical case studies. Covers questions of what constitutes a social movement, where and when social movements arise, who joins a social movement, and how social movements are able to contribute to change. Answers to these questions highlight issues of social movement recruitment and leadership, interactions between movements and the media, the state, and the broader public, ideology, strategies and tactics, and the factors contributing to the success and failure of social movements. Course readings drawn from case studies on civil rights, women's rights, gay rights, the environment, American Indians, abortion, globalization, antiapartheid, democratization, peace, and Islamic fundamentalism. Must have completed one 100-level SSP course.

**Attribute/Distribution:** SS

**AAS 318 African-American Literature and Culture 3,4 Credits**

Special Topics in African American culture and/or the cultures of the African diaspora. Topics may be focused by period, genre, thematic interest or interdisciplinary method including, for example, "Nineteenth-century African American Literature and Politics", "African-American Folklore", "Black Atlantic Literature", "The Harlem Renaissance", "African-American Women Writers". May be repeated for credit as title varies.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU, SS

**AAS 324 Globalization and Development in Africa 4 Credits**

This course examines the challenges Africa presents to expectations of modernization and development. It poses these questions: Have African societies been left behind by globalization, shut out from it, or do they merely reflect an unexpected side of globalization processes? What is Africa's place in the neoliberal world order? What role does "African culture" play in generating or blocking social change? And, how can anthropology illuminate prospects for change on what has long been regarded as the "dark continent"?

**Attribute/Distribution:** SS

**AAS 331 United States and Africa 4 Credits**

Reciprocal relationships between North America and the African continent from the slave trade in the seventeenth century to the twentieth century Afrocentric movement; impact of Americans on shaping of modern Africa, Pan-African relations; influence of African Americans on U.S. policies toward Africa.

**Attribute/Distribution:** SS

**AAS 332 Slavery and the American South 4 Credits**

The emergence and demise of the "peculiar institution" of African American slavery in British North America and the Old South. African background, colonial beginnings, 19th century slave community, the ruling race and proslavery ideology, the death of slavery and its aftermath, slavery and freedom in a comparative context.

**Attribute/Distribution:** SS

**AAS 343 Global Politics of Race: Asia and Africa 4 Credits**

An examination of the concept of "race" and its impact on domestic and international politics.

**Attribute/Distribution:** SS

**AAS 345 Colonialism and the Black Radical Tradition 4 Credits**

Karl Marx was not the only figure who developed an influential theory of social revolution. A cadre of theorists from the Global South have extensively theorized about the issues facing their particular nations, and they have developed social theories that have challenged social and global inequality. This course is a theory based course that will focus on the anti-colonial and post-colonial thought of radical black intellectuals from the Black America, the Caribbean, and West Africa.

**Attribute/Distribution:** SS

**AAS 371 Independent Study 1-3 Credit**

Independent study in advanced areas of Africana Studies. Independent research with an individual faculty member in the Africana Studies program. Consent of director.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** ND

**AAS 372 Independent Study 2-3 Credits**

Independent study in advanced areas of Africana Studies. Independent research with an individual faculty member in the Africana Studies program. Consent of director.

**Attribute/Distribution:** ND

**AAS 379 Race and Class in America 4 Credits**

The ways in which race and class intersect in the social, economic, and political structures of American society. Through sociological literature, fiction, nonfiction, film, and other media we will explore the place of race and class in American society. We will examine how race and class operate on a personal, "micro" level, while at the same time operating on a large-scale, "macro" level.

**Prerequisites:** SSP 103 or AAS 103

**Attribute/Distribution:** SS

**AAS 381 Special Topics 1-3 Credit**

**Attribute/Distribution:** ND

**AAS 382 Seminar on a topic in Africana Studies 1-4 Credit**

**Attribute/Distribution:** ND

**AAS 391 Special Topics 3,4 Credits****American Studies**

**Program Director:** Edward Whitley (<http://english.cas2.lehigh.edu/edward-whitley>), Ph. D. (Maryland) (<http://english.cas2.lehigh.edu/edward-whitley>)

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*Supported by the Office of Interdisciplinary Programs 610-758-3996; [incasip@lehigh.edu](mailto:incasip@lehigh.edu)*

Offered at the graduate level, American Studies is the interdisciplinary study of American thought, literature, and culture—both past and present. Born in the early years of the Cold War and with an implied commitment to American exceptionalism, American Studies has since transformed itself into a multifaceted critical examination of United States society. Comparative frameworks along with close attention to applying cultural and literary theory to such matters as violence, citizenship, democracy, community, poverty and prosperity, politics, race, and gender in the United States make American Studies an intellectually sophisticated yet practical course of graduate study.

**M.A. in American Studies**

A Master of Arts degree in American Studies is offered in the College of Arts and Sciences. Candidates for the master's degree must complete at least 30 credit hours, 18 of which must be at the 400 level.

AMST 400	American Studies: Theory and Method	3
Two humanities courses <sup>2</sup>		6
Two social science courses <sup>2</sup>		6
AMST 401	Special Topics in American Studies	3
Remaining courses for the master's degree will be divided between:		12
AMST 490	Master's Thesis <sup>1</sup>	
Other American Studies courses chosen at the student's discretion and with the approval of the program director		
<b>Total Credits</b>		<b>30</b>

<sup>1</sup> To fulfill the thesis requirement students will write a long work of scholarship or two shorter papers, or create a documentary film.

**Graduate Certificate in Documentary Film**

Designed to augment social science and humanities graduate students' education and training for employment inside and outside of the academy, this certificate program covers 1) the historical development and distinctive attributes of documentary film, including the genre's impressive capacity for drawing large viewerships and, with that, communicating research-based knowledge to general publics; and 2) the production of documentary text--from conceiving of a topic and "storyboarding" a narrative; to taking interviews; to composing and filming a variety of shots; and to editing visual and audio material into final digital form.

The program broadly defines documentary film to facilitate understanding and production of texts from Youtube-like social media to feature-length theatrically-released films.

Completion of 12 credits, no more than 6 credits at the 300-level.

AMST 425	Community Study Through Documentary Film	3
AMST 433	Documentary Film Production	3
Two courses in consultation with Graduate Certificate Director; possible courses include:		6
HIST 438	Techniques in Public History	
HIST 305	Public History	
HIST 336	Bethlehem and the Lehigh Valley	
HIST 337	History and Community Memory	
JOUR 325	Seminar in Journalism and Communication Issues	
<b>Total Credits</b>		<b>12</b>

**Courses****AMST 347 American Religious Thinkers 4 Credits**

An examination of the writings of key figures in the history of American religious thought (such as Edwards, Emerson, Bushnell, Peirce, James, Royce, Dewey and the Niebuhrs). Attention will be directed both to the historical reception of these writings and to their contemporary significance.

**Attribute/Distribution:** HU

**AMST 400 American Studies: Theory and Method 3 Credits**

An introduction to the theoretical orientations and methodological strategies of American Studies. Seminar involves extensive reading as well as application of theory and method to students' research.

**AMST 401 Special Topics in American Studies 1-3 Credit**

Graduate seminar focused on one particular subject area in American Culture.

**AMST 402 Independent Study 3 Credits**

Individually supervised course in the area of American Culture. Consent of the program director required.

**AMST 425 Community Study Through Documentary Film 3 Credits**

A film production course concentrating on lighting, sound, shooting interviews (among other types of shots), and Final Cut Pro editing; matched with producing a team-made thirty-minute documentary film on a local historical or contemporary topic of critical interest.

**AMST 433 Documentary Film Production 3 Credits**

An independent study mode of course awarding credit for the production of a 30-minute documentary film that meets two standards: 1) high production value, and 2) scholarly content based on detailed research and driven by critical analysis.

**AMST 471 Special Topics 3 Credits****AMST 481 Independent Study 1-3 Credit****AMST 482 Independent Study 1-3 Credit****AMST 490 Master's Thesis 1-6 Credit**

Independent work, with a faculty member, on a single master's thesis or two thesis papers. Topic approved by individual faculty member. Typically taken in the last semester of course work.

**Art, Architecture, and Design**

The three primary disciplines of the Department of Art, Architecture and Design share a common focus on design, visual literacy, the creative process and the making of the built environment. The emphasis on design as a broad concept begins to shape aesthetic principles, and initiates the structuring of the individual's creative process. To that end, the department offers undergraduate Bachelor of Arts degrees in four majors: art, architecture, design, and art history. Minor programs are available in studio art, graphic design, product design, history of the visual arts, history of architecture, and museum studies.

All programs are philosophically cross-disciplinary, as students are encouraged to take advantage of the many learning environments that constitute a university. Significant resources for all disciplines in the department include the Lehigh University permanent art collection and archives as well as the numerous on-campus galleries and the Zoellner Art Center. Students are encouraged to make use of the collections and facilities to enhance and enrich studios and courses, and to help shape their own creative work.

Most studio courses require department permission. The student interested in majoring in any of the department's disciplines should contact the program coordinator to schedule an appointment with an advisor well before pre-registration so that he or she can be rostered at the appropriate time. Registration preference is given to majors who have declared before pre-registration begins.

An **art major** centers on studio education wherein principal disciplines such as drawing, sculpture, painting and photography are explored. The student is required to engage in an intense concentration in studio work at Lehigh and when appropriate at other Lehigh Valley colleges that offer complementary courses. Studio work is enhanced by courses in history and theory, both within the department and throughout the university.

For the student interested in becoming a creative artist, the major provides a foundation for a life in art, or more immediately the potential path into a graduate degree program in fine art. A major in art may be combined with theater for those interested in costume design, or with architecture and theater for those who aspire to be set designers. A major in art combined with a minor in education is available for students interested in becoming primary, secondary or special education art teachers.

The **architecture major** is a pre-professional course of study focused on architectural design studios, complemented by art studios, history and theory courses, and introductory materials and building technology courses. The major results in a Bachelor of Arts degree. (That degree should not be confused with the Bachelor of Architecture, a professional five-year degree.) Those students who major in architecture and graduate with the Bachelor of Arts degree and wish to pursue a professional career in architecture will be required to obtain a Master of Architecture from an institution offering a graduate program in architecture.

The architecture major is a comprehensive undergraduate education that is the first step in a series of educational and apprenticeship



requirements leading to professional registration. Architecture majors regularly go on to the most respected graduate schools of architecture, with the University of Pennsylvania, University of Virginia, Washington University in St. Louis, and the University of Washington, among scores of institutions, actively seeking Lehigh graduates for their programs.

Alternatively, many architecture majors choose to work in fields allied to the discipline, such as interior design, adaptive reuse building, historic preservation, construction management, real estate development, etc. Since for such paths professional architectural registration is not required, the Lehigh degree alone is the springboard to various careers that involve the making of the built environment.

The Arts-Engineering program, a five-year, double-degree course of study, allows students to link the complementary disciplines of civil engineering and architecture. The result is two degrees from two different colleges within Lehigh, one a professional degree in engineering, one the pre-professional degree in architecture.

A **design major** engages students with new technologies, materials and media in developing the creative processes and critical thinking necessary for the modern designer. The major centers on studio wherein an emphasis on visual communication through digital media is complemented by the traditional focus on art making. Courses in art and design history and theory and in specific media techniques supplement the series of required studios.

A student may take a range of department courses in design or may choose a specific concentration in either graphic design or product design. The graphic design concentration introduces students to the tools and media related to print applications, web-based media, exhibition design, publishing and advertising. Product design concerns the creation of objects used in industrial applications, art objects, furniture, toys, exhibits and trade design, electronic products, household items and recreational equipment.

An **art history** major provides students with a comprehensive education in the history of art and architecture, and an opportunity to learn about the changing form and status of the visual arts and built environment in culture and society. Through introductory and advanced coursework, as well as museum and site visits, students learn how to examine, evaluate, and interpret works of art and architecture, and acquire a working knowledge of the methods, theories and research practices of art historical analysis.

The study of art and its history is a vital and fundamental part of a liberal arts education, and art history is unique among academic fields in the breadth and diversity of its objects of study: drawing, painting, sculpture, and printmaking; architecture, design, and urban planning; photography and film; material culture; as well as a variety of other cultural forms. Students majoring in art history go on to careers in art, architecture, design, curating, communications, imaging, advertising, education, and many other fields. The major also provides an important foundation for students who plan to pursue advanced graduate studies in the arts and humanities.

Art history majors choose one of three areas of concentration: history of the visual arts, history of architecture, or museum studies.

#### Departmental Honors

Exceptional students in art, architecture or design may apply for department honors at the end of their junior year or the beginning of their senior year. To be eligible, a student must have attained a 3.5 GPA in the major program and a minimum overall GPA of 3.0. Candidates should submit to the department chair a written proposal, prepared in consultation with a faculty member who will serve as honors sponsor. The project could result in a research paper, design project, or exhibition. Successful completion of the project will result in a "Department Honors" designation being affixed to the student's transcript.

**Professors.** Lucy C Gans, MFA (Pratt Institute); Ricardo Viera, MFA (Rhode Island School of Design); Anthony Viscardi, MArch (Georgia Institute of Technology)

**Associate Professors.** Berrisford W Boothe, MFA (Maryland Institute College of Art); Anna Chupa, MFA (University of Delaware); Amy Forsyth, MArch (Princeton University); J. Bruce Thomas, PhD (University of California Berkeley)

**Assistant Professors.** Brian Wesley Heiss, MArch (Rice University); Marilyn Jane Jones, MFA (Marywood University); Hyun-Tae Jung, PhD (Columbia University); Susan E. Kart, PhD (Columbia University); Nikolai P. Nikolov, MArch (Rice University); Nicholas Sawicki, PhD (University of Pennsylvania)

**Lecturer.** Jason E. Travers, MFA (University of Pennsylvania)

**Professor Of Practice.** Christine E. Ussler, MArch (Columbia University)

**Emeriti.** Carlos Alvare, MArch (Yale University); Tom F. Peters, DSC (ETH Zurich); Richard J. Redd, MFA (University of Iowa); Ivan Zaknic, MArch (Princeton University)

#### Art Major

52 credit hours required

##### Foundation

DES 003	Two-Dimensional Design	4
DES 004	Three-Dimensional Design	4
ART 011	Drawing I	4

##### History

ART 001	Art History: Ancient and Medieval	4
or ARCH 001	Architectural History I	
ART 002	Art History: Renaissance to Present	4
ARCH 002	Architectural History II	4
ART 220	20th Century Art	4

##### Studios

Select six of the following, at least two of which are at advanced level: 24

ART 007	Digital Photography I	
ART 013	Sculpture I	
ART 015	Figure I	
ART 034	Plein Air Painting	
ART 035	Painting I	
ART 052	Introduction to Video Recording and Editing	
ART 111	Drawing II	
ART 113	Sculpture II	
ART 135	Painting II	
DES 148	Furniture Design I	
ART 211	Drawing III	
ART 213	Sculpture Workshop	
ART 215	Figure III	
ART 235	Painting III	
DES 248	Furniture Design II	
ART 277	Digital Photography II	
ART 352	Advanced Studio Practice	

Total Credits 52

#### Art History Major

33-44 credit hours are required.

#### Core Requirements

Core requirements consist of four courses.

Select one introductory sequence course in the history of art and architecture, from the following: 4

ART 001	Art History: Ancient and Medieval	
ARCH 001	Architectural History I	

Select one course in ancient art, from the following: 4

ART 174	Greek Archaeology	
ART 176	Roman Archaeology	

ANTH 112	Doing Archaeology	
ANTH 377	Archaeology Of Death	
Select one course in medieval to renaissance art, from the following:		4
ART 206	Medieval Art and Architecture	
ART 207	Renaissance Art and Architecture	
Select one studio course, from the following:		3-4
DES 003	Two-Dimensional Design	
DES 004	Three-Dimensional Design	
ART 011	Drawing I	
ART 013	Sculpture I	
ART 015	Figure I	
ART 035	Painting I	
ART 007	Digital Photography I	
ARCH 211	Architectural Drawing/Analysis and Expressions	

### Concentration

Concentration requirements consists of three to four courses. 12-16  
Select one of the following concentrations:

#### History of the Visual Arts

ART 002	Art History: Renaissance to Present
ART 220	20th Century Art
ART 356	Advanced Seminar in Art History

#### History of Architecture

ARCH 002	Architectural History II
ARCH 210	20th Century Architecture
ARCH 107	History of American Architecture

#### Museum Studies

ART 175	Introduction to Museum Work
ART 275	Museums: Research, Collections Management and Exhibition Planning
ART 276	Museums: Education, Communication and Exhibition Design
ART 375	Museum Internship

### Electives <sup>1</sup>

See footnote instructions, and choose from any of the courses listed above, as well as the following: 6-12

ART 069	Special Topics in Art History
ART/WGSS 121	Women in Art
ART/REL 144	Raw Vision: Creativity and Ecstasy in the Work of Shamans, Mystics, and Artist Outsiders
ART 169	Special Topics in Art History
ART 183	France from Medieval to Modern: Politics, Society and Art
ART 222	Seminar in Art History
ART 269	Special Topics in Art History
ART 370	Special Topics in Museum and Curatorial Studies
ART 389	Honors Project
ARCH 134	Architecture and Urbanism of New York City
ARCH 209	Architecture and Ideas
ARCH 212	The Architecture of Carlos Scarpa/ Theory and Practice
ARCH 214	Architecture and the City since WWII
ARCH 253	Paris: Plan of Metropolis
ARCH 254	Modern Architecture in France: New Directions
ARCH 271	Special Topics in Architecture
ARCH 335	Issues in Contemporary Architecture
DES 066	Design History

DES 266	History of Contemporary Design
ANTH 172	North American Archaeology
ANTH 178	Mesoamerican Archaeology
ANTH 340	Archaeological Theory
HIST 333	American City to 1900
ANTH 370	Historical Archeology
HIST 334	American City in the Twentieth Century
HIST 339	Managing Nonprofit Organizations
HIST 350	19th Century Paris and the Invention of Modernity
LAS/SPAN 265	Spanish and Latin American Cinema
PHIL 123	Aesthetics
PHIL 223	Figures/Themes In Aesthetics
REL 189	Religion and the Visual Arts
DES/THTR 129	History of Fashion and Style

Total Credits 33-44

<sup>1</sup> Elective requirements normally consist of three courses (9-12 credit hours). For students in the museum studies concentration, elective requirements consist of two courses (6-8 credit hours).

### Architecture Major

64-66 credit hours are required.

#### Studio

DES 004	Three-Dimensional Design	4
ARCH 043	Architectural Design I	4
ARCH 143	Architectural Design II	6
ARCH 243	Architectural Design III	6
ARCH 343	Architectural Design IV	6

#### Additional Studios

Select three of the following: 11-12

DES 003	Two-Dimensional Design
ART 007	Digital Photography I
ART 011	Drawing I
ART 013	Sculpture I
ART 015	Figure I
ART 034	Plein Air Painting
ART 035	Painting I
ART 052	Introduction to Video Recording and Editing
ART 111	Drawing II
ART 113	Sculpture II
ART 115	Figure II
ART 135	Painting II
DES 148	Furniture Design I
DES 248	Furniture Design II
ARCH 033	Architectural Drawing
ARCH 211	Architectural Drawing/Analysis and Expressions
ARCH 328	Architectural Representation

#### History and Theory

ARCH 001	Architectural History I	4
or ART 001	Art History: Ancient and Medieval	
ARCH 002	Architectural History II	4
ARCH 210	20th Century Architecture	4
Select two of the following:		7-8
ARCH 107	History of American Architecture	
ARCH 174	Greek Archaeology	
ARCH 134	Architecture and Urbanism of New York City	
ARCH 176	Roman Archaeology	
ARCH 187	Synthetic Space	
ARCH 209	Architecture and Ideas	

ARCH 212	The Architecture of Carlos Scarpa/ Theory and Practice	
ARCH 214	Architecture and the City since WWII	
ARCH 342	Theory of Form and Materials	
ARCH 335	Issues in Contemporary Architecture	
PHIL 123	Aesthetics	
HIST 334	American City in the Twentieth Century	
DES 066	Design History	

**Materials and Technology**

ARCH 157	Architectural Technology I	4
ARCH 158	Architectural Technology II	4
Total Credits		64-66

For the Architecture Major, students must fulfill the mathematics and physical science requirements with the following:

**Mathematics Requirement**

Select one of the following: 5-8

MATH 021 & MATH 022	Calculus I and Calculus II	
MATH 051 & MATH 052	Survey of Calculus I and Survey of Calculus II	
MATH 075 & MATH 076 & MATH 022	Calculus I, Part A and Calculus I, Part B and Calculus II	
MATH 075 & MATH 076 & MATH 052	Calculus I, Part A and Calculus I, Part B and Survey of Calculus II	

**Physical Science Requirement**

PHY 012	Introductory Physics Laboratory I	1
Select one of the following:		
PHY 010 or PHY 011	General Physics I Introductory Physics I	4

A typical first-year might consist of:

**First Year**

First Semester	CR Second Semester	CR
ART 001 or ARCH 001	4 ARCH 002	4
MATH 021 or 051	4 MATH 022 or 052	4
DES 004	4 PHY 010 or 011	4
ENGL 001	3 PHY 012	1
First-year seminar	1 ENGL 002	3
	<b>16</b>	<b>16</b>

Total Credits: 32

**Design Major**

52 credit hours required

**Foundation**

DES 003	Two-Dimensional Design (required for graphic design concentration)	4
ART 011	Drawing I	4
DES 004 or ART 007	Three-Dimensional Design <sup>1</sup> Digital Photography I	4

**History**

ART 001 or ARCH 001	Art History: Ancient and Medieval Architectural History I	4
ART 002	Art History: Renaissance to Present	4
ARCH 002	Architectural History II	4
ART 220 or ARCH 210	20th Century Art <sup>2</sup> 20th Century Architecture	4

**Core Concentration**

Select six elective studio (24) or concentration in graphic design or product design: 24

**Graphic Design**

DES 053	Introduction to Graphic Design
DES 153	Graphic Design: Word and Image
DES 253	Graphic Design: Brand Experience
Plus three elective studios (12). Two of these electives must be 200 level or higher.	

**Product Design**

DES 040	Product Design I: Form, Process and Concept
DES 140	Product Design II: Designing for Others
DES 240	Product Design III: Materials to Market
Plus three elective studios (12). Two of these electives must be 200 level or higher.	

Total Credits 52

- DES 004 required for product design concentration.  
ART 007 required for graphic design concentration.
- ART 220 required for graphic design concentration.  
ARCH 210 required for product design concentration.

**Architecture Courses****ARCH 001 Architectural History I 4 Credits**

Survey of architecture from earliest building to the Renaissance, examined in the context of culture formation, design concepts, and the built environment.

**Attribute/Distribution:** HU

**ARCH 002 Architectural History II 4 Credits**

Survey of architecture from the Renaissance to the present, examined in the context of culture formation, design concepts, and the built environment.

**Attribute/Distribution:** HU

**ARCH 010 Engineering/Architectural Graphics and Design 3 Credits**

Graphical communication of civil engineering or architectural projects using manual techniques and commercial state-of-the-art computer software. Topics include visualization and sketching; orthographic, isometric and other drawings; points, lines and planes in descriptive geometry; site design; overview of geographical information systems and 3D applications. Teamwork on design projects with oral and graphical presentations. Open to a limited number of architecture, design arts or other students with project roles consistent with students' background. Not available to students who have taken MECH 10.

**Attribute/Distribution:** ND

**ARCH 033 Architectural Drawing 4 Credits**

Introduction to architectural hand drawing including orthographic, paraline, and perspective drawing types. Studio course.

**Attribute/Distribution:** ND

**ARCH 043 Architectural Design I 4 Credits**

Fundamental design studio for architecture majors. Composition, spatial concepts; precedent; materials and detail; light and color in architecture. Instruction in basic communication techniques. Reserved for declared Architecture majors. Prerequisites as noted below.

**Prerequisites:** (DES 004 or ART 004)

**Attribute/Distribution:** ND

**ARCH 071 Special Topics in Architecture 1-4 Credit**

Directed projects for students in architecture. Student must initiate contact with sponsoring professor. Permission of Instructor required.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** ND

**ARCH 107 History of American Architecture 4 Credits**

Survey of American building from European colonization to the present. Prerequisites as noted below or consent of instructor.

**Prerequisites:** (ARCH 001 or ART 001) and ARCH 002

**Attribute/Distribution:** HU

**ARCH 123 Visualization and Fabrication in Architecture 4 Credits**

This course concentrates on visualization and fabrication in architecture. Students are introduced to advanced architectural diagramming and model-making as well as conventional and digital representation skills. This course investigates architectural graphics as an active means of communication and as a generative element in organizing architectural space. Precedents and examples are extensively researched. All exercises are designed to enhance students' ability to imagine and visualize complex architectural forms and spaces. Various architectural materials are employed and tested. Digital fabrication is employed to explore the potential of new materials and techniques. At the end of the semester, students are expected to think and work within conventional and new media. Students are also required to submit an advanced portfolio with refined drawings and models. Consent of instructor required.

**Attribute/Distribution:** ND

**ARCH 134 Architecture and Urbanism of New York City 4 Credits**

This course deals with the architecture and urbanism of New York City. It focuses on the twentieth century and occasionally covers other historical periods as well. With the direction of the instructor, students visit and analyze, formally and historically, important structures and places of the city such as museums, transportation hubs, offices, parks and other landmarks of interest. Cultural and sociological as well as architectural readings are offered and discussed. There are six mandatory field trips to New York City led by the instructor. Writing Intensive. Consent of instructor required.

**Attribute/Distribution:** HU

**ARCH 143 Architectural Design II 6 Credits**

Studio format, introductory course in architectural design which introduces students to new ways of thinking about architecture and the perception of space, three-dimensional composition, drawing, and model-making. Previous or concurrent courses in studio art and/or architectural history are recommended. Prerequisites as noted below.

**Prerequisites:** ARCH 043

**Attribute/Distribution:** ND

**ARCH 157 Architectural Technology I 4 Credits**

The two-course sequence (ARCH 157 & ARCH 158) introduces the use of building materials, components and systems (slabs, walls, trusses, facade systems, etc.) while providing students with the knowledge to design and construct comfortable, technically sound and aesthetically pleasing buildings. Must have declared architecture major.

**ARCH 158 Architectural Technology II 4 Credits**

The two-course sequence (ARCH 157 & ARCH 158) introduces the use of building materials, components and systems (slabs, walls, trusses, facade systems, etc.) while providing students with the knowledge to design and construct comfortable, technically sound and aesthetically pleasing buildings. Must have declared architecture major.

**Attribute/Distribution:** ND

**ARCH 161 Performing Arts Venue Design and Technology 4 Credits**

Designing theatres. Theatre equipment systems and acoustics. Function and form.

**Attribute/Distribution:** HU

**ARCH 171 Special Topics in Architecture 1-4 Credit**

Directed projects for students in architecture. Student must initiate contact with sponsoring professor. Must have major standing in department and/or consent of instructor.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** ND

**ARCH 174 Greek Archaeology 4 Credits**

Ancient Greek cultures from the neolithic to hellenistic periods. Reconstructions of Greek social dynamics from study of artifacts.

**Attribute/Distribution:** SS

**ARCH 176 Roman Archaeology 4 Credits**

Cultures of the Roman Empire. Reconstructions of social, political, and economic dynamics of the imperial system from study of artifacts.

**Attribute/Distribution:** SS

**ARCH 187 Synthetic Space 4 Credits**

This course addresses formal concerns in contemporary architecture. Synthetic space exists between the actual and the virtual, between the analogue and the digital. The course will be a pure exploration of the possibilities of space, through animation and creative model making and deployment of parametric modeling software, film sets and motion graphics. Software tutorials will be given as needed. Must have declared architecture major or consent of instructor required.

**Attribute/Distribution:** ND

**ARCH 209 Architecture and Ideas 4 Credits**

Examination of philosophical, technological, and cultural forces shaping Western architecture and urbanism. Writing intensive. Prerequisites as noted below or consent of instructor.

**Prerequisites:** (ARCH 001 or ART 001 and ARCH 002)

**Attribute/Distribution:** HU

**ARCH 210 20th Century Architecture 4 Credits**

History and theories of modern and contemporary architecture. Analysis of buildings, architects, theories and manifestos from the early 20th century to the present. Prerequisites as noted below or consent of instructor.

**Prerequisites:** ARCH 002

**Attribute/Distribution:** HU

**ARCH 211 Architectural Drawing/Analysis and Expressions 3 Credits**

This studio course is part of the Lehigh in Italy summer program and will utilize several different architectural drawing techniques to study aspects of architecture from analysis of a piazza to architecture in detail. It will employ pencil sketching, charcoal drawing, and watercolor. These drawings will act as a way of seeing the Italian urban landscape and supplement the study and analysis of the Italian architects' contemporary work. Fulfills an art studio elective requirement.

**Attribute/Distribution:** ND

**ARCH 212 The Architecture of Carlos Scarpa/Theory and Practice 3 Credits**

This course which is part of the Lehigh in Italy summer program will survey several of the Venetian architect's most famous works. Meet with architects who worked with Scarpa and completed his unfinished projects. Explore thematic principles behind Scarpa's work, their origin and roll in his unique process of design.

**Attribute/Distribution:** HU

**ARCH 214 Architecture and the City since WWII 4 Credits**

Architectural and urban theories and projects from 1945 to the present. Analysis of the relationship between architecture and the city. Prerequisites as noted below or consent of instructor.

**Prerequisites:** (ARCH 002 or ART 002)

**Attribute/Distribution:** HU

**ARCH 243 Architectural Design III 6 Credits**

Continuation of ARCH 143. Design principles of space and form stressed in earlier studios to issues of "materiality," "structure," "modes of representation" and the "process of making." Prerequisites as noted below.

**Prerequisites:** (ARCH 001 or ART 001) and ARCH 143

**Attribute/Distribution:** ND

**ARCH 253 Paris: Plan of Metropolis 3 Credits**

The splendor of modern Paris is due in large part to bold, large-scale modernization and changes in the city's patterns during the 19th century. This course, which is part of the Lehigh in Paris summer program, will cover a century of change and focus on the major accomplishments of its visionary planners.

**Attribute/Distribution:** HU

**ARCH 254 Modern Architecture in France: New Directions 3 Credits**

The course, which is part of the Lehigh in Paris summer program, will cover the most important contributions to modern architecture in the Paris region including Centre Pompidou, Musee d'Orsay, Le Grand Louvre, Parc de la Villette, La Defense, and the new satellite towns around Paris.

**Attribute/Distribution:** HU

**ARCH 271 Special Topics in Architecture 1-4 Credit**

Directed projects for advanced students in architecture or architectural criticism. Must have major standing in the department or consent of instructor. Student must contact sponsoring professor and complete a contract sheet at preregistration.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** ND

**ARCH 300 Apprentice Teaching 1-4 Credit**

Supervised participation in various aspects of the teaching of a course. Transcript will identify department in which apprentice teaching was performed. Consent of department chair required. The transcript will reflect the subject area in which the teaching was done.

**Repeat Status:** Course may be repeated.

**ARCH 311 Portfolio 1 Credit**

The concept, layout, and preparation of a portfolio for graduate school application or employment search, including graphic techniques and reproduction method. Student must contact sponsoring professor.

Prerequisites as noted below.

**Prerequisites:** ARCH 243

**Attribute/Distribution:** ND

**ARCH 328 Architectural Representation 4 Credits**

Studio format, instruction in rendering media such as graphite, charcoal, color pencil, water color and pastel and a variety of three-dimensional drawing techniques. Intended for architectural students who have mastered orthographic drawing (plan, elevation, section). The origin, history, and theory of three-dimensional drawing techniques will also be studied. Prerequisites as noted below.

**Prerequisites:** ARCH 243

**Attribute/Distribution:** ND

**ARCH 335 Issues in Contemporary Architecture 4 Credits**

Seminar on selective architectural topics from the 1960s to the present. Analysis of important architectural projects and theories. Interaction among architecture and social, economic, political and technological changes. Prerequisites as noted below.

**Prerequisites:** (ART 001 or ARCH 001) and ARCH 002

**Attribute/Distribution:** HU

**ARCH 342 Theory of Form and Materials 4 Credits**

Study of the genesis of form, its representation and its interrelationship to related artistic disciplines. Formal notions will be studied, compared and manipulated through the role of time, scale, perceptual analysis and material transformation. Consent of instructor required.

**Attribute/Distribution:** ND

**ARCH 343 Architectural Design IV 6 Credits**

Continuation of ARCH 243. The design of buildings and building groups, with the emphasis on urban design and the city. Prerequisites as noted below.

**Prerequisites:** ARCH 243

**Attribute/Distribution:** ND

**ARCH 389 Honors Project 1-8 Credit**

**Repeat Status:** Course may be repeated.

**Art Courses****ART 001 Art History: Ancient and Medieval 4 Credits**

Survey of major monuments of art and architecture from the prehistoric caves of Lascaux and Altamira through the Gothic cathedrals of Chartres and Notre Dame of Paris, along with highlights of art and architecture of the non-Western civilizations of Africa, India, and China. Work seen in the context of cultural, historical, and technological developments.

**Attribute/Distribution:** HU

**ART 002 Art History: Renaissance to Present 4 Credits**

Survey of art and architecture from the Renaissance through the contemporary era. Examining developments in printing, sculpture, and built environment, as well as the rise of media such as printmaking and photography, the course explores the changing form and status of the visual arts in modern culture and society.

**Attribute/Distribution:** HU

**ART 007 Digital Photography I 4 Credits**

Intensive work in photography as fine art using digital input and output. Lectures, demonstrations, critiques.

**Attribute/Distribution:** HU

**ART 011 Drawing I 4 Credits**

Concepts and practice of drawing, both traditional and contemporary. Includes drawing from life and an introduction to materials and techniques.

**Attribute/Distribution:** HU

**ART 013 Sculpture I 4 Credits**

Projects directed toward developing design in sculpture. Exploration of materials and their application. Emphasis on sculptural form as it relates to techniques.

**Attribute/Distribution:** HU

**ART 015 Figure I 4 Credits**

Drawing and modeling in clay from direct observation of the human figure. Fundamental principles of drawing, and two- and three-dimensional design through analysis of the human form. Inclass exercises cover basic scale, proportion, structure, drawing media and techniques, and clay modeling. Emphasis on personal expression, the human figure as vehicle for narrative, abstract or formal drawings or sculpture.

**Attribute/Distribution:** HU

**ART 034 Plein Air Painting 4 Credits**

Students will paint outdoors during weekly excursions to local sites. An additional lecture and critique period will present the fundamentals of materials and technique. Summers. No prior experience required. 4 credits HU.

**Attribute/Distribution:** HU

**ART 035 Painting I 4 Credits**

Painting in oil beginning with color mixing and basic layering techniques. Students learn the basic mechanisms for creative expression.

Emphasis on understanding the physical nature of the materials. Studio Prerequisites as noted below or consent of instructor.

**Prerequisites:** DES 003 or DES 004 or ART 011

**Attribute/Distribution:** HU

**ART 037 Survey of Printmaking 4 Credits**

An introduction to the fundamentals of printmaking. Students will gain an understanding of the technical processes and the visual language of different printmaking techniques. Students examine historical approaches and context while exploring contemporary modes of expression. Students are encouraged to complete a drawing studio before taking this course.

**Prerequisites:** DES 003

**Attribute/Distribution:** HU

**ART 052 Introduction to Video Recording and Editing 4 Credits**

We will consider the interaction of image, sequence, motion, time and audio with video to create associative, abstract, documentary and narrative videos. Workshops in camera use, editing, concept development, lighting, sound and DVD authoring.

**Attribute/Distribution:** HU

**ART 068 Color Theory 4 Credits**

Application of color in design. Color in graphics, product, digital imaging, and all related fields of design.

**Attribute/Distribution:** HU

**ART 069 Special Topics in Art History 1-4 Credit**

Directed projects for students in the history of art or architecture. Consent of instructor required. May be repeated for credit.

**Repeat Status:** Course may be repeated.

**ART 073 Introductory Studio Practice 1-4 Credit**

An introduction to the methods and techniques of studio art. Designed to acquaint the student with general studio practice, covering topics not covered in other specific studio course listings. May be repeated for credit.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** ND

**ART 111 Drawing II 4 Credits**

Projects in creative drawing designed to build on concepts and practices initiated in basic drawing and life drawing. Prerequisites as noted below.

**Prerequisites:** ART 011

**Attribute/Distribution:** HU

**ART 113 Sculpture II 4 Credits**

Development of principles and techniques in Sculpture I. Modeling, casting, fabrication and carving. Emphasizes an approach to sculptural form and an exploration of the evolution of modern sculpture.

Prerequisites as noted below.

**Prerequisites:** ART 013

**Attribute/Distribution:** HU

**ART 115 Figure II 4 Credits**

Projects in figure modeling and drawing from direct observation of the human figure, designed to build on concepts and practices initiated in Figure I. Students may elect to concentrate in one particular medium, although the primary investigation of form will always incorporate both two and three dimensional work. Prerequisites as noted below.

**Prerequisites:** ART 015

**Attribute/Distribution:** HU

**ART 121 Women in Art 4 Credits**

A history of women artists from Renaissance to present day, with emphasis on artists of the 20th and 21st century from a global perspective. We explore attitudes toward women artists and their work as well as the changing role of women in art world. There may be required visits to museums and/or artists' studios.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**ART 135 Painting II 4 Credits**

A sustained exploration of paint media. Students concentrate on developing a body of related images using various media and approaches. Prerequisites as noted below.

**Prerequisites:** ART 035

**Attribute/Distribution:** HU

**ART 144 Raw Vision: Creativity and Ecstasy in the Work of Shamans, Mystics, and Artist Outsiders 4 Credits**

Comparative exploration of the nature and meaning of religious and artistic experience as reflected in shamanism (both prehistoric and tribal), mystic traditions (especially Taoism and Christianity), and contemporary self-taught artistic visionaries (e.g. Jean Dubuffet, Howard Finster, Mr. Imagination, Lonnie Holley, Norbert Kox). Various disciplinary perspectives will be employed including comparative religions, anthropology, art history, and psychology.

**Attribute/Distribution:** HU

**ART 152 Experimental Animation and Video 4 Credits**

An exploration of time, motion and interactivity in a series of conceptual and technical projects dealing with advanced digital imaging and nonlinear video editing. We will consider the interaction of image, sequence, motion, animation, and audio with video. Prerequisites as noted below.

**Prerequisites:** ART 052

**Attribute/Distribution:** HU

**ART 169 Special Topics in Art History 1-4 Credit**

Directed projects for students in the history of art or architecture. Consent of instructor required. May be repeated for credit.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**ART 173 Special Topics in Studio Practice 1-4 Credit**

Directed projects in art. Permission of instructor required.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** ND

**ART 174 Greek Archaeology 4 Credits**

Ancient Greek cultures from the neolithic to hellenistic periods. Reconstructions of Greek social dynamics from study of artifacts.

**Attribute/Distribution:** SS

**ART 175 Introduction to Museum Work 4 Credits**

Introduction to the world of museums, surveying theory and practice through readings and class discussions in all aspects of museums (A to Z), art galleries and art/historical management. The course combines in situ (LUAG/Museum Operation) instruction, conversations with museum professionals and hands-on experience. Students complete several interactive (PB & CL) exercises/projects.

**Attribute/Distribution:** ND

**ART 176 Roman Archaeology 4 Credits**

Cultures of the Roman Empire. Reconstructions of social, political, and economic dynamics of the imperial system from study of artifacts.

**Attribute/Distribution:** SS

**ART 183 France from Medieval to Modern: Politics, Society and Art 3 Credits**

France's artistic, cultural, social and political development from early kingship and the dominance of the Church in the Middle Ages to the grandeur of the court at Versailles in the Age of Absolutism; the radical transformation of culture and society during the French Revolution and advent of the Modern Nation-State; to twentieth century developments including the two World Wars, imperialism and impact of post-war globalization. Course pays particular attention to the history of artistic and architectural movements as indexes of social and cultural change. Offered in summer only through Lehigh Study Abroad Office as part of Lehigh in Paris program.

**ART 206 Medieval Art and Architecture 4 Credits**

Focus on art and architecture in Western Europe from 313 A.D. until ca. 1500 A.D. Topics include: the emergence of Christian art and architecture; the art of barbarian migrations; the Carolingian Renaissance; monasticism, pilgrimage and the Romanesque; the Gothic cathedral; and medieval manuscript illumination. Prerequisites as noted below.

**Prerequisites:** ART 001 or ARCH 001

**Attribute/Distribution:** HU

**ART 207 Renaissance Art and Architecture 4 Credits**

Survey of the art and architecture of the Italian Renaissance from its beginnings in 13th and 14th century Tuscany and its first flowering in 15th century Florence through the brilliant achievements of the masters of the High Renaissance and later 16th century.

**Prerequisites:** ART 002 or ARCH 002

**Attribute/Distribution:** HU

**ART 211 Drawing III 4 Credits**

Projects in traditional and contemporary drawing. Oriented toward developing an individual portfolio. Drawing as a vehicle for ideas, creative expression, and image making. Students investigate a broad range of materials, forms and traditions. Prerequisites as noted below.

**Prerequisites:** ART 111

**Attribute/Distribution:** HU

**ART 213 Sculpture Workshop 4 Credits**

An advanced studio emphasizing sculpture within a contemporary context. Through the exploration of various concepts, material processes and rigorous critique, the student works toward developing their own unique vision and practice. May be repeated as topics vary. Prerequisites as noted below.

**Repeat Status:** Course may be repeated.

**Prerequisites:** ART 013 or DES 004

**Attribute/Distribution:** HU

**ART 215 Figure III 4 Credits**

Further exploration of the human figure as the subject of art. More advanced students may elect to concentrate in either two or three dimensional representations in any media. The emphasis will be on personal interpretation and independent work with the instructor. Prerequisites as noted below.

**Prerequisites:** ART 115

**Attribute/Distribution:** HU

**ART 220 20th Century Art 4 Credits**

Introduction to the major developments of 20th century art, including cubism, futurism, surrealism, abstract expressionism, pop, performance and new media art. The course merges classroom lectures with discussion and museum visits. Prerequisites as noted below.

**Prerequisites:** ART 002

**Attribute/Distribution:** HU

**ART 222 Seminar in Art History 4 Credits**

In this seminar students undertake sustained and focused study of select themes and topics from the history of art. Particular attention is devoted to learning the methods, theories, and research practices that art historians use to interpret and understand art. Seminar topics change annually.

**Repeat Status:** Course may be repeated.

**Prerequisites:** ART 002 or ART 001

**Attribute/Distribution:** HU

**ART 227 Latino Visual Arts and Culture in the USA 4 Credits**

The thrust of the course is to explore the phenomenon of contemporary Latino and Latin American art from several angles. Because art has no country, but the artist does, is contemporary art a product of globalization? Is Latino and Latin American art, culture and art criticism a nationalistic platform of cultures, or just a contemporary enterprise of sorts? Who's who in the current Latino and Latin American art world? Students will utilize works from the university (LUAG) collection and/or research and interview a contemporary artist at his or her studio (if possible) for essays or media projects.

**ART 235 Painting III 4 Credits**

Emphasis on identifying an individual creative style or direction with the media. Students are encouraged to develop a body of painted work ready for professional exhibitions. Outside critics invited to final reviews.

**Repeat Status:** Course may be repeated.

**Prerequisites:** ART 135

**Attribute/Distribution:** HU

**ART 269 Special Topics in Art History 1-4 Credit**

ART 269. Special Topics in Art History (1-4) Directed projects for advanced students in the history of art or architecture. Consent of instructor required. May be repeated for credit.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** ND

**ART 273 Special Topics in Studio Practice 1-4 Credit**

Individually directed projects for advanced students capable of undertaking independent creative work in studio art. Consent of instructor required. May be repeated for credit.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** ND

**ART 275 Museums: Research, Collections Management and Exhibition Planning 4 Credits**

Theory and practice in contemporary museums and galleries through readings and class discussion. Practicum at the LUAG/Museum Operation dealing with care of museum collections, collection management, intellectual and practical tasks of preparing and communicating through exhibitions, and the professional responsibilities of the curator and curatorial staff. Students will complete a number of exercises and a research report or equivalent. Prerequisites as noted below.

**Repeat Status:** Course may be repeated.

**Prerequisites:** ART 175

**Attribute/Distribution:** ND

**ART 276 Museums: Education, Communication and Exhibition Design 4 Credits**

Theory and practice in contemporary museums and galleries through readings and class discussions. Practicum in the LUAG/Museum Operation dealing with design and installation of exhibitions; educational programming and the community; organization, principles of management and strategic planning; museum advocacy. Students complete a number of exercises and a research report or equivalent. Prerequisites as noted below.

**Prerequisites:** ART 175

**Attribute/Distribution:** ND

**ART 277 Digital Photography II 4 Credits**

An opportunity to produce a unified body of work and to explore digital photography on a deeper level with an emphasis on conceptually driven images. Experimental process encouraged. May be repeated for credit. Prerequisites as noted below or consent of instructor.

**Repeat Status:** Course may be repeated.

**Prerequisites:** ART 007

**Attribute/Distribution:** HU

**ART 300 Apprentice Teaching 1-4 Credit**

**Repeat Status:** Course may be repeated.

**ART 311 Art Portfolio 1-4 Credit**

The concept, layout, and preparation of a portfolio for graduate school application or employment search, including graphic techniques and reproduction method. Student must contact sponsoring professor. Must have junior standing. Consent of instructor required.

**Attribute/Distribution:** ND

**ART 350 Special Topics in Graphic Design and Theory Seminar 1-4 Credit**

Current topics in graphic communication theory and practice. Course will cover preparation, production, and formulation of individual portfolio. Selected readings and discussions in professional ethics as well as legal issues in the field will be covered. May be repeated for credit. Prerequisites as noted below.

**Repeat Status:** Course may be repeated.

**Prerequisites:** ART 253 or DES 253

**Attribute/Distribution:** ND

**ART 352 Advanced Studio Practice 1-4 Credit**

Advanced studio for art or architecture majors under guidance of faculty. Oral and written critiques. Variable media. May be repeated for credit. Must have completed a third level (200 numbered) course of a studio art discipline. Consent of instructor required.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**ART 356 Advanced Seminar in Art History 4 Credits**

In this upper level seminar, students undertake advanced study of select themes and topics from the history of art. Special emphasis is accorded to the practical application of art historical methods, theories, and research practices. Students pursue advanced research projects related to the seminar topic, which changes annually. Writing Intensive. Prerequisites as noted below.

**Prerequisites:** (ART 001 or ARCH 001) and ART 002 and ART 220

**Attribute/Distribution:** HU

**ART 370 Special Topics in Museum and Curatorial Studies 1-4 Credit**

Special project and/or internship for graduate and advanced undergraduates. May be repeated for credit. Prerequisites as noted below.

**Repeat Status:** Course may be repeated.

**Prerequisites:** ART 275 or ART 276

**Attribute/Distribution:** ND

**ART 373 Studio Art Internship 1-4 Credit**

Practical infield experience in an artist's studio or art-related apprenticeship opportunity. Requires approval a semester in advance by instructor and host organization.

**Attribute/Distribution:** ND

**ART 375 Museum Internship 1-4 Credit**

Internship under professional supervision in all areas of museums and/or related organizations, regionally, nationally or abroad in well established or accredited institutions. Students must initiate contact/application. A contractual agreement or letter of acceptance is required. Prerequisites as noted below or consent of department required.

**Prerequisites:** ART 276 or ART 275

**Attribute/Distribution:** ND

**ART 389 Honors Project 1-8 Credit**

**Repeat Status:** Course may be repeated.

**Design Courses****DES 003 Two-Dimensional Design 4 Credits**

This class will present the foundations necessary to understand, discuss and create in the two-dimensional visual world. Using variety of materials and techniques and digital media, students will explore the concepts of line, form, shape, value, texture, space and color. Required for all Art and Design majors.

**Attribute/Distribution:** ND

**DES 004 Three-Dimensional Design 4 Credits**

An introduction to the basic elements and principles of design. Course involves use of various materials to solve 3D design problems in studio and computer lab. Problem solving in variety of materials for 3D design including assemblages, models, constructions, and conceptual forms. Required for all majors in department.

**Attribute/Distribution:** ND

**DES 040 Product Design I: Form, Process and Concept 4 Credits**

Introduction to the field of Industrial Design. Through research, analysis, drawing and prototyping, students will acquire an understanding of the various aesthetic, technological, and business issues a designer must consider when creating a product. Prerequisites as noted below or consent of department required.

**Prerequisites:** (DES 003 or ART 003 or ART 011) and DES 004

**Attribute/Distribution:** HU

**DES 053 Introduction to Graphic Design 4 Credits**

This course serves as an introduction to the graphic design process, with a primary focus on concept development and craft. Students examine how to identify and resolve visual problems and learn the basics of design and typography. Creative solutions will be encouraged for projects with practical applications. Topics include logo development and execution, professional typography, image basics and resolution, print production, studio skills and professional practices. Digital applications include Photoshop, Illustrator and In-design. Prerequisites as noted below.

**Prerequisites:** DES 003 or DES 096

**Attribute/Distribution:** HU

**DES 066 Design History 4 Credits**

History of product design, graphic design and time-based media in artistic, cultural, technological, and business contexts.

**Attribute/Distribution:** HU

**DES 070 Web Design I 4 Credits**

Introduction to the design and fabrication of web pages. Students will learn how to create pages using HTML and web fabrication software, with an emphasis on aesthetic and structure. Prerequisites as noted below.

**Prerequisites:** DES 003 or ART 003

**Attribute/Distribution:** ND

**DES 073 Special Topics in Design 1-4 Credit**

An introduction to methods and techniques of design studio. Designed to acquaint the student with general design elements, covering topics not covered in other specific studio course listings. Instructor permission required.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** ND

**DES 079 Digital Bridges 2 Credits**

Run as an independent study: research ancient Chinese bridges, gardens, and pavilions. Digitize images and website design. Create photographic documentation of the Bridge Project. Produce documentary from historical materials concerning history of Chinese students at Lehigh. Bridge Project students could continue project work in Shanghai and Beijing. May be repeated for credit.

**DES 087 Design for the Theatre 4 Credits**

Introduction to the process of creating integrated designs in theatre production. The study and practice of the principles of visual representation, historical and conceptual research and the study of theatrical styles.

**Attribute/Distribution:** HU

**DES 111 Sound Design 4 Credits**

Techniques, materials, and methods of designing sound for theatrical production.

**Attribute/Distribution:** HU

**DES 129 History of Fashion and Style 4 Credits**

Dress and culture in the Western Hemisphere from prehistory to today. The evolution of silhouette, garment forms and technology. The relationship of fashion to politics, art and behavior. Cultural and environmental influences on human adornment.

**Attribute/Distribution:** HU

**DES 140 Product Design II: Designing for Others 4 Credits**

This course will expose students to client based projects and issues of branding relevant to the product designer. Special emphasis will be given to functionality from a user centered perspective. Projects will also include the use of 3D digital prototyping software and computer based fabrication techniques. Prerequisites as noted below.

**Prerequisites:** DES 040

**Attribute/Distribution:** ND

**DES 148 Furniture Design I 4 Credits**

Design methodology, fabrication techniques, and methods of design presentation. Prerequisites as noted below.

**Prerequisites:** DES 004

**Attribute/Distribution:** HU

**DES 153 Graphic Design: Word and Image 4 Credits**

This course explores techniques of image making in relation to analyzing and creating meaning in graphic and typographic messages. Students solve visual communication problems with visual, conceptual and social impact. Assignments may include book covers, posters, music packaging, and promotional materials. Students will work in both traditional and digital media. Prerequisites as noted below.

**Prerequisites:** ART 053 or DES 053

**Attribute/Distribution:** HU

**DES 154 Scene Painting 4 Credits**

Study and practice of basic and advanced methods of painting for the theatre. Includes basic elements and principles of design, color theory, the influence of light, atmosphere and aesthetics for the theatre.

**Attribute/Distribution:** HU

**DES 164 Ergonomics 4 Credits**

Introduction to physical, emotional, and psychological ways design interacts with people. Analyze real design problems and create solutions.

**Attribute/Distribution:** HU

**DES 170 Web Design II 4 Credits**

Creation of dynamic content in web design. Various 2D animation software applications and simple scripting will be explored. Prerequisites as noted below.

**Prerequisites:** DES 070

**Attribute/Distribution:** ND

**DES 173 Special Topics in Design 1-4 Credit**

Directed projects in design with selected readings as required. Student must initiate contact with sponsoring professor. Instructor permission required.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** ND

**DES 186 Lighting Design 4 Credits**

An introduction to the art and practice of lighting design for the theatre. Script analysis, research, and the interplay of lighting technology and design. Students will develop a sense of the dramatic while creating a portfolio of lighting designs. Prerequisites as noted below.

**Prerequisites:** THTR 087 or DES 087

**Attribute/Distribution:** HU

**DES 188 Scenic Design 4 Credits**

An introduction to the art and practice of scenic design for the theatre. Script analysis, research, drafting and modeling techniques. Students will develop a sense of the dramatic while creating a portfolio of scenic designs. Prerequisites as noted below.

**Prerequisites:** THTR 087 or DES 087

**Attribute/Distribution:** HU



**DES 189 Costume Design 4 Credits**

An introduction to the art and practice of costume design for the theatre. Script analysis, research and rendering techniques. Students will develop a sense of the dramatic while creating a portfolio of costume designs. Prerequisites as noted below.

**Prerequisites:** THTR 087 or DES 087

**Attribute/Distribution:** HU

**DES 211 Integrated Product Development (IPD) 1 3 Credits**

Business, engineering, and design arts students work in cross-disciplinary teams of 46 students on conceptual design including marketing, financial and economic planning, economic and technical feasibility of new product concepts. Teams work on industrial projects with faculty advisers. Oral presentations and written reports. Must have junior standing in business, economics, arts, design or engineering. Mechanical Engineering students must register for ME 211.

**Attribute/Distribution:** ND

**DES 212 Integrated Product Development (IPD) 2 2 Credits**

Business, engineering, and design arts students work in cross disciplinary teams of 46 students on the detailed design including fabrication and testing of a prototype of the new product designed in the IPD course 1. Additional deliverables include a detailed production plan, marketing plan, detailed base case financial models, project and product portfolio. Teams work on industrial projects with faculty advisors. Oral presentations and written reports. Prerequisites as noted below.

**Prerequisites:** BUS 211 or DES 211 or ENGR 211 or ME 211

**Attribute/Distribution:** ND

**DES 240 Product Design III: Materials to Market 4 Credits**

In this advanced level studio students will research fabrication techniques and materials, develop ideas into prototypes, outsource production and sell their designs in a competitive retail market. This course confronts the financial realities of being an independent designer while offering an opportunity to create innovative and desirable domestic products. Prerequisites as noted below.

**Prerequisites:** DES 040

**Attribute/Distribution:** ND

**DES 248 Furniture Design II 4 Credits**

Advanced fabrication. Contemporary art issues and furniture history. Prerequisites as noted below.

**Repeat Status:** Course may be repeated.

**Prerequisites:** DES 148

**Attribute/Distribution:** HU

**DES 253 Graphic Design: Brand Experience 4 Credits**

In this course, students examine the basic principles of corporate identity and develop a clear understanding of the process of creating brands. Projects will offer a framework for looking at business strategy as it relates to the creative process of design. Emphasis will be placed on creating visual elements that support a brand and the steps a designer takes to create a consistent brand. In addition, students will develop self-promotion materials and identity systems. Prerequisites as noted below.

**Prerequisites:** DES 053

**Attribute/Distribution:** HU

**DES 260 Exhibit Design 4 Credits**

Team projects in development of exhibits for museums, conferences, or educational centers. Project work is supplemented by lectures and demonstrations. Teams will produce real and virtual exhibit prototypes and will design and maintain an exhibit website.

**Attribute/Distribution:** HU

**DES 266 History of Contemporary Design 4 Credits**

History of modern design from mid 19th century to the present. Studies and discussion of contemporary issues and technology in Design Arts. Topics will include green design, digital technology, current legal and ethical principles, and other issues.

**Attribute/Distribution:** HU

**DES 268 Advanced Design Projects 1-4 Credit**

Advanced projects or studies applying Design Arts practices or theories. Consent of instructor required. May be repeated for credit. Consent of department required.

**Attribute/Distribution:** ND

**DES 300 Apprentice Teaching 1-4 Credit****DES 311 Design Portfolio 1-4 Credit**

The concept, layout, and preparation of a portfolio for graduate school application or employment search, including graphic techniques and reproduction method. Student must contact sponsoring professor.

Prerequisites as noted below.

**Repeat Status:** Course may be repeated.

**Prerequisites:** DES 240 or DES 253

**DES 370 Special Topics in Design 1-4 Credit**

Current topics in design, with selected readings, discussions, and studio work as required. May be repeated for credit. Must have completed two 100-level Design courses. Consent of department required.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** ND

**DES 375 Design Internship 1-4 Credit**

Practical experience following apprenticeship model. Requires approval of instructor and host prior to beginning of the term, with a memorandum of understanding outlining student work responsibilities and educational objectives for the experience.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** ND

**DES 387 Scenography II 4 Credits**

Advanced projects in theatrical design. Portfolio readiness and resume preparation. Prerequisites as noted below.

**Prerequisites:** (THTR 087 or DES 087) and (THTR 186 or DES 186 or THTR 188 or DES 188 or THTR 189 or DES 189)

**Attribute/Distribution:** HU

**DES 389 Honors Project 1-8 Credit**

**Repeat Status:** Course may be repeated.

**Asian Studies**

**Program Director:** Kiri Lee, Ph. D. (Harvard)

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*Supported by the Office of Interdisciplinary Programs 610-758-3996; [incasip@lehigh.edu](mailto:incasip@lehigh.edu)*

The Asian Studies program provides undergraduates an opportunity to acquire a systematic knowledge of East Asia, Southeast Asia, and South Asia. The program focuses on the rich historical and cultural heritage of the countries of Asia, as well as their growing importance in world affairs.

The overall program is administered by the Asian Studies Committee, an interdisciplinary body of faculty with special interests in the region. This committee oversees both the formal academic work within the program as well as extracurricular activities. It also cooperates with the Asian Cultural Society and other student organizations involved in Asian Studies.

The courses listed are regularly offered in the program and new ones are currently under development in several subject areas. (Consult the Registrar's Schedule of Classes for specific offerings in any particular semester.)

Courses offered at other LVAIC institutions may be taken for credit by Lehigh students. Students are encouraged to participate in a variety of extracurricular activities that are offered by the Asian Studies Program, such as special lectures and seminars, films, performances, and exhibits.

**Major in Asian Studies**

The Asian Studies major is designed to accomplish three goals: to ground the student in a regional language and culture, to survey various disciplines in Asian Studies more broadly, and to provide advanced research opportunities. The program, when successfully completed, prepares the student for further graduate work, professional education, or employment in the public or private sector. There is an increasing demand for graduates who combine a major in a disciplinary field (e.g., business, economics, international relations) with a second major (or

minor) in Asian Studies, including Chinese or Japanese language competence.

The major in Asian Studies may have a Chinese studies or a Japanese studies concentration, each requiring a minimum of 9 courses (36 credits). The distribution of credits is as follows:

2 years (or 16 credits) of an Asian language which is not the student's native language	16
3 courses (or 10 credits) of humanities and social science courses under the 200 level (see list below)	10
2 courses from the following:	10
Advanced language and culture	
Humanities and social sciences. At least one course must be at the 300 level.	
<b>Total Credits</b>	<b>36</b>

The academic advisor is the director of the Asian Studies Program. Students may also request an advisor from among the Asian Studies faculty.

#### Minor in Asian Studies

The minor in Asian Studies is intended to complement a student's major field of study and it is flexible according to individual needs. Students are free to survey the field broadly or concentrate in a specific area such as Chinese or Japanese studies. The minor comprises a minimum of 4 courses (16 credits) in Asian studies, chosen from an approved list in consultation with the director of the Asian Studies Program.

While students minoring in Asian Studies are encouraged to study languages, only 8 credits of language study count towards the Asian Studies minor. Students interested only in language study are encouraged to minor in Chinese or Japanese language (see MLL (p. 171)). To declare a minor in Asian Studies, students must complete a minor declaration form ([http://catalog.lehigh.edu/coursesprogramsandcurricula/artsandsciences/asianstudies/Asian\\_Studies\\_Minor\\_Declaration\\_Form1.pdf](http://catalog.lehigh.edu/coursesprogramsandcurricula/artsandsciences/asianstudies/Asian_Studies_Minor_Declaration_Form1.pdf)).

#### Study Abroad Programs

Students are encouraged to spend a summer, semester, or year in an approved study program in China, Japan, Korea, Thailand, India, or elsewhere in Asia. Students who wish to study abroad, and who wish to have the academic work taken in that program count toward a Lehigh degree, must have a GPA of 3.0 or higher. Any student with a lower GPA may petition the Committee on the Standing of Students for an exception to this rule before applying to an approved study abroad program. These programs are open to all LVAIC students subject to the regulations of their home institutions. For details on all programs, consult Study Abroad Office, Coxe Hall, 32 Sayre Dr, 610-758-3351, ([www.lehigh.edu/studyabroad](http://www.lehigh.edu/studyabroad)) **Asian Studies offers a limited number of study abroad travel grants.**

#### Core Requirements

<b>Language and Culture</b>	16
Chinese or Japanese or other approved Asian languages to intermediate level (2 years);	
or select four of the following courses (16 credits), based on placement: <sup>1</sup>	

ASIA 091	Elementary Asian Language and Culture Abroad
ASIA 191	Intermediate Asian Language and Culture Abroad
CHIN 001	Beginning Chinese Reading and Writing I
CHIN 002	Beginning Chinese Reading and Writing II
CHIN 003	Beginning Spoken Chinese I
CHIN 004	Beginning Spoken Chinese II
CHIN 011	Intermediate Chinese Reading and Writing I
CHIN 012	Intermediate Chinese Reading and Writing II

CHIN 013	Intermediate Spoken Chinese I
CHIN 014	Intermed Spoken Chinese II
CHIN 021	Survival Chinese
CHIN 091	Chinese Language & Culture Abroad I
CHIN 111	Advanced Chinese Reading & Writing I
CHIN 112	Advanced Chinese Reading & Writing II
CHIN 113	Advanced Spoken Chinese I
CHIN 114	Advanced Spoken Chinese II
CHIN 191	Chinese Language & Culture Abroad III
JPNS 001	Elementary Japanese I
JPNS 002	Elementary Japanese II
JPNS 011	Intermediate Japanese I
JPNS 012	Intermediate Japanese II
JPNS 131	Advanced Japanese Reading and Writing I
JPNS 132	Advanced Japanese Reading and Writing II
JPNS 141	Advanced Japanese I
JPNS 142	Advanced Japanese II
JPNS 151	Advanced Spoken Japanese

#### Humanities and Social Science 10

Select 3 courses (minimum 10 credits):

ASIA/REL 012	Introduction to Asian Religions
ASIA/REL 060	Religions of South Asia
ASIA/IR 061	Pacific Asian International Relations
ASIA/REL 064	Religions of China
ASIA/REL 065	Religions of Japan
ASIA/REL 067	Japanese Civilization
ASIA/MLL 068	Japanese Language: Past and Present
ASIA/GCP/MLL/WGSS 073	Film, Fiction, and Gender in Modern China
ASIA/MLL 074	Chinese Cultural Program
ASIA/HIST/MLL 075	Chinese Civilization
ASIA/HIST/MLL 076	Understanding Contemporary China
ASIA/REL 077	The Islamic Tradition
ASIA/MLL 078	Asian-American Studies
ASIA/DES/MLL 079	Digital Bridges
ASIA 091	Elementary Asian Language and Culture Abroad
ASIA/SSP 114	Social Issues in Contemporary China
ASIA/MLL 125	Immortal Images: Traditional Chinese Literature in Translation
ASIA/MLL 127	ORIENTations: Approaches to Modern Asia
ASIA/PHIL 140	Eastern Philosophy
ASIA/GCP/REL 145	Islam and the Modern World
ASIA/REL 146	Islam in South Asia
ASIA/REL 160	The Taoist Tradition
ASIA/IR 161	China in World Affairs
ASIA/REL 162	Zen Buddhism
ASIA/IR 163	Japan in World Affairs
ASIA/MLL 165	Love and Revolution in Shanghai
ASIA/REL 166	Religious Nationalism in South Asia
ASIA/REL 167	Engaged Buddhism
ASIA/REL 168	Buddhism in the Modern World
ASIA/HIST 170	The Last Samurai
ASIA/MLL 177	China Enters the Modern Age
ASIA/ANTH 187	Peoples and Cultures of Southeast Asia
ASIA/ANTH 188	Southeast Asian Migrants and Refugees

ASIA 191	Intermediate Asian Language and Culture Abroad	
<b>Advanced Electives</b>		7-8
Select two courses (7-8 credits), one of which must be at the 300 level: <sup>2</sup>		
CHIN 251	Chinese Special Topics	
CHIN 252	Business Chinese	
CHIN 253	Chinese Fiction	
CHIN 254	Intensive Chinese Conversation	
CHIN 255	Newspaper Readings In Chinese	
CHIN 291	Chinese Language & Culture Abroad III	
CHIN 371	Advanced Readings in Chinese	
JPNS 231	Advanced Japanese Reading and Writing I	
JPNS 232	Advanced Japanese Reading and Writing II	
JPNS 290	Japanese Special Topics	
JPNS 291	Advanced Japanese and Culture Abroad	
JPNS 390	Japanese Special Topics	
Total Credits		33-34

<sup>1</sup> Students with prior knowledge of Chinese or Japanese will be placed on the basis of a competence test.

<sup>2</sup> Other suitable courses at LVAIC or other approved institutions in the United States or courses in approved study abroad programs in Asia may be substituted with the Director's approval.

#### Courses

##### ASIA 012 Introduction to Asian Religions 4 Credits

This course explores the principal religions of Asia, including Hinduism, Buddhism, Daoism, Confucianism, and Shinto. What is each tradition's view of human potential? How is ultimate reality depicted and experienced? What do home altars, boisterous festivals, and silent meditation halls have in common? Several primary texts are read in translation.

**Attribute/Distribution:** HU

##### ASIA 060 Religions of South Asia 4 Credits

A thematic introduction to the foundational religious traditions of South Asia: Hinduism, Jainism, Buddhism, Sikhism and Islam. Students explore the social and spiritual dimensions of these religious worlds through scripture, ritual practices, narrative and teaching traditions, music and art.

**Attribute/Distribution:** HU

##### ASIA 061 Pacific Asian International Relations 4 Credits

Introduction to Pacific Asian international relations, with emphasis on post 1945 period: historical background; Cold War conflicts; China's rise to power; Japan's growing role; Korea and the NIC's; Southeast Asia; U.S. and Russian policies; current and future issues.

**Attribute/Distribution:** SS

##### ASIA 064 Religions of China 4 Credits

History and meaning of the major forms of Chinese religion, especially Confucianism and Neo-Confucianism, Taoist mysticism, Buddhism (Ch'an/Zen), and popular religion.

**Attribute/Distribution:** HU

##### ASIA 065 Religions of Japan 4 Credits

A survey of Japan's diverse religious heritage and its impact on contemporary culture. Japanese approaches to the self, the world, and the sacred are considered in comparative perspective. Topics covered include: Shinto, Buddhism, Zen, Confucianism, the way of the warrior, folklore, and postwar movements.

**Attribute/Distribution:** HU

##### ASIA 067 Japanese Civilization 4 Credits

This course explores the history and culture of Japan from the sixth century to the nineteenth century. How did Japan develop its distinct sense of itself? What aspects of Japanese culture have gained recognition on an international scale? Special consideration is given to the rise of the warrior class, the flowering of religious expression, and the dynamics of family life.

##### ASIA 068 Japanese Language: Past and Present 4 Credits

Historical and contemporary aspects of the Japanese language, including the origins of Japanese in relation to Korean, the influence of Chinese, syntactic features which reflect the hierarchical character of Japanese society, differences in female and male speech, and use of foreign loan words.

**Prerequisites:** (JPNS 001)

**Attribute/Distribution:** HU

##### ASIA 073 Film, Fiction, and Gender in Modern China 4 Credits

Study of the struggle for an individual "modern" identity out of traditionally defined roles for men and women as depicted by Chinese writers and filmmakers. Class, texts, and films in English. Students interested in setting up a corollary Chinese language component for credit as Chin 251, may discuss this possibility with the professor.

**Attribute/Distribution:** HU

##### ASIA 074 Chinese Cultural Program 1-8 Credit

A summer program in China, taught in English.

**Attribute/Distribution:** HU

##### ASIA 075 Chinese Civilization 4 Credits

The development of traditional Chinese thought, beliefs, technology, and institutions from a historical perspective.

**Attribute/Distribution:** HU, SS

##### ASIA 076 Understanding Contemporary China 4 Credits

An overview of recent history, politics, economy, religion, problems of modernization, popular culture, and attitudes. Contemporary Chinese society viewed against the backdrop of tradition and the tumultuous history of twentieth-century China.

**Attribute/Distribution:** SS

##### ASIA 077 The Islamic Tradition 4 Credits

A thematic introduction to Islamic history, doctrine and practice.

Topics include: Qur'an; prophecy and sacred history; ritual practices; community life; legal interpretation; art and aesthetics; mysticism; politics and polemics.

**Attribute/Distribution:** HU

##### ASIA 078 Asian-American Studies 4 Credits

A survey of issues concerning Asians living in the United States from the perspectives of history, language, literature, and film.

**Attribute/Distribution:** HU

##### ASIA 079 Digital Bridges 2 Credits

Run as an independent study; research ancient Chinese bridges, gardens, and pavilions. Digitize images and website design.

Create photographic documentation of the Bridge Project. Produce documentary from historical materials concerning history of Chinese students at Lehigh. Bridge Project students could continue project work in Shanghai and Beijing. May be repeated for credit.

**Repeat Status:** Course may be repeated.

##### ASIA 091 Elementary Asian Language and Culture Abroad 1-8 Credit

Elementary language and culture abroad other than Chinese or Japanese.

**Attribute/Distribution:** HU

##### ASIA 114 Social Issues in Contemporary China 4 Credits

Dramatic Economic, cultural and social changes are underway in China today and have aroused much debate among social scientists East and West. The following social issues are critical for understanding China's development trajectory: inequality and poverty; rapid demographic shifts; provision of health care services; provision of education services; and becoming an "information society." We will explore how these issues intersect with old hierarchies in China, urban-rural differences, and gender differences.

**Attribute/Distribution:** SS

**ASIA 125 Immortal Images: Traditional Chinese Literature in Translation 4 Credits**

Explore age-old themes in literature as diverse as pre-modern novels, ghost stories, poetry, divination manuals, and medical texts. Students interested in setting up a corollary Chinese language component for credit as CHIN 251, may discuss this possibility with the professor.

**Attribute/Distribution:** HU

**ASIA 127 ORIENTations: Approaches to Modern Asia 4 Credits**

A survey of the rapid economic, political, and social changes occurring in East, South, and Southeast Asian countries. How do the contemporary societies and historical traditions of Asian countries differ from the West? What distinguishes our perspectives on politics, individual liberties, civic responsibility, religious faith, the "pursuit of happiness"? How are Asians represented (or misrepresented) in the West, and how will the ongoing process of globalization change, and be changed by, Asian cultures? (H/S).

**ASIA 140 Eastern Philosophy 4 Credits**

Survey of selected texts and issues in the eastern philosophical traditions. Attention will be given to the development and interrelations of these traditions as well as a comparison of western and eastern treatments of selected issues. Areas of focus may include Confucianism, Taoism, and Zen Buddhism.

**Attribute/Distribution:** HU

**ASIA 145 Islam and the Modern World 4 Credits**

Examines how numerous Muslim thinkers, religious scholars, modernists, and Islamists have responded to the changes and challenges of the colonial and postcolonial eras. Special emphasis is placed on the public debates over Islamic authority and authenticity in contemporary South Asia.

**Attribute/Distribution:** HU

**ASIA 146 Islam in South Asia 4 Credits**

A survey of the dynamic encounter between Islamic and Indic civilizations. Topics include: Islamic identity, piety and practice; art and aesthetic traditions; intercommunal exchange and conflict; the colonial legacy; and the politics of contemporary religious nationalism.

**Attribute/Distribution:** HU

**ASIA 160 The Taoist Tradition 4 Credits**

Consideration of the religious and cultural significance of Taoism in its various historical forms. Primary attention will be given to a close reading of some of the most important texts of the early philosophical tradition (e.g. Tao Te Ching, Chuang Tzu) and of the later religious tradition (e.g. Pao P'u Tzu and other selections from the Tao Tsang). Contemporary implications of Taoist thought will also be considered (e.g. "The Tao of Physics", "a Taoist on Wall Street", and "the Tao of Japanese Management").

**Attribute/Distribution:** HU

**ASIA 161 China in World Affairs 4 Credits**

China in world affairs, emphasizing role in Pacific Rim: historical background; domestic politics; foreign and security policies; relations with regional and global powers; policies toward Asia and Third World; current and future issues.

**Attribute/Distribution:** SS

**ASIA 162 Zen Buddhism 4 Credits**

History, doctrines, and practices of Zen Buddhism in China, Japan, and the West. Monastic life, notable Zen masters, Zen's cultural impact, and enlightenment. Current aspects of the Zen tradition. (Optional meditation workshop.)

**Attribute/Distribution:** HU

**ASIA 163 Japan in World Affairs 4 Credits**

Japan in world affairs, emphasizing role in Pacific Rim: historical background; domestic politics; foreign and security policies; relations with regional and global powers; policies toward Asia and Third World; current and future issues.

**Attribute/Distribution:** SS

**ASIA 165 Love and Revolution in Shanghai 4 Credits**

This project-based course will examine human relationships and political-economic changes in Shanghai through the lens of literature, film, and a selection of other readings. Students will discuss the conflicts between and influences of pre-communist, communist, and capitalist systems as played out in the Shanghai urban arena.

**Attribute/Distribution:** HU

**ASIA 166 Religious Nationalism in South Asia 4 Credits**

This course explores the conflation and conflict of religion and politics in one of the most complex, dynamic and volatile regions on the planet (South Asia). Through literature, film and scholarly writings, students will examine the history of cooperation and conflict between the Muslim and Hindu communities in South Asia from the movements for national independence to twenty-first century identity politics.

**Attribute/Distribution:** HU

**ASIA 167 Engaged Buddhism 4 Credits**

Examines a contemporary international movement that applies Buddhist teachings and practices to social, political, and environmental issues. Topics include: important thinkers, forms of engagement, and areas of controversy.

**Attribute/Distribution:** HU

**ASIA 168 Buddhism in the Modern World 4 Credits**

Explores contemporary Buddhism in Asia, America, and Europe. Topics include the plight of Tibet, Buddhist environmentalism, and the emergence of a socially engaged Buddhism. How are Westerners adapting this ancient tradition to address present day concerns?.

**Attribute/Distribution:** HU

**ASIA 170 The Last Samurai 4 Credits**

Explores the revolutionary character of the political upheaval in 1868 that led to the fall of the ruling shogun and the dissolution of the elite samurai class. Examines both the causes of these major political and social changes and their continuing impact upon Japanese culture and society.

**Attribute/Distribution:** HU

**ASIA 177 China Enters the Modern Age 4 Credits**

The collapse of the imperial order and China's agonizing transformation into a modern nation-state over the past 150 years. The impact of imperialism, war, radical social change, and protracted revolution on Chinese traditions, values, and institutions.

**Attribute/Distribution:** HU, SS

**ASIA 187 Peoples and Cultures of Southeast Asia 4 Credits**

Peoples and cultures of Burma, Laos, Cambodia, Thailand, Malaysia, Singapore, Indonesia, and the Philippines. World view, religion, economy, politics, and social organization.

**Attribute/Distribution:** SS

**ASIA 188 Southeast Asian Migrants and Refugees 4 Credits**

Focus on migrants and refugees from Southeast Asia to the United States; examines cultures and practices while in Southeast Asia, the migration process, and the ways in the people and their cultural practices have changed in the United States.

**Attribute/Distribution:** SS

**ASIA 191 Intermediate Asian Language and Culture Abroad 1-8 Credit**

Intermediate language and culture abroad other than Chinese and Japanese.

**Attribute/Distribution:** HU

**ASIA 201 Democracy and Dictatorship in South Asia 4 Credits**

Theories of democracy and democratization explored in the South Asian context. Relationship of democracy to economic development and identity considered. How do historical legacies and conflict shape contemporary outcomes.

**Attribute/Distribution:** SS

**ASIA 220 Classics of Asian Religion 4 Credits**

Sacred scriptures of Asia and an introduction to the religions they represent. What do these texts teach about reality, humanity, divinity, and society? How is the path of spiritual practice presented in the different traditions?.

**Attribute/Distribution:** HU

**ASIA 221 Topics in Asian Religions 4 Credits**

Selected thematic and comparative issues in different Asian religious traditions. May include Buddhism and Christianity, religion and martial arts, Asian religions in America, Taoist meditation, Zen and Japanese business, Buddhist ethics. May be repeated for credit. (H/S).

**Repeat Status:** Course may be repeated.

**ASIA 234 Buddhist Visions of a Good Society 4 Credits**

This course examines Buddhist visions of a better world. Present-day Buddhist teachers, most notably the Dalai Lama, propose "zones of peace," advocate "a policy of kindness," and extol "compassionate consumption." Are there wiser ways to pursue happiness? What is the relation between individual transformation and social transformation? Can we imagine a community guided by altruism and nonviolence? The process of contemplating alternative societies is also a way to achieve a clearer understanding of one's own highest ideals.

**Attribute/Distribution:** HU

**ASIA 240 Figures/Themes in Eastern Philosophy 4 Credits**

This seminar course will involve in-depth focus upon a major figure in Eastern thought or upon the Eastern treatment of a particular theme or set of themes. Content varies. Course Requirement: One HU-designated course in Philosophy at 100-level or higher.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**ASIA 247 Islamic Mysticism 4 Credits**

Sufism, the inner or 'mystical' dimension of Islam, has deep historical roots and diverse expressions throughout the Muslim world. Students examine Sufi doctrine and ritual, the master-disciple relationship, and the tradition's impact on art and music, poetry and prose.

**Attribute/Distribution:** HU

**ASIA 254 Buddhism and Ecology 4 Credits**

Buddhism's intellectual, ethical, and spiritual resources and reexamined in light of contemporary environmental problems. Is Buddhism the most green of the major world religions? What are the moral implications of actions that affect the environment?

**Attribute/Distribution:** HU

**ASIA 291 Advanced Asian Language and Culture Abroad 3 Credits**

Advanced language and culture abroad other than Chinese and Japanese.

**Attribute/Distribution:** HU

**ASIA 337 Buddhism and Society 4 Credits**

In this course we explore ways in which Buddhism is localized to become lived religions in Thailand, Tibet, Japan, and the United States. We examine how Buddhist practices are integrated into local traditions and how religious practices become part of the larger social, political, and value systems. Students will develop a comparative framework that includes Theravada, Tibetan, and Zen Buddhism.

**Attribute/Distribution:** ND, SS

**ASIA 339 The Rise of the State in Modern East Asia 4 Credits**

An examination of Asian nationalism in the construction of the modern state form in Asia.

**Attribute/Distribution:** SS

**ASIA 340 Japanese Industrialization 3-4 Credits**

Explores economic growth in the traditional economy, the rise of an entrepreneurial class, the importation of western technology, and the social, political and economic institutions which support industrial society since the early 19th century.

**Attribute/Distribution:** SS

**ASIA 343 Global Politics of Race: Asia and Africa 4 Credits**

An examination of the concept of "race" and its impact on domestic and international politics.

**Attribute/Distribution:** SS

**ASIA 361 Internship in Asian Studies 1-4 Credit**

Internship in public or private agency involved in some aspect of Asian studies. Individual faculty mentor. Written report required. May be repeated for credit. Program permission required. (HU/SS depending on topic).

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU, SS

**ASIA 364 International Relations of Pacific Asia 4 Credits**

Research oriented seminar on contemporary international relations of Pacific Asia. Special emphasis on China, Japan and regional and global powers. Substantial research paper on topic of student's own choice is required. Prerequisites as noted below.

**Prerequisites:** IR 061 or IR 161 or IR 163 or IR 164

**Attribute/Distribution:** SS

**ASIA 371 Advanced Readings in Asian Studies 1-4 Credit**

Directed course of reading and writing in advanced topic not covered in regular Asian Studies course offerings. May be repeated for credit. Program permission required. (HU/SS depending on topic).

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU, SS

**ASIA 381 Special Topics in Asian Studies 1-4 Credit**

Advanced study of aspects of Asian studies not covered in regular course offerings. Individual faculty supervision. Research paper required. May be repeated for credit. Program permission required. (HU/SS depending on topic).

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU, SS

**ASIA 386 Chinese Culture in a Multinational Workplace 3 Credits**

Students explore the interaction between Chinese and non-Chinese cultures at a variety of work sites in the city of Shanghai, a port city that has involved people of many nationalities since its birth in the 1840s. This project-based course involves a faculty mentored practicum at one or more specific sites related to the student's own field or major, assigned readings, weekly electronic Course Site discussions, and a written summary of the experience. (H/S).

**ASIA 389 Honors Project 1-6 Credit****ASIA 391 Senior Seminar in Asian Studies 1-4 Credit**

Advanced seminar focusing on discussion and research on specialized subjects in Asian studies. Variable subject matter. Offered by faculty on rotating basis. May be repeated for credit. Program permission required. (HU/SS depending on topic).

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU, SS

**ASIA 399 Senior Thesis in Asian Studies 1-4 Credit**

Advanced, individual research project on topic agreed between faculty and student. Research paper and oral defense required. May be repeated for credit. Open to Asian studies majors only. Program permission required. (HU/SS depending on topic).

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU, SS

**Astronomy and Astrophysics**

Astronomy and Astrophysics are offered in the department of Physics.

Astrophysicists apply physics and mathematics to the study of planets, stars, galaxies, pulsars, black holes, quasars and the universe, among many other fascinating objects in order to understand their origin, evolution and ultimate fate. Students who major in astronomy or astrophysics usually have very inquisitive minds and a good aptitude for physics and mathematics. The bachelor degree programs in astronomy and astrophysics provide the student with a solid background in laboratory and theoretical astrophysics as well as in the fundamentals of physics and mathematics. Research opportunities are available to supplement classroom instruction.

The bachelor of science degree in astrophysics is designed for students who wish to go on to graduate studies in astrophysics with the goal of becoming professional astronomers. Professional astronomers generally find positions at colleges, and universities, national labs, NASA or its contractors and in various space industries. This degree also prepares you for many jobs in related fields such as computer science, mathematics or physics.

The bachelor of arts degree in astronomy is intended for students who desire a broad background in astronomy, mathematics and physics but do not plan to do graduate work in astrophysics. With this broad background, the student is well prepared in many fields of endeavor, including planetarium and museum work, teaching astronomy at

colleges and universities, secondary education, science writing, or, in fact, in many professions in which the ability to learn is critical.

Both of these degrees can be profitably combined with mathematics and other sciences producing excellent double majors or double degrees.

A minor program in astronomy is also available for students who wish to enlarge their potential for a career choice or who may be eager to learn more about astrophysics than an introductory course can provide.

### Astronomy and Astrophysics Degree Programs

#### Requirements for the Bachelor of Arts Degree in Astronomy

##### Mathematics

MATH 021	Calculus I	4
MATH 022	Calculus II	4
MATH 023	Calculus III	4
MATH 205	Linear Methods	3

##### Basic and Intermediate-Level Science

ASTR 007 & ASTR 008	Introduction to Astronomy and Introduction to Astronomy Laboratory	4
PHY 010 or PHY 011	General Physics I Introductory Physics I	4
PHY 013 or PHY 021	General Physics II Introductory Physics II	3-4
PHY 012	Introductory Physics Laboratory I	1
PHY 022	Introductory Physics Laboratory II	1
PHY 031	Introduction to Quantum Mechanics	3
PHY 262	Advanced Physics Laboratory	2
CHM 030	Introduction to Chemical Principles	4
EES 021 & EES 022	Introduction to Planet Earth and Exploring Earth	4
Select 24 credit hours at 100 level or above		24

##### Intermediate - Advanced Astronomy/Astrophysics

ASTR/PHY/EES 105	Planetary Astronomy	4
ASTR/PHY 110	Methods of Observational Astronomy	1
Select one of the following:		4
ASTR/PHY 301	Modern Astrophysics I	
ASTR/PHY 302	Modern Astrophysics II	

##### Approved Electives<sup>1</sup>

Select two additional physics/astronomy courses at the 200 level or above	6
Select two additional science or mathematics courses at the 200 level or above	6
<b>Total Credits</b>	<b>86-87</b>

<sup>1</sup> Approved Electives are subject to the approval of the student's advisor, and should be chosen to provide a coherent program.  
Recommended courses are MATH 012, PHY 212, EES 031, BIOS 041.

A total of 120 credit hours are required for the Bachelor of Arts in Astronomy.

#### Requirements for the Bachelor of Science degree in Astrophysics

##### Mathematics

MATH 021	Calculus I	4
MATH 022	Calculus II	4
MATH 023	Calculus III	4
MATH 205	Linear Methods	3
MATH 320 or MATH 322	Ordinary Differential Equations Methods of Applied Analysis I	3-4

##### Basic and Intermediate-Level Science

PHY 011 or PHY 010	Introductory Physics I General Physics I	4
PHY 021 or PHY 013	Introductory Physics II General Physics II	3-4

PHY 012	Introductory Physics Laboratory I	1
PHY 022	Introductory Physics Laboratory II	1
PHY 031	Introduction to Quantum Mechanics	3
PHY 212	Electricity and Magnetism I	3
PHY 215	Classical Mechanics I	4
PHY 262 or PHY 352	Advanced Physics Laboratory Modern Optics	2-3
CHM 030	Introduction to Chemical Principles	4
EES 021	Introduction to Planet Earth	3
EES 022	Exploring Earth	1
Select 2-4 credit hour at 100 level or above		2-4

##### Intermediate - Advanced Astronomy/Astrophysics

ASTR/PHY/EES 105	Planetary Astronomy	4
ASTR/PHY 110	Methods of Observational Astronomy	1
ASTR/PHY 301	Modern Astrophysics I	4
ASTR/PHY 302	Modern Astrophysics II	4
Select one of the following:		3
ASTR/PHY 332	High-Energy Astrophysics	
ASTR/PHY 342	Relativity and Cosmology	
ASTR 350	Topics in Astrophysics	

##### Approved Electives

Select three additional physics/astronomy courses at the 200 level or above	9
Select one additional science course (not physics or astronomy) at the 100 level or above	3

**Total Credits** 77-82

A total of 123 credit hours are required for the Bachelor of Science in Astrophysics.

#### Recommended sequence of courses for the first two years

##### B.A. Astronomy

###### First Year

Fall	CR Spring	CR
ENGL 001	3 ENGL 002	3
ASTR 007 & ASTR 008	4 PHY 011 & PHY 012	5
EES 021	3 MATH 022	4
MATH 021	4 Col Sem	3-4
	<b>14</b>	<b>15-16</b>

###### Second Year

Fall	CR Spring	CR
PHY 021 & PHY 022	5 PHY 031	3
MATH 023	4 MATH 205	3
ASTR 105	4 ASTR 110	1
Dist req	3-4 Appr. Elec.	3
	Dist req	4-7
	<b>16-17</b>	<b>14-17</b>

**Total Credits:** 59-64

##### B.S. Physics

###### First Year

Fall	CR Spring	CR
ENGL 001	3 ENGL 002	3
PHY 011 & PHY 012	5 EES 021	3
MATH 021	4 MATH 022	4
Col Sem or Dist req <sup>1</sup>	3-4 Col Sem and/or Dist Req	3-6
	<b>15-16</b>	<b>13-16</b>

**Second Year**

Fall	CR Spring	CR
PHY 021 & PHY 022	5 PHY 031	3
MATH 023	4 MATH 205	3
ASTR 105	4 ASTR 110	1
Dist req	3-4 Appr. Elec. Dist req	3 4-7
	<b>16-17</b>	<b>14-17</b>

Total Credits: 58-66

<sup>1</sup> If the College Seminar is deferred until spring, students may choose to select ASTR 007 by deferring a distribution requirement.

**Departmental Honors in Astronomy or Astrophysics**

Students receiving a BA in Astronomy or a BS in Astrophysics may earn Departmental Honors by satisfying the following requirements:

1. Academic Performance: Minimum grade point average of 3.50 in astronomy and physics courses used to satisfy the major degree requirements.
2. Research or Project-Based/Creative Activity: completion of approved<sup>1</sup> special topics courses in astronomy that include written reports, or completion of 6 credits of PHY 273 (research) or equivalent, or completion of a summer research project with written report and oral presentation
3. Additional Course Work: Completion of at least one approved<sup>1</sup> 300-level course in either physics or astronomy beyond those required in the student's degree program. This course may not be selected from special topics or research courses such as ASTR 350 or PHY 372.

<sup>1</sup> Specific approvals are granted by the Program Director.

**The minor program in Astronomy**

The requirements for a minor in astronomy are:

PHY 011 & PHY 012	Introductory Physics I and Introductory Physics Laboratory I	5
PHY 021 & PHY 022	Introductory Physics II and Introductory Physics Laboratory II	5
ASTR 105	Planetary Astronomy	4
ASTR 301	Modern Astrophysics I	4
ASTR 302	Modern Astrophysics II	4
One ASTR course at the 300 level		3
Select two of the following:		6
Any ASTR course (except ASTR 7 or 8)		
CSE 017	Programming and Data Structures	
MATH 208	Complex Variables	
MATH 231	Probability and Statistics	
PHY 031	Introduction to Quantum Mechanics	
PHY 213	Electricity and Magnetism II	
PHY 215	Classical Mechanics I	
PHY 348	Plasma Physics	
PHY 362	Atomic and Molecular Structure	

Total Credits 31

The minor program must be designed in consultation with the program director.

**Courses**

**ASTR 007 Introduction to Astronomy 3 Credits**

Introduction to planetary, stellar, galactic, and extragalactic astronomy. An examination of the surface characteristics, atmospheres, and motions of planets and other bodies in our solar system. Properties of the sun, stars, and galaxies, including the birth and death of stars, stellar explosions, and the formation of stellar remnants such as white dwarfs, neutron stars, pulsars, and black holes. Quasars, cosmology, and the evolution of the universe. May not be taken by students who have previously completed ASTR/PHY 105, 301, or 302.

**Attribute/Distribution:** NS

**ASTR 008 Introduction to Astronomy Laboratory 1 Credit**

Laboratory to accompany ASTR/PHY 7. Must be enrolled concurrently in ASTR 007 (PHY 007).

**Attribute/Distribution:** NS

**ASTR 105 Planetary Astronomy 4 Credits**

Structure and dynamics of planetary interiors, surfaces, and atmospheres. Models for the formation of the solar system and planetary evolution. Internal structure, surface topology, and composition of planets and other bodies in our solar system. Comparative study of planetary atmospheres. Organic materials in the solar system. Properties of the interplanetary medium, including dust and meteoroids. Orbital dynamics. Extrasolar planetary systems.

**Attribute/Distribution:** NS

**ASTR 110 Methods of Observational Astronomy 1 Credit**

Techniques of astronomical observation, data reduction, and analysis. Photometry, spectroscopy, CCD imaging, and interferometry. Computational analysis. Examination of ground-based and spacecraft instrumentation, and data transmission, reduction, and analysis.

**Attribute/Distribution:** NS

**ASTR 300 Apprentice Teaching 3 Credits**

**ASTR 301 Modern Astrophysics I 4 Credits**

Physics of stellar atmospheres and interiors, and the formation, evolution, and death of stars. Variable stars. The evolution of binary star systems. Novae, supernovae, white dwarfs, neutron stars, pulsars, and black holes. Stellar spectra, chemical compositions, and thermodynamic processes. Thermonuclear reactions. Interstellar medium.

**Prerequisites:** (PHY 010 or PHY 011 or PHY 090) and (PHY 013 or PHY 021) and (MATH 022 or MATH 032 or MATH 052)

**Attribute/Distribution:** NS

**ASTR 302 Modern Astrophysics II 4 Credits**

The Milky Way Galaxy, galactic morphology, and evolutionary processes. Active galaxies and quasars. Observed properties of the universe. Relativistic cosmology, and the origin, evolution and fate of the universe. Elements of General Relativity and associated phenomena.

**Prerequisites:** (PHY 010 or PHY 011 or PHY 090) and (PHY 013 or PHY 021) and (MATH 022 or MATH 032 or MATH 052)

**Attribute/Distribution:** NS

**ASTR 332 High-Energy Astrophysics 3 Credits**

Observation and theory of X-ray and gamma-ray sources, quasars, pulsars, radio galaxies, neutron stars, black holes. Results from ultraviolet, X-ray and gamma-ray satellites. Generally offered in the spring of even-numbered years.

**Prerequisites:** PHY 021 and (MATH 023 or MATH 033)

**Can be taken Concurrently:** MATH 023, MATH 033

**Attribute/Distribution:** NS

**ASTR 342 Relativity and Cosmology 3 Credits**

Special and general relativity. Schwarzschild and Kerr black holes. Supermassive stars. Relativistic theories of the origin and evolution of the universe. Generally offered in the spring of even-numbered years. Prerequisites as noted below.

**Prerequisites:** (PHY 021) and (MATH 023 or MATH 033)

**Can be taken Concurrently:** MATH 023, MATH 033

**Attribute/Distribution:** NS

**ASTR 350 Topics in Astrophysics 3 Credits**

For science or engineering majors who desire to study an active area of research in astrophysics. Individual supervision. May be repeated for credit with the consent of the program director. Prerequisites as noted below.

**Repeat Status:** Course may be repeated.

**Prerequisites:** (ASTR 301 or PHY 301) and PHY 021 and (MATH 023 or MATH 033)

**Attribute/Distribution:** NS

**ASTR 372 Special Topics in Astronomy 1-4 Credit**

Selected topics not sufficiently covered in other courses. May be repeated for credit.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** NS

**ASTR 389 Honors Project 1-6 Credit**

**Repeat Status:** Course may be repeated.

**ASTR 472 Special Topics in Astronomy 1-4 Credit**

Selected topics not sufficiently covered in other courses. May be repeated for credit.

**Repeat Status:** Course may be repeated.

**Biochemistry**

An interdepartmental B.S. biochemistry major is offered in the College of Arts and Sciences. The B.S. in biochemistry degree is managed by an interdepartmental committee composed of biochemists, bioorganic chemists, and molecular/cellular biologists. The committee administers the degree, monitors the academic program, provides research possibilities, and advises student majors. The director of the program is currently Linda J. Lowe-Krentz. Faculty in both Biological Sciences (Lowe-Krentz and Iovine) and Chemistry (Schray) serve as advisors. Majors should be declared in Biological Sciences.

**Bachelor of Science Degree in Biochemistry****College and University Requirements**

ENGL 001	Composition and Literature	3
ENGL 002	Composition and Literature II	3
First Year Seminar		3
Non-science Electives <sup>1</sup>		16

**Collateral Science Requirements**

Select one of the following options: 9-10

**Option A**

PHY 010 & PHY 012	General Physics I and Introductory Physics Laboratory I
PHY 013 & PHY 022	General Physics II and Introductory Physics Laboratory II

**Option B**

PHY 011 & PHY 012	Introductory Physics I and Introductory Physics Laboratory I
PHY 021 & PHY 022	Introductory Physics II and Introductory Physics Laboratory II

Select one of the following options: <sup>2</sup> 10-12

**Option A**

MATH 051	Survey of Calculus I
MATH 052	Survey of Calculus II
MATH 043	Survey of Linear Algebra

**Option B**

MATH 021	Calculus I
MATH 022	Calculus II
MATH 023	Calculus III

One statistics course <sup>2</sup> 3

CSE 012 or ENGR 010	Survey of Computer Science Applied Engineering Computer Methods	3
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**Required Chemistry Courses**

CHM 040	Concepts, Models and Experiments I <sup>3</sup>	4
CHM 041	Concepts, Models and Experiments II <sup>3</sup>	4
CHM 110 & CHM 111	Organic Chemistry I and Organic Chemistry Laboratory I	4
CHM 112 & CHM 113	Organic Chemistry II and Organic Chemistry Laboratory II	4
CHM 307	Advanced Inorganic Chemistry	3
CHM 194	Physical Chemistry for Biological Sciences	3
CHM 332	Analytical Chemistry	3

**Required Biological Science courses**

BIOS 041 & BIOS 042	Biology Core I: Cellular and Molecular and Biology Core I: Cellular and Molecular Lab	4
BIOS 115	Biology Core II: Genetics	3
BIOS 371	Elements of Biochemistry I	3
BIOS 372 & BIOS 377	Elements of Biochemistry II and Biochemistry Laboratory	6
Advanced Laboratory		4
Electives in Biological Sciences (3 hours minimum) <sup>4</sup>		3
Technical Writing (2 hours minimum)		2

Total Credits 100-103

- 16 hours to be broadly distributed in fields of thought other than natural science and mathematics, including at least 8 hours each in humanities and social sciences.
- Mathematics option and statistics course must be at least 12 hours combined.
- The CHM 030 / CHM 031 sequence may be substituted.
- The three credit hours of biological sciences electives are chosen with the approval of the adviser.

**Model Pattern Roster**

First Year	CR
CHM 040	4
CHM 041	4
BIOS 041 & BIOS 042	4
Dept 90 College Seminar	3
ENGL 001	3
ENGL 002	3
Select one of the following:	
MATH 051 & MATH 052	7
MATH 021 & MATH 022	8
Select one of the following:	
PHY 010 & PHY 012	5
PHY 011 & PHY 012	5
	<b>46</b>
Second Year	CR
CHM 110 & CHM 111	4
CHM 112 & CHM 113	4
MATH 043 or 023	3
BIOS 130 <sup>1</sup>	4
BIOS 115	3
Select one of the following:	
PHY 013 & PHY 022	4



PHY 021 & PHY 022	5
	<b>27</b>
<b>Third Year</b>	<b>CR</b>
CHM 194	3
CHM 332	3
BIOS 371	3
BIOS 372 & BIOS 377	6
CSE 012	3
Technical Writing	2
	<b>20</b>
<b>Fourth Year</b>	<b>CR</b>
BIOS Advanced laboratory course(s)	
BIOS elective	
CHM 307	3
	<b>3</b>
<hr/>	
Total Credits: 96	

<sup>1</sup> A statistics course from the MATH department could also fulfill the statistics requirement

## Biological Sciences

The biological sciences include the study of living systems at levels ranging from the structure and function of molecules to the behavior and evolution of communities of organisms. The department offers four different routes to mastering skills and knowledge in this broad area. The B.A. and B.S. programs in biology provide a broad introduction to biology with opportunities for students to create a program of study suited to their specific interests. Programs of study focused on particular aspects of biology are the B.A. and B.S. degree in the areas of behavioral neuroscience and molecular biology. For programs in biochemistry and bioengineering, see those separate sections in the catalog.

The Department of Biological Sciences strongly supports the positions of both the American Association for the Advancement of Science and the National Academy of Sciences that intelligent design is not scientific and should not be presented as science in science classes.

The requirements for the B.A. and B.S. in biology, behavioral neuroscience, and molecular biology are listed below. Research interests of the faculty and instrumentation are described in the section on graduate education.

**Professors.** Michael J. Behe, PhD (University of Pennsylvania); Lynne U. Cassimeris, PhD (University of North Carolina); David L. Cundall, PhD (University of Arkansas); Murray Itzkowitz, PhD (University of Maryland); Linda J. Lowe-Krentz, PhD (Northwestern University); John G. Nyby, PhD (University Texas Austin); Jeffrey A. Sands, PhD (The Pennsylvania State University); Jill E. Schneider, PhD (Wesleyan University); Neal G. Simon, PhD (Rutgers University); Robert V. Skibbens, PhD (University of North Carolina Chapel Hill); Jennifer Swann, PhD (Northwestern University); Vassie C. Ware, PhD (Yale University)

**Associate Professors.** R. Michael Burger, PhD (University Texas Austin); Matthias Maria Falk, PhD (Ruprecht Karl University of Heidelberg); Mary Kathryn Iovine, PhD (Washington University); Michael R. Kuchka, PhD (Carnegie Mellon University)

**Assistant Professors.** Julie Haas, PhD (Boston University); Gregory I. Lang, PhD (Harvard University); Julie M. Miwa, PhD (Rockefeller University); Amber M. Rice, PhD (University of North Carolina)

**Emeriti.** John H. Abel, Jr., SCD (Brown University); Steven Krawiec, PhD (Yale University)

## B.A. with Major in Biology

### College and university requirements for all majors

ENGL 001	Composition and Literature	3
ENGL 002	Composition and Literature II	3
First Year Seminar		3
Social Sciences		8
Humanities		8
<b>Biology</b>		
BIOS 041 & BIOS 042	Biology Core I: Cellular and Molecular and Biology Core I: Cellular and Molecular Lab	4
BIOS 115 & BIOS 116	Biology Core II: Genetics and Biology Core II: Genetics Laboratory	4
BIOS 120	Biology Core III: Integrative and Comparative	4
Biology electives <sup>1</sup>		18
<b>Mathematics</b>		
MATH 051	Survey of Calculus I	4
Select one of the following:		3-4
MATH 052	Survey of Calculus II	
MATH 012	Basic Statistics	
BIOS 130	Biostatistics	

### Collateral Sciences

CHM 030	Introduction to Chemical Principles	4
CHM 110 & CHM 111	Organic Chemistry I and Organic Chemistry Laboratory I	4
CHM 112 & CHM 113	Organic Chemistry II and Organic Chemistry Laboratory II	4
Total Credits		74-75

<sup>1</sup> Biology electives must include one course from list A (see below) and one course from list B (see below). These will be chosen in consultation with the major advisor. No more than 3 credits from the following courses: BIOS 161, BIOS 261, BIOS 262, BIOS 391, BIOS 393, College scholar project, not BIOS 130.

### Biology Electives List A

Choose one of the following:

BIOS 234	Comparative Vertebrate Anatomy	4
BIOS 235	Human Physiology	4
BIOS 241	Vertebrate Natural History	4
BIOS 276	Central Nervous System and Behavior	3
BIOS 313	Vertebrate Histology	4
BIOS 314	Vertebrate Development	4
BIOS 315	Neuropharmacology	3
BIOS 329	Herpetology	3
BIOS 334	Species and Speciation	3
BIOS 335	Animal Behavior	3
BIOS 337	Behavioral Ecology	3
BIOS 365	Neurobiology of Sensory Systems	3
BIOS 366	Diseases of the Nervous System	3
BIOS 369	Comparative Physiology of Vertebrate Systems	3-4
BIOS 374	Sex Determination and Differentiation	3
BIOS 382	Endocrinology of Behavior	3

### Biology Electives List B

Choose one of the following:

BIOS 307	Male Reproductive Biology	1-3
BIOS 324	Microbiology	3
BIOS 328	Immunology	3
BIOS 340	Molecular Basis of Disease	3

BIOS 345	Molecular Genetics	3
BIOS 347	Advanced Topics in Genetics	3
BIOS 353	Virology	3
BIOS 356	Human Genetics and Reproduction	3
BIOS 367	Cell Biology	3
BIOS 371	Elements of Biochemistry I	3
BIOS 372	Elements of Biochemistry II	3
BIOS 376	Classical & Molecular Embryology	3
BIOS 381	Physical Biochemistry	3
BIOS 384	Eukaryotic Signal Transduction	3

**The B.S. in Biology**

The Bachelor of Science in biology offers broad scientific preparation in biology to facilitate advanced work in the life sciences. Progression through the program is best served through early commitment.

**Requirements for the B.S. in Biology****College and university requirements for all majors**

ENGL 001	Composition and Literature	3
ENGL 002	Composition and Literature II	3
First Year Seminar		3
Social Sciences		8
Humanities		8

**Biology**

BIOS 041 & BIOS 042	Biology Core I: Cellular and Molecular and Biology Core I: Cellular and Molecular Lab	4
BIOS 115 & BIOS 116	Biology Core II: Genetics and Biology Core II: Genetics Laboratory	4
BIOS 120	Biology Core III: Integrative and Comparative	4
BIOS 317	Evolution	3
Biology electives <sup>1</sup>		22

**Mathematics**

Select one of the following:		7-8
MATH 021 & MATH 022	Calculus I and Calculus II	
MATH 051 & MATH 052	Survey of Calculus I and Survey of Calculus II	
BIOS 130	Biostatistics	4

**Collateral Sciences**

Select one of the following:		8
CHM 030 & CHM 031	Introduction to Chemical Principles and Chemical Equilibria in Aqueous Systems	
CHM 040 & CHM 041	Concepts, Models and Experiments I and Concepts, Models and Experiments II	
CHM 110 & CHM 111	Organic Chemistry I and Organic Chemistry Laboratory I	4
CHM 112 & CHM 113	Organic Chemistry II and Organic Chemistry Laboratory II	4
PHY 010 or PHY 011	General Physics I and Introductory Physics I	4
PHY 012	Introductory Physics Laboratory I	1
PHY 013	General Physics II	3
PHY 022	Introductory Physics Laboratory II	1

Total Credits 98-99

**Biology Electives List A**

Choose two of the following:

BIOS 234	Comparative Vertebrate Anatomy	4
BIOS 235	Human Physiology	4
BIOS 241	Vertebrate Natural History	4
BIOS 276	Central Nervous System and Behavior	3
BIOS 313	Vertebrate Histology	4
BIOS 314	Vertebrate Development	4
BIOS 315	Neuropharmacology	3
BIOS 329	Herpetology	3
BIOS 334	Species and Speciation	3
BIOS 335	Animal Behavior	3
BIOS 337	Behavioral Ecology	3
BIOS 365	Neurobiology of Sensory Systems	3
BIOS 366	Diseases of the Nervous System	3
BIOS 369	Comparative Physiology of Vertebrate Systems	3-4
BIOS 374	Sex Determination and Differentiation	3
BIOS 382	Endocrinology of Behavior	3

**Biology Electives List B**

Choose two of the following:

BIOS 307	Male Reproductive Biology	1-3
BIOS 324	Microbiology	3
BIOS 328	Immunology	3
BIOS 340	Molecular Basis of Disease	3
BIOS 345	Molecular Genetics	3
BIOS 347	Advanced Topics in Genetics	3
BIOS 353	Virology	3
BIOS 356	Human Genetics and Reproduction	3
BIOS 367	Cell Biology	3
BIOS 371	Elements of Biochemistry I	3
BIOS 372	Elements of Biochemistry II	3
BIOS 376	Classical & Molecular Embryology	3
BIOS 381	Physical Biochemistry	3
BIOS 384	Eukaryotic Signal Transduction	3

**Recommended B.S. Biology Sequence**

<b>First Year</b>	<b>CR</b>
BIOS 041 & BIOS 042	4
MATH 051	4
MATH 052	3
CHM 030	4
CHM 031	4
	<b>19</b>
<b>Second Year</b>	<b>CR</b>
BIOS 115 & BIOS 116	4
CHM 110 & CHM 111	4
CHM 112 & CHM 113	4
BIOS 120	4
BIOS 130	4
	<b>20</b>
<b>Third Year</b>	<b>CR</b>
PHY 010 & PHY 012	5
PHY 013 & PHY 022	4

<sup>1</sup> Biology electives must include two courses from list A (see below), two courses from list B (see below) and at least four credits of laboratory experience (e.g., two 2 credit laboratory courses). These will be chosen in consultation with the major advisor.

Approved biology electives including two from list A and two from list B

9-12	CHM 112 & CHM 113	Organic Chemistry II and Organic Chemistry Laboratory II	4
	PSYC 001	Introduction to Psychology	4
<b>18-21</b>	<b>Total Credits</b>		<b>56-57</b>

**Fourth Year**

BIOS 317			3
Biology electives including at least 4 credits of laboratory			10-14
			<b>13-17</b>

Total Credits: 70-77

**Minor in Biology**

A minor in biology may be achieved by completing the following requirements (17-18 credits):

BIOS 041 & BIOS 042	Biology Core I: Cellular and Molecular and Biology Core I: Cellular and Molecular Lab	4
BIOS 115 & BIOS 116	Biology Core II: Genetics and Biology Core II: Genetics Laboratory	4
BIOS 121	Comparative/Integrative Biology for BIOS Minors	3
CHM 110	Organic Chemistry I	3
Biology electives at the 200 or 300 level		3-4
<b>Total Credits</b>		<b>17-18</b>

**B.A. with major in Behavioral Neuroscience**

The B.A. in Behavioral Neuroscience is a natural science major for B.A. distribution purposes.

**Required Major Courses**

BIOS 041 & BIOS 042	Biology Core I: Cellular and Molecular and Biology Core I: Cellular and Molecular Lab	4
BIOS 115 & BIOS 116	Biology Core II: Genetics and Biology Core II: Genetics Laboratory	4
BIOS 120	Biology Core III: Integrative and Comparative	4
BIOS 130	Biostatistics	4
BIOS 276 & BIOS 277	Central Nervous System and Behavior and Experimental Neuroscience Laboratory	5
BIOS 365	Neurobiology of Sensory Systems	3
BIOS 382	Endocrinology of Behavior	3

**Major Electives**

Select two of the following: 6

Any 300-level BIOS course not fulfilling another BNS requirement above <sup>1</sup>

CHM 031	Chemical Equilibria in Aqueous Systems	
or CHM 041	Concepts, Models and Experiments II	
PSYC 117	Cognitive Psychology	
PSYC 153	Personality	
PSYC 176	Mind and Brain	

**Math and Science Requirements for the B.A.**

Select one of the following: 7-8

MATH 021 & MATH 022	Calculus I and Calculus II	
MATH 051 & MATH 052	Survey of Calculus I and Survey of Calculus II	
CHM 030 or CHM 040	Introduction to Chemical Principles Concepts, Models and Experiments I	4
CHM 110 & CHM 111	Organic Chemistry I and Organic Chemistry Laboratory I	4

CHM 112 & CHM 113	Organic Chemistry II and Organic Chemistry Laboratory II	4
PSYC 001	Introduction to Psychology	4

**Total Credits** 56-57

<sup>1</sup> Except BIOS 320, BIOS 347, BIOS 383, BIOS 387, BIOS 388, BIOS 391, or BIOS 393.

**Other Options**

The B.A. in Behavioral Neuroscience can be structured for a wide variety of possibilities (see listing of recommended elective courses). By using free electives to take additional science, the B.A. also can serve as a pre-professional degree for many graduate and professional schools. Students interested in a particular career based program should consult their advisor or the program director, Professor Michael Kuchka.

**B.S. in Behavioral Neuroscience**

An early commitment to the B.S. is desirable to meet all the requirements of this program.

**Required Major Courses**

BIOS 041 & BIOS 042	Biology Core I: Cellular and Molecular and Biology Core I: Cellular and Molecular Lab	4
BIOS 115 & BIOS 116	Biology Core II: Genetics and Biology Core II: Genetics Laboratory	4
BIOS 120	Biology Core III: Integrative and Comparative	4
BIOS 130	Biostatistics	4
BIOS 276 & BIOS 277	Central Nervous System and Behavior and Experimental Neuroscience Laboratory	5
BIOS 365	Neurobiology of Sensory Systems	3
BIOS 382	Endocrinology of Behavior	3

**Additional Biological Sciences Requirements for the B.S.**

BIOS 371	Elements of Biochemistry I	3
BIOS 372	Elements of Biochemistry II	3
Select one of the following:		2-4
BIOS 234	Comparative Vertebrate Anatomy	
BIOS 377	Biochemistry Laboratory	
BIOS 368	Cell Biology Laboratory <sup>1</sup>	

**Advanced BIOS Course Requirement**

Select one of the following: 3-4

BIOS 315	Neuropharmacology	
BIOS 366	Diseases of the Nervous System	
BIOS 384	Eukaryotic Signal Transduction	

**Math and Science Requirements for the B.S.**

Select one of the following: 7-8

MATH 021 & MATH 022	Calculus I and Calculus II	
MATH 051 & MATH 052	Survey of Calculus I and Survey of Calculus II	

Select one of the following: 8

CHM 030 & CHM 031	Introduction to Chemical Principles and Chemical Equilibria in Aqueous Systems	
CHM 040 & CHM 041	Concepts, Models and Experiments I and Concepts, Models and Experiments II	

CHM 110 & CHM 111	Organic Chemistry I and Organic Chemistry Laboratory I	4
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CHM 112 & CHM 113	Organic Chemistry II and Organic Chemistry Laboratory II	4
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Select one of the following: 5

PHY 010 & PHY 012	General Physics I and Introductory Physics Laboratory I	
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PHY 011 & PHY 012	Introductory Physics I and Introductory Physics Laboratory I	
Select one of the following:		4-5
PHY 013 & PHY 022	General Physics II and Introductory Physics Laboratory II	
PHY 021 & PHY 022	Introductory Physics II and Introductory Physics Laboratory II	
PSYC 001	Introduction to Psychology	4
<b>Major Electives</b>		
Select two of the following:		6
Any 300-level BIOS course not fulfilling another BNS requirement above. <sup>2</sup>		
PSYC 117	Cognitive Psychology	
PSYC 153	Personality	
PSYC 176	Mind and Brain	
Total Credits		80-85

<sup>1</sup> If this course is elected, Cell Biology BIOS 367 must be taken as an elective.

<sup>2</sup> Except BIOS 320, BIOS 347, BIOS 383, BIOS 387, BIOS 388, BIOS 391, or BIOS 383.

### B.A. with Major in Molecular Biology

#### Requirements for the B.A. in Molecular Biology

##### College and university requirements for all majors

ENGL 001	Composition and Literature	3
ENGL 002	Composition and Literature II	3
First Year Seminar		3
Social Sciences		8
Humanities		8

##### Biology

BIOS 041 & BIOS 042	Biology Core I: Cellular and Molecular and Biology Core I: Cellular and Molecular Lab	4
BIOS 115 & BIOS 116	Biology Core II: Genetics and Biology Core II: Genetics Laboratory	4
BIOS 120	Biology Core III: Integrative and Comparative	4

Select one of the following: 3

BIOS 324	Microbiology	
BIOS 328	Immunology	
BIOS 353	Virology	

Select one of the following: 2-3

BIOS 325	Bacteriology Laboratory	
BIOS 368	Cell Biology Laboratory	
BIOS 377	Biochemistry Laboratory	

BIOS 371 Elements of Biochemistry I 3

BIOS 345 & BIOS 346 Molecular Genetics and Molecular Genetics Laboratory 5

BIOS 367 Cell Biology 3

BIOS approved electives 6

##### Mathematics

Select one of the following: 7-8

MATH 021 & MATH 022	Calculus I and Calculus II	
MATH 051 & MATH 052	Survey of Calculus I and Survey of Calculus II	

##### Chemistry

CHM 030 Introduction to Chemical Principles 4

CHM 031 Chemical Equilibria in Aqueous Systems 4

CHM 110 & CHM 111 Organic Chemistry I and Organic Chemistry Laboratory I 4

CHM 112 & CHM 113 Organic Chemistry II and Organic Chemistry Laboratory II 4

##### Physics

Select one of the following: 5

PHY 010 & PHY 012 General Physics I and Introductory Physics Laboratory I

PHY 011 & PHY 012 Introductory Physics I and Introductory Physics Laboratory I

PHY 013 & PHY 022 General Physics II and Introductory Physics Laboratory II 4

Total Credits 91-93

### The B.S. in Molecular Biology

#### Requirements for the B.S. in Molecular Biology

##### Mathematics

Select one of the following: 7-8

MATH 021 & MATH 022 Calculus I and Calculus II

MATH 051 & MATH 052 Survey of Calculus I and Survey of Calculus II

BIOS 130 Biostatistics 4

##### Chemistry

CHM 030 Introduction to Chemical Principles 4

CHM 031 Chemical Equilibria in Aqueous Systems 4

CHM 110 & CHM 111 Organic Chemistry I and Organic Chemistry Laboratory I 4

CHM 112 & CHM 113 Organic Chemistry II and Organic Chemistry Laboratory II 4

##### Physics

Select one of the following: 5

PHY 010 & PHY 012 General Physics I and Introductory Physics Laboratory I

PHY 011 & PHY 012 Introductory Physics I and Introductory Physics Laboratory I

Select one of the following: 4-5

PHY 013 & PHY 022 General Physics II and Introductory Physics Laboratory II

PHY 021 & PHY 022 Introductory Physics II and Introductory Physics Laboratory II

##### Molecular Biology

BIOS 041 & BIOS 042 Biology Core I: Cellular and Molecular and Biology Core I: Cellular and Molecular Lab 4

BIOS 115 & BIOS 116 Biology Core II: Genetics and Biology Core II: Genetics Laboratory 4

BIOS 120 Biology Core III: Integrative and Comparative 4

Select one of the following: 3

BIOS 324	Microbiology	
BIOS 328	Immunology	
BIOS 353	Virology	

Select one of the following: 2-3

BIOS 325	Bacteriology Laboratory	
BIOS 368	Cell Biology Laboratory	
BIOS 377	Biochemistry Laboratory	

BIOS 345 & BIOS 346 Molecular Genetics and Molecular Genetics Laboratory 5

BIOS 367 Cell Biology 3

BIOS 371	Elements of Biochemistry I	3
BIOS 372	Elements of Biochemistry II	3
BIOS 381	Physical Biochemistry	3
BIOS Approved Molecular Biology Electives		12
<b>Total Credits</b>		<b>82-85</b>

**Recommended sequence for the B.S. in Molecular Biology**

<b>First Year</b>	<b>CR</b>
BIOS 041 & BIOS 042	4
MATH 021	4
MATH 022	4
CHM 030	4
CHM 031	4

<b>Second Year</b>	<b>CR</b>
BIOS 115 & BIOS 116	4
BIOS 120	4
CHM 110 & CHM 111	4
CHM 112 & CHM 113	4
PHY 010 & PHY 012	5
PHY 013 & PHY 022	4
<b>25</b>	

<b>Third Year</b>	<b>CR</b>
BIOS 324, 328, or 353	3
BIOS 325, 368, or 377	2
BIOS 345 & BIOS 346	5
BIOS 371 & BIOS 372	6
<b>16</b>	

<b>Fourth Year</b>	<b>CR</b>
BIOS 367	3
BIOS 381	3
BIOS Approved Molecular Biology Electives	12
<b>18</b>	

Total Credits: 79

**Molecular Biology Minor****Minor Program**

BIOS 041 & BIOS 042	Biology Core I: Cellular and Molecular and Biology Core I: Cellular and Molecular Lab	4
BIOS 115 & BIOS 116	Biology Core II: Genetics and Biology Core II: Genetics Laboratory	4
BIOS 345 & BIOS 346	Molecular Genetics and Molecular Genetics Laboratory	5
BIOS coursework at the 200 or 300 level (minimum 4 additional credits).		4

**Collateral coursework**

MATH 051 or MATH 021	Survey of Calculus I Calculus I	4
CHM 030	Introduction to Chemical Principles	4
CHM 110	Organic Chemistry I	3
<b>Total Credits</b>		<b>28</b>

**Departmental Honors**

A student may apply for admission to the departmental honors program through a potential thesis advisor. Requirements for Departmental Honors include a major GPA of 3.25 and at least 2 semesters of research for a minimum of 6 cr. The student must write a research proposal for their project and a thesis at the conclusion of their research. This work must be presented in a symposium at the end of the project. Students must meet regularly with their advisor and research group to discuss their research progress and also must complete the year-long, 2-course sequence for BIOS honors students (BIOS 387 and BIOS 388).

**Special Health Professions Programs**

Students may apply for admission to an accelerated B.A.-Doctor of Medicine program and a B.A.-Doctor of Medical Dentistry program. A seven-year B.A.M.D. program is offered in conjunction with Drexel University College of Medicine, and a seven year B.A.D.M.D. program is offered in conjunction with the University of Pennsylvania School of Dental Medicine. Students in these programs receive a B.A. from Lehigh and a graduate degree from the designated professional school within a seven-year period. For details concerning admission to these programs, see Health Professions (p. 55).

**Graduate Study in the Biological Sciences**

Rigorous, research-oriented graduate programs leading to a Doctor of Philosophy are offered in three divisions of the Department of Biological Sciences: biochemistry, integrative biology and neuroscience, and cell and molecular biology. To complete the program students must successfully complete core courses, pass a qualifying exam, prepare, submit, and successfully defend a written research proposal, complete the research described in the proposal, and submit a written dissertation and defend the completed research to the department.

Once students enter the department, their progress is monitored by the graduate committee until they are admitted to candidacy. Members of the committee meet with the student each semester to assess the student's progress towards the degree and to assist students in choosing the appropriate courses to provide a solid scientific foundation and an up-to-date understanding of the discipline. This will be assessed by the qualifying exam.

The qualifying exam generally should be taken after the third semester and no later than the fourth semester of course work. It will be prepared, administered and graded by the faculty associated with the specific graduate program in which the student is enrolled. It consists of a two-day written exam and an oral examination. The exam can be repeated once. Admission to candidacy is granted after successful completion of the qualifying exam and the thesis proposal. The proposal is a written description of an original research project developed under the guidance of a faculty member chosen by the student to be his/her advisor. The proposal will be presented orally to the thesis committee, typically after the fifth semester. Following the presentation of the proposal, an oral examination will take place in which the thesis committee will question the student about general science related to the project. This will constitute the general examination.

Core requirements for each division are listed below. The graduate school requires students to register for at least 72-post baccalaureate credits to earn the Ph.D. In addition, all students must take BIOS 408 (0 credits) Responsible Conduct of Science within their first year of graduate study. All students must also attend departmental seminars and enroll in BIOS 406 (1 credit) Biological Sciences Seminar at least twice in the first four semesters. A minimum of 24 course credits may be chosen from upper level courses in biochemistry, molecular biology, cell biology, behavioral biology and evolutionary biology, and neuroscience. At least 12 of these credits must be at the 400 level.

**Biochemistry**

In the biochemistry program, research areas include DNA structure and function, regulation of protein synthesis, and signal transduction. Students admitted to graduate study in biochemistry will typically have an undergraduate degree in chemistry or biochemistry. Students with an undergraduate degree in a related discipline will be expected to have the following undergraduate preparation for graduate study beyond introductory chemistry and a year of organic chemistry: at least one semester of analytical chemistry and one semester of physical

chemistry thermodynamics and kinetics, with appropriate math. Students without that background will be expected to take courses to fulfill those requirements as part of their graduate study.

#### Required courses

BIOS 371	Elements of Biochemistry I	3
BIOS 372	Elements of Biochemistry II	3
BIOS 469	Biochemical Problem Solving I	1
BIOS 470	Biochemical Problem Solving II	1
CHM 423	Bio-Organic Chemistry	3
BIOS 345	Molecular Genetics	3
Seminar course		
BIOS 408	Responsible Conduct of Science <sup>1</sup>	0
or CHM 400	First Year Graduate Student Seminar	

#### Integrative Biology and Neuroscience

The graduate program in integrative biology and neuroscience is designed to train students in advanced organismal biology with the emphasis on behavioral ecology, evolution, functional morphology, endocrinology, and neurobiology of animals. The mission of the program is to create students who are broadly trained and uniquely capable of asking questions and solving problems at the interface of these traditionally defined fields. Students admitted to the program should have a basic knowledge of evolution, anatomy, physiology, behavioral neuroscience, and/or behavioral ecology. Students will begin by taking core courses providing a broad foundation in integrative biology at the graduate level and work toward a Ph.D. with a concentration in either behavioral neuroscience or behavioral and evolutionary biology. Regardless of concentration, all students in the program develop an appreciation for the fact that all aspects of biology, whether cellular, physiological, anatomical, behavioral, evolutionary, or social, are inextricably linked and cannot be fully understood as separate, parallel systems of knowledge. The integrative program consists of two tracks: (I) Animal Behavior and Evolution, and (II) Neuroscience.

#### Track 1: Animal Behavior and Evolution

Select 4 from the following with at least one course taken from each core area: 12

##### Behavior/Evolution

BIOS 409	Evolutionary and Functional Morphology	3
BIOS 429	Advances in Herpetology	3
BIOS 439	Advanced Behavioral Ecology	3
BIOS 334	Species and Speciation	3

##### Behavioral Neuroscience

BIOS 453	General Neuroanatomy	3
BIOS 457	Advanced Behavioral Neuroendocrinology	3

##### Sensory Systems and Physiology

BIOS 404	Behavioral Neuroscience	3
BIOS 416	Neurophysiology and Memory	3
BIOS 450	Developmental Neurobiology	3

##### Additional Requirements

BIOS 401	Professional Skills for Biological Sciences Graduate Students (strongly recommended to be taken in first two years)	3
BIOS 406	Biological Sciences Seminar (2 semesters)	1

#### Track 2: Neuroscience

Students will take a total of 5 courses.

##### Neuroscience Core

BIOS 424	Advanced Neurobiology of Sensory Systems (mandatory)	3
BIOS 453	General Neuroanatomy (mandatory)	3

#### Behavioral Neuroscience and Vertebrate Physiology Elective

One of the following courses:

BIOS 450	Developmental Neurobiology	3
BIOS 457	Advanced Behavioral Neuroendocrinology	3

#### Systematics, Evolution and Ecology

One of the following courses:

BIOS 409	Evolutionary and Functional Morphology	3
BIOS 439	Advanced Behavioral Ecology	3
BIOS 334	Species and Speciation	3

#### Cell and Molecular Neuroscience

One of the following courses:

BIOS 411	Advanced Cell Biology	3
BIOS 421	Molecular Cell Biology I	3
BIOS 422	Molecular Cell Biology II	3
BIOS 431	Advanced Topics in Cell Biology	3
BIOS 432	Advanced Topics in Molecular Genetics	3

#### Additional Requirements

BIOS 401	Professional Skills for Biological Sciences Graduate Students (strongly recommended to be taken in first two years)	3
BIOS 406	Biological Sciences Seminar (two semesters)	1

Depending on the student's background, additional courses may be required.

#### Cell and Molecular Biology

In the cell and molecular biology program, research areas include microbial evolution and genetics, plant and animal molecular genetics, eukaryotic cell biology, and regulation of gene expression.

BIOS 345	Molecular Genetics	3
BIOS 371	Elements of Biochemistry I	3
BIOS 372	Elements of Biochemistry II	3
BIOS 411	Advanced Cell Biology	3
BIOS 421	Molecular Cell Biology I	3
BIOS 422	Molecular Cell Biology II	3

#### Additional Requirements

BIOS 406	Biological Sciences Seminar (2 semesters)	1
Upper level electives in molecular biology, cell biology, and biochemistry		6

Total Credits 25

Facilities available for research in the biological sciences include core facilities with equipment (for example, for DNA synthesis, confocal microscopy, digital imaging, chromatography, cell culture, centrifugation, controlled environments, gamma and scintillation counting, flow cytometry, and rodent surgery). Individual research laboratories and advanced teaching laboratories contain a variety of additional equipment. Ongoing interactions with a variety of private companies contribute additional opportunities for student experiences.

#### Courses

##### BIOS 007 Human Reproduction 3 Credits

Basic and applied human reproductive biology for nonscience majors. May not be used in life science major or minor programs.

Attribute/Distribution: NS

**BIOS 008 Drugs and Behavior 3 Credits**

Basic principles of drug action in the central nervous system. Effects of stimulants, depressants, intoxicants and drug abuse on behavioral function. Clinical use of drugs in the treatment of various psychological and psychiatric disorders.

**Attribute/Distribution:** NS

**BIOS 010 Bioscience in the 21st Century 4 Credits**

A multidisciplinary survey of advances in bioscience. Exploration of themebased topics (e.g., infectious diseases, cancer, genomebase medicine, engineered biomedical systems) coupled with social/ethical considerations. Three lectures per week. Participation in online multidisciplinary discussion, writing assignments, field trips, and/or other activities.

**Attribute/Distribution:** NS

**BIOS 041 Biology Core I: Cellular and Molecular 3 Credits**

Basic building blocks and higherorder structures required for cellular processes. Topics include the character of membranes, the molecular/cellular basis of energy production, cell cycle progression, DNA replication, gene expression, signal transduction, and cell division. Prerequisites as noted below.

**Prerequisites:** CHM 075 or CHM 025 or CHM 030 or CHM 040

**Can be taken Concurrently:** CHM 075, CHM 025, CHM 030, CHM 040

**Attribute/Distribution:** NS

**BIOS 042 Biology Core I: Cellular and Molecular Lab 1 Credit**

Experiments, observations, and discussions related to the principal topics covered in BIOS 041. Prerequisites as noted below.

**Prerequisites:** BIOS 041

**Can be taken Concurrently:** BIOS 041

**Attribute/Distribution:** NS

**BIOS 115 Biology Core II: Genetics 3 Credits**

The structure, function, and continuity of hereditary information. Classical genetic analysis. Molecular biology of genes and genomes. Population genetics and evolution. Genetics of complex traits. Prerequisites as noted below.

**Prerequisites:** BIOS 041

**Attribute/Distribution:** NS

**BIOS 116 Biology Core II: Genetics Laboratory 1 Credit**

Laboratory work that demonstrates major principles of genetics: included are experiments on microorganisms and the common fruit fly, *Drosophila melanogaster*. Prerequisites as noted below.

**Prerequisites:** BIOS 115

**Can be taken Concurrently:** BIOS 115

**BIOS 118 Phage Genetics Laboratory 2 Credits**

Part of a 2-semester series focusing on genetic analysis of novel bacteriophage genomes to determine gene function using recombinering strategies. Phage genome annotation using bioinformatics for previously sequenced phage genomes. Additional genetics, molecular biology, and/or biochemical research on previously isolated bacteriophages may also be included. Prerequisites as noted below.

**Prerequisites:** BIOS 115

**Can be taken Concurrently:** BIOS 115

**Attribute/Distribution:** NS

**BIOS 120 Biology Core III: Integrative and Comparative 4 Credits**

Experimental and historical approaches to the analysis of structural and functional properties in organisms. Use of scientific method to study species diversity. Introduction to the analysis of organismal attributes that explain behavioral repertoire and ecological relationships. Prerequisites as noted below.

**Prerequisites:** BIOS 115 and (BIOS 116 or BIOS 195 or BIOS 118)

**Attribute/Distribution:** NS

**BIOS 121 Comparative/Integrative Biology for BIOS Minors 3 Credits**

BIOS 120 without the lab. Can serve as a prerequisite for some advanced courses (with instructor's permission) for which BIOS 120 is also a prerequisite. Will NOT satisfy the CORE III requirement for biology, molecular biology, behavioral neuroscience or accelerated (combined-degree) programs in the health sciences. Must have non-major status. Prerequisites as noted below.

**Prerequisites:** BIOS 115

**Attribute/Distribution:** NS

**BIOS 130 Biostatistics 4 Credits**

Elements of statistics and probability theory with emphasis on biological applications. Statistical analysis of experimental and observational data. Prerequisites as noted below.

**Prerequisites:** BIOS 041 and MATH 052 or MATH 022

**Attribute/Distribution:** ND

**BIOS 161 Supervised Research 1-3 Credit**

Apprenticeship in ongoing faculty research program. Literature review, experimental design, data collection and analysis, and professional writing under faculty sponsor supervision. May be repeated but only 3 credits can be counted toward any life science major. Consent of instructor required. Prerequisites as noted below.

**Repeat Status:** Course may be repeated.

**Prerequisites:** BIOS 041

**Attribute/Distribution:** ND

**BIOS 177 Behavioral Neuroscience I 3 Credits**

Nervous system functioning with varying emphasis on neurophysiology, neuroanatomy, behavior genetics, information transmission, research techniques, sensory and motor functions. Prerequisite: BIOS 41.

**Prerequisites:** BIOS 031 or BIOS 041

**Attribute/Distribution:** NS

**BIOS 202 Biomedical Externship 1-3 Credit**

Analysis of individualized experiences at external biomedical clinical or research sites. Limited enrollment. May not be taken for pass/fail grading. May be taken only once and may not be used to satisfy any life science major or minor requirement. Consent of department chair required.

**Attribute/Distribution:** NS

**BIOS 233 Invertebrate Zoology 4 Credits**

Survey of representative invertebrates. Structure and behavior of selected types and concepts of evolutionary relationships among the major groups. Two lectures and two laboratory periods.

**Attribute/Distribution:** NS

**BIOS 234 Comparative Vertebrate Anatomy 4 Credits**

A course in vertebrate zoology with emphasis on the study of homologous body structures in the various vertebrate classes and their relationship to the functional demands of habit and environment in each class. Detailed dissections of representative vertebrates are made in the laboratory. Two lectures and two laboratory periods. Prerequisites as noted below.

**Prerequisites:** BIOS 120

**Attribute/Distribution:** NS

**BIOS 235 Human Physiology 4 Credits**

Movement, digestion, respiration, circulation and excretion. Sensory systems, hormonal and electrical signal transduction, reproduction. Writing intensive. Prerequisites as noted below.

**Prerequisites:** BIOS 120

**Attribute/Distribution:** NS

**BIOS 241 Vertebrate Natural History 4 Credits**

An introduction to the ecology, behavior, distribution and evolution of vertebrates, with emphasis on the North American fauna. Two lectures, one tutorial and one laboratory and field trip. This course may be used to fulfill junior writing requirements with the permission of the instructor. Prerequisites as noted below.

**Prerequisites:** BIOS 120

**Attribute/Distribution:** NS

**BIOS 251 Writing and Biological Sciences 3 Credits**

A course designed to acquaint students with some of the intellectual foundations of science, with attention to the distinctiveness of the biological sciences. Format includes readings, intensive writing, extemporaneous speaking, and discussion. May not be used to fulfill Biology B.A. elective requirements. Must have major status. Consent of department required.

**Attribute/Distribution:** NS

**BIOS 261 Special Topics in Biological Sciences 1-3 Credit**

Research, conferences and reports on selected topics not covered in the general undergraduate offerings. May be taken more than once for credit. Must have major status. Consent of instructor required.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** NS

**BIOS 262 Research Proposal 3 Credits**

Literature and methods of research in area of department faculty expertise. Requires development of detailed proposal for research to be performed in senior year. Must have major in any biological sciences degree program, junior standing, GPA of 3.0 in major, and consent of department.

**Attribute/Distribution:** NS

**BIOS 276 Central Nervous System and Behavior 3 Credits**

Neuroanatomy and neurophysiology of animal and human behavior. Feeding, thirst, sleep, emotions, learning, and psychopathology.

Prerequisites as noted below.

**Prerequisites:** BIOS 120

**Attribute/Distribution:** ND

**BIOS 277 Experimental Neuroscience Laboratory 2 Credits**

Structure and function of the mammalian brain with special attention to cellular morphology and organization. Standard, cutting edge techniques to determine how the shape and function of the nervous system regulates behavior. Experimental design, hypothesis testing, statistical analysis, reading and writing of scientific papers, basic histology and imaging. Prerequisites as noted below.

**Prerequisites:** BIOS 276

**Can be taken Concurrently:** BIOS 276

**Attribute/Distribution:** NS

**BIOS 300 Apprentice Teaching 1-4 Credit**

**Repeat Status:** Course may be repeated.

**BIOS 307 Male Reproductive Biology 1-3 Credit**

Molecular, cellular, and genetic aspects of the mammalian male reproductive system. Consent of instructor required. Prerequisites as noted below.

**Prerequisites:** BIOS 120

**Attribute/Distribution:** NS

**BIOS 313 Vertebrate Histology 4 Credits**

Microstructural and ultrastructural properties of vertebrate cells and tissues. Techniques of tissue preparation. Two lectures and two labs. Prerequisites as noted below.

**Prerequisites:** BIOS 120

**Attribute/Distribution:** ND, NS

**BIOS 314 Vertebrate Development 4 Credits**

Germ cell formation, fertilization, early development, and the origin of the principal organ systems. Location, structure, and regulation of information from molecular to organismal levels of organization. Prerequisites as noted below.

**Prerequisites:** BIOS 120

**Attribute/Distribution:** NS

**BIOS 315 Neuropharmacology 3 Credits**

Mechanisms of drug action in the central nervous system. Pharmacokinetics/pharmacodynamics. Depressant, stimulants, analgesics, and psychedelics. Treatments for neuropsychiatric disorders. Drug abuse. Prerequisites as noted below.

**Prerequisites:** BIOS 276

**Attribute/Distribution:** NS

**BIOS 317 Evolution 3 Credits**

Mechanisms of evolution, emphasizing genetic structure and variation of populations, and isolation. Origin of species and higher taxa. Rates of evolution, extinction. Prerequisites as noted below.

**Prerequisites:** BIOS 120

**Attribute/Distribution:** NS

**BIOS 320 The Business of Life Science 3 Credits**

An examination of business process in startup, early stage and developing bioscience companies. Technology assessment, business plan and proposal preparation, financial strategies, resource management, intellectual property, and legal as well as regulatory issues. Cannot be used to fulfill major or minor requirements in Biological Sciences. Prerequisites as noted below or consent of instructor.

**Prerequisites:** (BIOS 120)

**Attribute/Distribution:** ND

**BIOS 324 Microbiology 3 Credits**

An examination of microbial life, including archaea, bacteria, fungi, protists and viruses. Emphasis on microbial molecular genetics and its relationship to the origin of life, human health/medicine, and the environment. Prerequisites as noted below.

**Prerequisites:** CHM 110 and BIOS 120

**Attribute/Distribution:** NS

**BIOS 325 Bacteriology Laboratory 2 Credits**

Laboratory studies of microbes. Experiments on environmental microbiology, bacterial molecular genetics, bacteriophages, and/or other topics covered in BIOS 324 using modern and classical microbiology techniques. Prerequisites as noted below.

**Prerequisites:** BIOS 324

**Can be taken Concurrently:** BIOS 324

**Attribute/Distribution:** NS

**BIOS 328 Immunology 3 Credits**

Distinction of "self" and "nonself" through humoral and cellular mechanisms. Antigens; biochemical structures, cellular mechanisms, genetic control and processing, phylogenetic distribution, diseased states. Prerequisites as noted below.

**Prerequisites:** BIOS 120

**Attribute/Distribution:** NS

**BIOS 329 Herpetology 3 Credits**

Biology of amphibians and reptiles. Two lectures, one laboratory or field trip per week. Prerequisites as noted below.

**Prerequisites:** BIOS 120

**Attribute/Distribution:** ND

**BIOS 334 Species and Speciation 3 Credits**

Consideration of the origin of species. Discussion of a variety of "species" definitions and exploration of the evolutionary mechanisms by which new species arise. Alternation between lecture and discussion, drawing on the textbook and on current and classical literature. Prerequisites as noted below.

**Prerequisites:** BIOS 317

**BIOS 335 Animal Behavior 3 Credits**

Discussion of the behavior of invertebrates and vertebrates and analysis of the physiological mechanisms responsible for behavioral stimuli, and adaptive value of specific behavior patterns. Prerequisite: BIOS 120.

**Prerequisites:** (BIOS 120)

**Attribute/Distribution:** NS

**BIOS 336 Animal Behavior Laboratory 2 Credits**

Experiments and field observations illustrating principles discussed in BIOS 335. Emphasis on observing animals, performing experiments, collecting and analyzing data, and individual research. Six hours of laboratory per week. Prerequisites as noted below.

**Prerequisites:** BIOS 335 or BIOS 337

**Can be taken Concurrently:** BIOS 335, BIOS 337

**Attribute/Distribution:** NS



**BIOS 337 Behavioral Ecology 3 Credits**

Social systems of vertebrate and invertebrate groups. Emphasis on ecological and evolutionary factors that influence social behavior.

Prerequisites as noted below.

**Prerequisites:** BIOS 120

**Attribute/Distribution:** NS

**BIOS 340 Molecular Basis of Disease 3 Credits**

Lectures and student projects on molecular mechanisms of human disease. Physiology of disease, molecular mechanisms, therapeutic approaches, ongoing research. Topics include: neurodegenerative diseases, cancer, autoimmune diseases, infectious diseases.

Prerequisites as noted below.

**Prerequisites:** BIOS 120

**Attribute/Distribution:** NS

**BIOS 345 Molecular Genetics 3 Credits**

The organization and replication of genetic material; mutagenesis; mechanisms of regulation; mechanisms of gene transmission involving prokaryotes and eukaryotes and their viruses; techniques for intervention into genetic organization and expression. Prerequisites as noted below.

**Prerequisites:** BIOS 120 or (BIOS 115 and BIOE 210)

**Attribute/Distribution:** NS

**BIOS 346 Molecular Genetics Laboratory 2 Credits**

Laboratory experiments related to the topics covered in BIOS 345. Emphasis is on molecular characterization of DNA and the principles of gene isolation and transfer. Prerequisites as noted below.

**Prerequisites:** BIOS 345

**Can be taken Concurrently:** BIOS 345

**Attribute/Distribution:** NS

**BIOS 347 Advanced Topics in Genetics 3 Credits**

Lectures and student projects on selected aspects of genetics such as the genetics and evolution of particular organisms, regulation of gene expression and transmission, human genetics, gene therapy, etc. Prerequisites as noted below or consent of department chair.

**Prerequisites:** BIOS 120

**Attribute/Distribution:** NS

**BIOS 353 Virology 3 Credits**

Structure and replication of viruses. Emphasis on the organization, replication, and regulation of expression of viral genomes; the mechanisms of virus assembly and release; and on virus-host interactions. Special attention given to human pathogenic viruses. Prerequisites as noted below.

**Prerequisites:** (BIOS 120 and CHM 052 or CHM 112)

**Attribute/Distribution:** NS

**BIOS 356 Human Genetics and Reproduction 3 Credits**

Frontiers in human genetics, including simple and complex genetic diseases, cancers. Emphasis on genes and structures that enable reproductive processes; genetic functions of mammalian germ lines. Analysis of current publications. Prerequisites as noted below.

**Prerequisites:** (BIOS 120) or (BIOS 115 and BIOE 210)

**Attribute/Distribution:** NS

**BIOS 365 Neurobiology of Sensory Systems 3 Credits**

The fundamental features of sensory systems in a diverse array of animals. Focus on how nervous systems detect, compute, and internally represent aspects of the environment from the single cell to whole system level. Special attention to the way sensory processing influences how we think about the biological basis of perception and possible mechanisms for consciousness. Prerequisites as noted below.

**Prerequisites:** (BIOS 177 and BIOS 120) or BIOS 276

**BIOS 366 Diseases of the Nervous System 3 Credits**

Neurobiological basis of CNS disorders, including affective, neurological and psychotic conditions. Emphasis on primary literature covering causes, diagnostic and treatment issues. Prerequisites as noted below.

**Prerequisites:** BIOS 276 or BIOS 382

**Attribute/Distribution:** NS

**BIOS 367 Cell Biology 3 Credits**

Molecular aspects of cell biology. Emphasis on membrane structure and function, organelle biogenesis, cell motility, the cytoskeleton, and extracellular matrix. Prerequisites as noted below.

**Prerequisites:** (BIOS 120) or (BIOS 115 and BIOE 210)

**Attribute/Distribution:** NS

**BIOS 368 Cell Biology Laboratory 2 Credits**

Basic methods used in cell biology laboratories around the world and the opportunity to carry out an independent research project. Techniques include histology and microscopy (both white and fluorescent light), tissue culture and sterile procedures, cellular fractionation, nuclear import assays, and immunological probing. Consent of department required. Prerequisites as noted below.

**Prerequisites:** BIOS 367

**Can be taken Concurrently:** BIOS 367

**Attribute/Distribution:** NS

**BIOS 369 Comparative Physiology of Vertebrate Systems 3-4 Credits**

Functional analysis of energy balance in vertebrate animal models. Digestion, respiration, circulation, and excretion, across aquatic and terrestrial vertebrates. Homeostatic mechanisms of salt, water, and gas exchange. Ionotropic and metabotropic signal transduction. Hormonal and electrical cellular communication among muscles, glands, and neurons. Sensory systems, movement and reproduction. Physiological adaptations to extreme environments. When offered for 4 credits, the course includes one laboratory meeting per week. Prerequisites as noted below.

**Prerequisites:** BIOS 120

**Attribute/Distribution:** NS

**BIOS 371 Elements of Biochemistry I 3 Credits**

A general study of carbohydrates, proteins, lipids, nucleic acids and other biological substances and their importance in life processes. Protein and enzyme chemistry are emphasized. Must have completed one year of organic chemistry.

**Prerequisites:** CHM 052 or CHM 112

**Attribute/Distribution:** NS

**BIOS 372 Elements of Biochemistry II 3 Credits**

Dynamic aspects of biochemistry; enzyme reactions including energetics, kinetics and mechanisms; metabolism of carbohydrates, lipids, proteins and nucleic acids; photosynthesis, electron transport mechanisms, coupled reactions, phosphorylations, and the synthesis of biological macromolecules. Prerequisites as noted below or consent of instructor.

**Prerequisites:** (BIOS 371 or CHM 371) and (BIOS 041)

**Attribute/Distribution:** NS

**BIOS 374 Sex Determination and Differentiation 3 Credits**

An examination of the primary scientific literature on how sex is conferred to a zygote. Hormonal and non-hormonal mechanisms of sexual differentiation. Neural correlates of sex, gender, and sexual orientation. Prerequisites as noted below.

**Prerequisites:** BIOS 367 or BIOS 371 or BIOS 382

**Attribute/Distribution:** NS

**BIOS 376 Classical & Molecular Embryology 3 Credits**

Differentiation of multicellular organisms from a single cell. Axis determination; gradients; induction and pattern formation viewed through modern analysis of regulated gene expression. Prerequisites as noted below.

**Prerequisites:** BIOS 345

**Can be taken Concurrently:** BIOS 345

**Attribute/Distribution:** NS

**BIOS 377 Biochemistry Laboratory 3 Credits**

Laboratory studies of the properties of chemicals of biological origin and the influence of chemical and physical factors on these properties. Laboratory techniques used for the isolation and identification of biochemicals. Prerequisites as noted below or consent of instructor.

**Prerequisites:** (BIOS 371 or CHM 371) and (BIOS 041)

**Can be taken Concurrently:** BIOS 371, CHM 371

**Attribute/Distribution:** ND

**BIOS 378 Biochemical Preparations 1-3 Credit**

A laboratory course involving the preparation or isolation, purification and identification of chemicals of biological origin. Prerequisites as noted below.

**Prerequisites:** (BIOS 377 or CHM 377) and (BIOS 372 or CHM 372)

**Attribute/Distribution:** ND

**BIOS 380 Molecular and Cellular Biophysics 3-4 Credits**

Physical principles of biomolecular and cellular organization. Biomolecular interaction and recognition, molecular motors, physical organization and functioning of cellular membranes, electrical signaling in live cells. Modern techniques in biophysics: X-ray analysis, molecular spectroscopy, molecular modeling, fluorescence imaging, electrophysiology, electron microscopy.

**Prerequisites:** (BIOS 115) and (PHY 013 or PHY 021)

**BIOS 381 Physical Biochemistry 3 Credits**

Topics include: thermodynamics of biological systems; Forces acting on and between biological molecules; Principles of macromolecular structure; Physical methods used to characterize biomolecules; and other topics to be determined. Prerequisites as noted below.

**Prerequisites:** (BIOS 371 or CHM 371) and (BIOS 041)

**Attribute/Distribution:** NS

**BIOS 382 Endocrinology of Behavior 3 Credits**

Hormonal effects upon animal and human behavior. Emphasis on neuroendocrinology of steroid hormone involvement in reproductive behaviors. Prerequisites as noted below.

**Prerequisites:** BIOS 120

**Attribute/Distribution:** NS

**BIOS 383 Biological Sciences Colloquia 1 Credit**

Analysis of weekly colloquia in the biological sciences. For senior majors in the biological sciences. May be taken twice for credit.

**Repeat Status:** Course may be repeated.

**Prerequisites:** BIOS 120

**Attribute/Distribution:** ND

**BIOS 384 Eukaryotic Signal Transduction 3 Credits**

Signal transduction between cells of multicellular eukaryotic organisms examined in the context of specialized functions that include: nutrition, hormones and neurotransmitters, vision, muscle contraction, adhesion, and the immune system. The evolution of cancer based on mutations in these signaling systems. Prerequisites as noted below.

**Prerequisites:** BIOS 367 or BIOS 372 or CHM 372 or BIOS 382 or BIOS 365

**BIOS 385 Neurophysiology and Memory 3 Credits**

Lectures and seminars on mechanisms of neuronal communication, the ability of neuronal networks to store and retrieve information, cellular basis for memory.

**Prerequisites:** BIOS 177 and PHY 013

**Attribute/Distribution:** NS

**BIOS 387 Biological Sciences Honors Seminar 1 Credit**

Development, presentation and implementation of research proposals, and discussions of research. Required for senior biology, molecular biology, biochemistry, and behavioral neuroscience majors pursuing departmental honors. Departmental permission required.

**Attribute/Distribution:** ND

**BIOS 388 Biological Sciences Honors Seminar 1 Credit**

Continuation and extension of BIOS 387. Departmental permission required.

**Attribute/Distribution:** ND

**BIOS 389 Honors Project 1-6 Credit**

**Repeat Status:** Course may be repeated.

**BIOS 391 Undergraduate Research 1-3 Credit**

Laboratory research under tutorial with a faculty member. May be taken more than once for credit. Must have junior standing. Consent of instructor required.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** ND

**BIOS 393 Thesis 3 Credits**

Literature review and design of project in selected area, execution of the project, final report and presentation. Consent of department required. Intended for senior majors in BIOS only. May be repeated one time for additional credit. Consent of instructor required.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** ND

**BIOS 401 Professional Skills for Biological Sciences Graduate Students 3 Credits**

Students learn expectations and fundamental skills related to success in the biological sciences. The course is designed to help students make the most out of their graduate education. Students learn the principles underlying fundable, publishable research, and how these general principles can be applied to their specific research area. They learn to write and review manuscripts and grant proposals by serving on a mock editorial board and scientific review panel. They gain experience in giving oral presentations. Readings are from texts on scientific writing and research styles, and from original journal articles and grant proposals written by the faculty. Required of all Integrative Biology graduate students.

**BIOS 404 Behavioral Neuroscience 3 Credits**

Theoretical and empirical issues in biopsychology. Must have graduate standing or consent of instructor.

**BIOS 405 Special Topics in Molecular Biology 1-3 Credit**

Research, conferences, and reports on selected topics not covered in the general graduate offerings. May be taken more than once for credit.

**Repeat Status:** Course may be repeated.

**BIOS 406 Biological Sciences Seminar 1 Credit**

An advanced seminar in current developments including departmental research. Required for candidates for graduate degrees in molecular biology. May be taken more than once for credit.

**Repeat Status:** Course may be repeated.

**BIOS 407 Research in Biological Science 1-9 Credit**

Laboratory investigations in one of the department's research areas.

**BIOS 408 Responsible Conduct of Science 0 Credits**

Responsible practice in research. Training in general laboratory methods; human subjects concerns; radiation safety; chemical hazards; aseptic technique; physical, mechanical, biological, and fire hazards; animal welfare. Occupational and workplace considerations. Recombinant DNA guidelines; patent and proprietary rights; controversies over applications of science. Appropriate aspects required of investigators in all departmental research projects.

**BIOS 409 Evolutionary and Functional Morphology 3 Credits**

Readings in the current literature, demonstrations and laboratory exercises exploring the applications of comparative methods to the analysis of evolutionary patterns at a range of morphological levels (molecular and macroscopic). Students will also learn experimental approaches to testing relationships between form and function in vertebrates. Emphasis will be on the musculoskeletal and nervous systems.

**BIOS 410 Special Topics in Behavioral and Evolutionary Bioscience 1-3 Credit**

Readings and discussions on selected topics not covered in the general graduate offerings. May be taken more than once for credit.

**BIOS 411 Advanced Cell Biology 3 Credits**

Cell structure and biochemistry, as related to specialized cell functions.

**BIOS 412 Metabolic Influences on Behavior 3 Credits**

Sensory systems that detect metabolic energy availability and affect the behavior of humans and other animals: food intake and body weight regulation, sexual and parental behavior, aggression, learning, and body temperature regulation.

**BIOS 414 Sexual Differentiation 3 Credits**

Genetic and hormonal events mediating the development and expression of sexual dimorphisms in physiology and behavior. Current theoretical models; emphasis on biochemical, neuroanatomical and molecular biological considerations.

**BIOS 415 Neuropharmacology 3 Credits**

Mechanism of drug action in the central nervous system, including cell surface receptors and second messenger systems. Drug use/abuse and cellular changes mediating behavioral effects. Drug use in clinical therapy.

**BIOS 416 Neurophysiology and Memory 3 Credits**

Lectures and seminars on mechanisms of neuronal communication, the ability of neuronal networks to store and retrieve information, cellular basis for memory.

**Prerequisites:** BIOS 177 and PHY 013

**BIOS 420 Pheromonal Communication 3 Credits**

Mechanisms of pheromone synthesis, biochemistry, sensory transduction, neuroanatomy/neuroendocrinology, and adaptive significance.

**BIOS 421 Molecular Cell Biology I 3 Credits**

Molecular aspects of cell structure, cell motility, intracellular transport; and biomembrane dynamics. Prerequisites as noted below.

**Prerequisites:** BIOS 411

**BIOS 422 Molecular Cell Biology II 3 Credits**

Molecular aspects of gene expression, including genome structure and replication, RNA synthesis/processing, and protein synthesis. Prerequisites as noted below.

**Prerequisites:** BIOS 345

**BIOS 424 Advanced Neurobiology of Sensory Systems 3 Credits**

This course is designed to provide an overview of core principles of neuroscience through exploration of sensory systems. The course will provide an intensive review of fundamental neural signaling followed by a broad introduction to the major sensory pathways. Focus will be on major organizing principles of neural systems, and information processing. Student discussions and presentations will incorporate current literature and concepts.

**Prerequisites:** BIOS 117 and BIOS 120

**BIOS 425 Male Reproductive Biology 1-3 Credit**

Molecular, cellular, and genetic aspects of the mammalian male reproductive system. Consent of instructor required.

**BIOS 427 Techniques in Cell and Molecular Biology 1-3 Credit**

Laboratory experiences in three or more cell and molecular biological techniques: gel electrophoresis of nucleic acids/proteins; polymerase chain reaction; DNA/RNA sequencing; molecular hybridization techniques; fluorescence microscopy; confocal microscopy; flow cytometry; electron microscopy tissue preparation; immunological detection methods; molecular cloning techniques; oocyte microinjection techniques; tissue culture methods; and autoradiography.

**BIOS 429 Advances in Herpetology 3 Credits**

Lectures and readings from the primary literature on current research in amphibian and reptilian biology. Two lectures, one discussion session and one laboratory or field trip. Not open to students who have received credit for BIOS 329.

**BIOS 431 Advanced Topics in Cell Biology 3 Credits**

Current research problems in cell biology. May be repeated when a different topic is offered. Prerequisites as noted below.

**Repeat Status:** Course may be repeated.

**Prerequisites:** BIOS 367 or BIOS 367 or BIOS 411

**BIOS 432 Advanced Topics in Molecular Genetics 3 Credits**

Current research in molecular genetics.

**Repeat Status:** Course may be repeated.

**BIOS 433 Advanced Topics in Developmental Biology 3 Credits**

Current research problems in developmental biology. May be repeated when a different topic is offered. Prerequisites as noted below.

**Repeat Status:** Course may be repeated.

**Prerequisites:** BIOS 345 or BIOS 345

**BIOS 437 Pathophysiological Chemistry 3 Credits**

Biochemical basis of human diseases involving abnormal metabolism of proteins, nucleic acids, carbohydrates, and lipids. Emphasis on the correlation of the clinical presentation of disease processes seen as physiological dysfunctions with clinical laboratory methods. Lectures, student presentations, and clinical case discussions. Consent of department required.

**BIOS 439 Advanced Behavioral Ecology 3 Credits**

Critical evaluation of the theoretical foundation in sociobiology.

Emphasis placed on kinship, altruism, mate choice, parental investment, parent-offspring conflict, etc. Lectures and seminars. Not open to students who have taken BIOS 337. Prerequisites as noted below.

**Prerequisites:** BIOS 317 or BIOS 317

**BIOS 445 Systematics and Evolution 3 Credits**

Theoretical, philosophical and methodological foundations of the classification of eukaryotic organisms and the manner in which systematic theory and method relate to evolutionary theory. Two lectures and one lab/recitation/discussion session.

**BIOS 450 Developmental Neurobiology 3 Credits**

Fundamental mechanisms underlying neural development. Early events leading to the induction of the neuroectoderm and the reorganization of the vertebrate central nervous system during adulthood and aging. Major developmental events such as phenotype commitment, cell migration, differentiation and growth cone guidance. Emphasis on the interplay between concepts emerging from organismal and molecular levels of analyses.

**BIOS 453 General Neuroanatomy 3 Credits**

Graduate level study of the neuroanatomy and neurochemistry of systems that underlie behavior in vertebrates. Emphasis will be on the traditional and novel methodologies used to reveal neuroanatomical pathways as well as the function of these pathways. Consent of instructor required.

**BIOS 456 Human Genetics and Reproduction 3 Credits**

Frontiers in human genetics, including simple and complex genetic diseases, cancers. Emphasis on genes and structures that enable reproductive processes; genetic functions of mammalian germ lines. Analysis of current publications.

**BIOS 457 Advanced Behavioral Neuroendocrinology 3 Credits**

A seminar course that covers current primary literature on the hormone-nervous system interactions that underlie physiology and behavior. The course covers the neuroendocrinology of reproduction, sex behavior, parental behavior, social behavior, agonistic and territorial behavior, learning and memory, homeostasis (caloric, nutritional, water and salt balance, temperature regulation), circadian rhythms and seasonality in a variety of vertebrates.

**BIOS 464 Molecular Biology of Eukaryotic Organisms 3 Credits**

Comparative analysis of several eukaryotes as model systems in cell biology, developmental biology, genetics, and molecular biology.

**BIOS 466 Structure and Function of RNAs and Ribonucleoprotein Complexes 3 Credits**

Biochemistry and function of small nuclear RNPs, RNase P, ribosomes, self-splicing introns, signal recognition particle, RNA viruses. Functions of RNA in DNA replication, in regulation, as an enzyme, and as a repressor.

**BIOS 467 Principles of Nucleic Acid Structure 3 Credits**

An examination of the principles underlying nucleic acid structure including stereochemistry, electrostatics, hydration, torsional constraints, sequence specific effects, and interaction with nuclear proteins. Special emphasis will be placed on DNA structure. Must have completed one year of biochemistry and one year of physical chemistry or consent of department required.

**BIOS 468 Principles of Protein Structure 3 Credits**

An examination of the principles underlying protein structure including stereochemistry, preferred tertiary structures, protein homology, excluded volume effects, time dependent structural fluctuations, and prediction of protein structure from sequence information. Must have completed one year of biochemistry and one year of physical chemistry or consent of department required.

**BIOS 469 Biochemical Problem Solving I 1 Credit**

Applications of material covered in BIOS/CHM 371 including techniques used in research.

**BIOS 470 Biochemical Problem Solving II 1 Credit**

Applications of concepts covered in BIOS/CHM 372 including techniques used in research.

**BIOS 471 Eukaryotic Signal Transduction 3 Credits**

Signal transduction between and within cells of multicellular organisms examined in the context of specialized functions that include: nutrition, hormones and neurotransmitters, vision, muscle contraction, adhesion and the immune system. The evolution of cancer based on mutations in these signaling systems. Lecture, discussion, and student presentations. Prerequisites as noted below.

**Prerequisites:** (BIOS 372 or CHM 372 or BIOS 411)

**BIOS 472 Lipids and Membranes 3 Credits**

Structure, physical properties and functions of lipids and their biological aggregates. Techniques for studying lipid assemblies, enzymes which act on lipids, membrane proteins and lipoproteins will also be discussed. Prerequisites as noted below or consent of department.

**Prerequisites:** BIOS 372 or CHM 372

**BIOS 477 Topics in Biochemistry 1-3 Credit**

Selected areas of biochemistry, such as mechanisms of enzyme action, new developments in the chemistry of lipids, nucleic acids, carbohydrates and proteins. May be repeated for credit when different topics are offered.

**Repeat Status:** Course may be repeated.

**BIOS 479 Biochemical Techniques 3 Credits**

Laboratory studies of the techniques and principles involved in the isolation, identification, and biochemical transformation of carbohydrates, lipids, nucleic acids and proteins. Prerequisites as noted below.

**Prerequisites:** (BIOS 371)

**Can be taken Concurrently:** BIOS 371

**BIOS 480 Advanced Biochemical Preparations 1-3 Credit**

An advanced laboratory course in the preparation, isolation, purification, and identification of biochemically produced materials. Emphasis is placed on materials and procedures of current interest in biochemistry. Consent of department required.

**BIOS 483 Special Topics in Behavioral Neuroscience 3 Credits**

Examination of the biological substrates of behavior. Topics may include animal communication, sociobiology, behavioral endocrinology, or behavior genetics.

**Repeat Status:** Course may be repeated.

**BIOS 488 Seminar in Neuroscience, Behavior, and Evolution 1 Credit**

Advanced seminar in current research developments. May be taken more than once for credit.

**BIOS 490 Thesis 1-6 Credit**

**Repeat Status:** Course may be repeated.

**BIOS 499 Dissertation 1-15 Credit****Biology**

Biology, life science, and related courses at Lehigh University are offered in a variety of settings that reflect the various levels of organization in life science and different orientations relating to areas of application. The College of Arts and Sciences offers degree programs in Behavioral Neuroscience, Biochemistry, Biology, Earth and Environmental Science, and Molecular Biology. The P. C. Rossin College of Engineering and Applied Science offers a degree program in Bioengineering. Refer to the catalog entries below for complete descriptions.

Major and Minor Programs	Catalog Entry
Behavioral Neuroscience (BA or BS)	Biological Sciences
Biochemistry	Biochemistry (BS only)
Bioengineering (BS only)	Bioengineering

Biology (BA or BS)	Biological Sciences
Earth and Environmental Science	Earth and Environmental Sciences
Molecular Biology (BA or BS)	Biological Sciences

Courses related to life science interest can be found under the catalog entries above as well as in other departments, including Chemical Engineering, Chemistry, Mathematics, Physics, Psychology, and Sociology and Anthropology

**Professors.** Michael J. Behe, PhD (University of Pennsylvania); Lynne U. Cassimeris, PhD (University of North Carolina); David L. Cundall, PhD (University of Arkansas); Murray Itzkowitz, PhD (University of Maryland); Linda J. Lowe-Krentz, PhD (Northwestern University); John G. Nyby, PhD (University Texas Austin); Jeffrey A. Sands, PhD (The Pennsylvania State University); Jill E. Schneider, PhD (Wesleyan University); Neal G. Simon, PhD (Rutgers University); Robert V. Skibbens, PhD (University of North Carolina Chapel Hill); Jennifer Swann, PhD (Northwestern University); Vassie C. Ware, PhD (Yale University)

**Associate Professors.** R. Michael Burger, PhD (University Texas Austin); Matthias Maria Falk, PhD (Ruprecht Karl University of Heidelberg); Mary Kathryn Iovine, PhD (Washington University); Michael R. Kuchka, PhD (Carnegie Mellon University)

**Assistant Professors.** Julie Haas, PhD (Boston University); Gregory I. Lang, PhD (Harvard University); Julie M. Miwa, PhD (Rockefeller University); Amber M. Rice, PhD (University of North Carolina)

**Emeriti.** John H. Abel, Jr., SCD (Brown University); Steven Krawiec, PhD (Yale University)

**Chemistry**

Chemistry is a versatile subject area and the pursuit of a career in chemistry can be a most intellectually satisfying experience. No other basic science touches and shapes as many aspects of modern society as does chemistry. The study of chemistry has provided solutions to complex problems and has improved the quality of all phases of human life from soft contact lenses and synthetic blood to longer-lasting paint and alternative fuels. A particular strength of this department is in surface and interface chemistry, which bridges many areas of modern science and technology.

Chemists at all levels of education find a market for their skills and knowledge in many employment areas. Chemists provide the technical backbone for the manufacturing industries (pharmaceuticals, plastics, paper, semiconductor electronics technology, and agriculture), for service industries (clinical and forensic laboratories, academe, environmental protection, and information science) and for governmental positions in regulatory agencies and in science policy analyses. Many chemists are employed in nontraditional areas, such as patent law, insurance underwriting, sales, product management, journalism, and even banking.

The alluring challenge of chemistry inspires many bachelor degree recipients to study for advanced degrees within the discipline of chemistry and in other areas, as well. Chemistry or biochemistry is the strongest preparation for graduate studies or for professional school in the health-related disciplines (medicine, pharmacology, and biochemistry), and for other science programs (materials science, polymers, biotechnology, environmental studies, and mineralogy).

The study of chemistry opens doors to satisfying careers, to a stimulating view of the world, and to a professional life in which one's natural tendency to ask "Why?" can lead to personally rewarding endeavors. The undergraduate curriculum in chemistry contains many of the prerequisites for biology, earth and environmental sciences, materials science, molecular biology, physics, and chemical engineering. This allows students to transfer credits among these majors through the sophomore year.

Chemistry students have the opportunity to design their undergraduate curricula for specialization in a variety of fields through the ChemFlex curriculum.

### The ChemFlex Curriculum

The Department of Chemistry offers degrees in both the College of Arts and Sciences and the College of Engineering and Applied Sciences. Students in the College of Arts and Sciences have three options: the B. S. in Chemistry, the B. A. in Chemistry, and the B. S. in Pharmaceutical Chemistry. In addition we offer an interdepartmental B. S. in Biochemistry in collaboration with the Department of Biological Sciences. For students in the College of Engineering and Applied Sciences we offer the B. S. in Chemistry.

In the College of Arts and Sciences, the traditional degree certified by the American Chemical Society is offered; the B. S. degree in the College of Engineering is very similar to the certified degree. All B. S. programs have a Common Chemistry Core and similar collateral science requirements. These programs are pre-professional in nature, and students planning to attend graduate school in chemistry or an allied science should elect the B. S. program in the college to which they have been admitted. The traditional B. A. Program in the College of Arts and Sciences is not a pre-professional program and may be elected by students who do not plan to do graduate work in chemistry or allied sciences but who desire a stronger background in chemistry than is provided by a chemistry minor.

In addition to the traditional certified B. S. degree and B. A. degree, the B. A. and B. S. Chemistry programs in the College of Arts and Sciences feature an alternative flexible curriculum, called ChemFlex, which enables a student to concentrate in a specific area. The concentrations possible for the B. S. are Physical/Analytical, Polymers, and Materials. The B. A. has two areas of concentration: Business and the Health Professions. All concentrations in ChemFlex share a Common Chemistry Core; all students complete the core and then follow one of two paths (Path A or Path B) as outlined in the following lists.

Students may transfer from a B. S. program to a B. A. program easily, but the reverse is more difficult. Students in a B. A. program who make the decision to attend graduate school in chemistry or allied sciences can achieve a minimum preparation for this transition by electing 307 Advanced Inorganic Chemistry.

### Department Modern Language and Literature Requirement

The modern foreign language requirement is met by one of three options:

1. Completion of the second semester of a modern foreign language;
2. Certification of language equivalent to this level taken in high school;
3. Substitution of six credits of science electives. If science electives are chosen, the non-science distribution requirement must still be met.

**Professors.** Gregory S Ferguson, PhD (Cornell University); Robert A. Flowers, II, PhD (Lehigh University); Ned D. Heindel, PhD (University of Delaware); Steven L. Regen, PhD (Massachusetts Institute of Technology); Keith J. Schray, PhD (The Pennsylvania State University); David A. Vivic, PhD (University of Rochester)

**Associate Professors.** Kerney Jebrell Glover, PhD (University of California San Diego); Kai Manfred Martin Landskron, PhD (University of Munich); James E. Roberts, PhD (Northwestern University); Dmitri V. Vezenov, PhD (Harvard University)

**Assistant Professors.** Heather Jaeger, PhD (University Georgia Athens); David T. Moore, PhD (University of North Carolina Chapel Hill); Marcos Pires, PhD (Purdue University); Damien Thevenin, PhD (University of Delaware)

**Professors Of Practice.** Andy W. Ho, PhD (Harvard University); Rebecca S. Miller, PhD (Duke University); Raymond Sam Niedbala, PhD (Lehigh University)

**Emeriti.** Jack A. Alhadeff, PhD (Oregon Health Science University); Natalie M Foster, PhD (Lehigh University); Kamil Klier, PhD (Acad Sciences Czech Republic); John W. Larsen, PhD (Purdue University Calumet); Joseph R. Merkel, PhD (University of Maryland College Park); Fortunato J. Micale, PhD (Lehigh University); Gary W. Simmons, PhD (University of Virginia); Robert S. Sprague, PhD (University of Illinois Urbana); James E. Sturm, PhD (University of Notre Dame); Daniel Zeroka, PhD (University of Pennsylvania)

### Degrees in the College of Arts and Sciences

In the College of Arts and Sciences the Chemistry Department offers three degrees: a B.S. in Chemistry, a B.A. in Chemistry and a B.S. in Pharmaceutical Chemistry with an interdepartmental B.S. Biochemistry degree with the Department of Biological Sciences. The ChemFlex Curriculum allows the flexibility for a student to develop a concentration in a specific area if he/she wishes to do so. The specific concentrations are noted in the following Table.

#### Table: ChemFlex Curriculum Overview Specialization Requirements

B.S. Chemistry (ACS) <sup>1,2,3</sup>
B.S. Chemistry Analytical/Physical <sup>1,2,3</sup>
B.S. Chemistry Polymers <sup>1,2,3</sup>
B.S. Chemistry Materials <sup>1,2,3</sup>
B.A. Chemistry <sup>1,3 or 2,4</sup>
B.A. Chemistry Business <sup>1,3 or 2,4</sup>
B.A. Chemistry Health Professions <sup>1,3 or 2,4</sup>
B.S. Pharmaceutical Chemistry <sup>1,3 or 2,4</sup>
B.S. Biochemistry (interdepartmental degree) <sup>1,3 or 2,4</sup>

- 1 Common Chemistry Core
- 2 Courses required for specific concentration
- 3 Path A (see below)
- 4 Path B (see below)

With regard to the B.S. in Pharmaceutical Chemistry, the pharmaceutical industry is focused on exploring the biochemistry of disease and designing or finding drugs to cure or ameliorate disease. Biochemists, organic chemists, biologists, and chemical engineers collaborate to achieve this end. The majority of chemists hired today go into the pharmaceutical industry. The B.S. in Pharmaceutical Chemistry is a chemistry degree option which focuses on core chemistry, biochemistry, and molecular biology to prepare students for careers in this field. Since it is a highly interdisciplinary field it requires the breadth of knowledge offered by this degree program.

### Freshman chemistry courses

The freshman courses CHM 030 and CHM 040 have similar course content. If both courses are taken, only credit for CHM 040, the more advanced course, will be awarded.

### Common Chemistry Core

Select one of the following:

CHM 040 & CHM 041	Concepts, Models and Experiments I and Concepts, Models and Experiments II	8
or		
CHM 030 & CHM 031	Introduction to Chemical Principles and Chemical Equilibria in Aqueous Systems	
CHM 110 & CHM 111	Organic Chemistry I and Organic Chemistry Laboratory I	4
CHM 112 & CHM 113	Organic Chemistry II and Organic Chemistry Laboratory II	4
CHM 332	Analytical Chemistry	3
Concentrations (see below)		3-8

CHM 201	Technical Writing <sup>1</sup>	2
CHM 301	Chemistry Seminar <sup>2</sup>	1
CHM 307	Advanced Inorganic Chemistry	3
Total Credits		28-33

<sup>1</sup> Other writing intensive courses may be substituted with the approval of the advisor but any substitute course should have a science focus.

<sup>2</sup> CHM 301 may be substituted by any course having a major presentation component with the approval of the major advisor.

#### Collateral requirements

##### Path A

MATH 021	Calculus I	4
MATH 022	Calculus II	4
MATH 023	Calculus III	4
MATH 205	Linear Methods	3
PHY 011 & PHY 012	Introductory Physics I and Introductory Physics Laboratory I	5
PHY 021 & PHY 022	Introductory Physics II and Introductory Physics Laboratory II	5
ENGR 010	Applied Engineering Computer Methods	2
or CSE 002	Fundamentals of Programming	
Total Credits		27

##### Path B

MATH 051	Survey of Calculus I	4
MATH 052	Survey of Calculus II	3
MATH 043	Survey of Linear Algebra	3
PHY 010 & PHY 012	General Physics I and Introductory Physics Laboratory I	5
PHY 013 & PHY 022	General Physics II and Introductory Physics Laboratory II	4
Total Credits		19

#### Specializations

##### B.S. Chemistry (ACS certified Degree)

###### Common Core

Select one of the following: 8

CHM 040 & CHM 041	Concepts, Models and Experiments I and Concepts, Models and Experiments II	8
CHM 030 & CHM 031	Introduction to Chemical Principles and Chemical Equilibria in Aqueous Systems	
CHM 110 & CHM 111	Organic Chemistry I and Organic Chemistry Laboratory I	4
CHM 112 & CHM 113	Organic Chemistry II and Organic Chemistry Laboratory II	4
CHM 332	Analytical Chemistry	3
See Concentrations - Physical chemistry		3-8
CHM 201	Technical Writing <sup>1</sup>	2
CHM 301	Chemistry Seminar <sup>2</sup>	1
CHM 307	Advanced Inorganic Chemistry	3

###### Collateral Requirement - Path A

MATH 021	Calculus I	4
MATH 022	Calculus II	4
MATH 023	Calculus III	4
MATH 205	Linear Methods	3
PHY 011 & PHY 012	Introductory Physics I and Introductory Physics Laboratory I	5

PHY 021 & PHY 022	Introductory Physics II and Introductory Physics Laboratory II	5
ENGR 010	Applied Engineering Computer Methods	2
or CSE 002	Fundamentals of Programming	

###### Specialization Courses

CHM 334	Advanced Chemistry Laboratory I	3
CHM 335	Advanced Chemistry Laboratory II	3
CHM 341	Molecular Structure, Bonding and Dynamics	3
CHM 342	Thermodynamics & Kinetics	3
CHM 343	Physical Chemistry Laboratory	2
CHM 371	Elements of Biochemistry I	1-3

###### Advanced Chemistry Elective Requirement

Select one of the following: 3

CHM 358	Advanced Organic Chemistry	
CHM 372	Elements of Biochemistry II	
CHM 376	Advanced Research Chemistry Laboratory	
CHM 391	Colloid and Surface Chemistry	
CHE 392	Introduction to Polymer Science	
CHM 393	Physical Polymer Science	
CHM 394	Organic Polymer Science I	
PHY 363	Physics of Solids	
Total Credits		73-80

<sup>1</sup> Other writing intensive courses may be substituted with the approval of the advisor but any substitute course should have a science focus.

<sup>2</sup> CHM 301 may be substituted by any course having a major presentation component with the approval of the major advisor.

##### B.S. Chemistry - Analytical/Physical Concentration

###### Common Core

Select one of the following: 8

CHM 040 & CHM 041	Concepts, Models and Experiments I and Concepts, Models and Experiments II	8
CHM 030 & CHM 031	Introduction to Chemical Principles and Chemical Equilibria in Aqueous Systems	
CHM 110 & CHM 111	Organic Chemistry I and Organic Chemistry Laboratory I	4
CHM 112 & CHM 113	Organic Chemistry II and Organic Chemistry Laboratory II	4
CHM 332	Analytical Chemistry	3
See Concentrations - Physical chemistry		3-8
CHM 201	Technical Writing <sup>1</sup>	2
CHM 301	Chemistry Seminar <sup>2</sup>	1
CHM 307	Advanced Inorganic Chemistry	3

###### Collateral Requirement - Path A

MATH 021	Calculus I	4
MATH 022	Calculus II	4
MATH 023	Calculus III	4
MATH 205	Linear Methods	3
PHY 011 & PHY 012	Introductory Physics I and Introductory Physics Laboratory I	5
PHY 021 & PHY 022	Introductory Physics II and Introductory Physics Laboratory II	5
ENGR 010	Applied Engineering Computer Methods	2
or CSE 002	Fundamentals of Programming	

###### Specialization Courses

CHM 334	Advanced Chemistry Laboratory I	3
CHM 335	Advanced Chemistry Laboratory II	3
CHM 341	Molecular Structure, Bonding and Dynamics	3
CHM 342	Thermodynamics & Kinetics	3
CHM 343	Physical Chemistry Laboratory	2
<b>Total Credits</b>		<b>69-74</b>

<sup>1</sup> Other writing intensive courses may be substituted with the approval of the advisor but any substitute course should have a science focus.

<sup>2</sup> CHM 301 may be substituted by any course having a major presentation component with the approval of the major advisor.

### B.S. Chemistry - Polymers Concentration

#### Common Core

Select one of the following: 8

CHM 040 & CHM 041	Concepts, Models and Experiments I and Concepts, Models and Experiments II	8
CHM 030 & CHM 031	Introduction to Chemical Principles and Chemical Equilibria in Aqueous Systems	
CHM 110 & CHM 111	Organic Chemistry I and Organic Chemistry Laboratory I	4
CHM 112 & CHM 113	Organic Chemistry II and Organic Chemistry Laboratory II	4
CHM 332	Analytical Chemistry	3
See Concentrations - Physical chemistry		3-8
CHM 201	Technical Writing <sup>1</sup>	2
CHM 301	Chemistry Seminar <sup>2</sup>	1
CHM 307	Advanced Inorganic Chemistry	3

#### Collateral Requirement - Path A

MATH 021	Calculus I	4
MATH 022	Calculus II	4
MATH 023	Calculus III	4
MATH 205	Linear Methods	3
PHY 011 & PHY 012	Introductory Physics I and Introductory Physics Laboratory I	5
PHY 021 & PHY 022	Introductory Physics II and Introductory Physics Laboratory II	5
ENGR 010	Applied Engineering Computer Methods	2
or CSE 002	Fundamentals of Programming	

#### Specialization Courses

CHM 341	Molecular Structure, Bonding and Dynamics	3
CHM 342	Thermodynamics & Kinetics	3
CHM 343	Physical Chemistry Laboratory	2
CHM 388	Polymer Synthesis and Characterization Laboratory	3
CHM 393	Physical Polymer Science	3
CHM 393	Physical Polymer Science	3
CHM 394	Organic Polymer Science I	3
<b>Total Credits</b>		<b>75-80</b>

<sup>1</sup> Other writing intensive courses may be substituted with the approval of the advisor but any substitute course should have a science focus.

<sup>2</sup> CHM 301 may be substituted by any course having a major presentation component with the approval of the major advisor.

### B.S. Chemistry - Materials Concentration

#### Common Core

Select one of the following: 8

CHM 040 & CHM 041	Concepts, Models and Experiments I and Concepts, Models and Experiments II	8
CHM 030 & CHM 031	Introduction to Chemical Principles and Chemical Equilibria in Aqueous Systems	
CHM 110 & CHM 111	Organic Chemistry I and Organic Chemistry Laboratory I	4
CHM 112 & CHM 113	Organic Chemistry II and Organic Chemistry Laboratory II	4
CHM 332	Analytical Chemistry	3
See Concentrations - Physical chemistry		3-8
CHM 201	Technical Writing <sup>1</sup>	2
CHM 301	Chemistry Seminar <sup>2</sup>	1
CHM 307	Advanced Inorganic Chemistry	3

#### Collateral Requirement - Path A

MATH 021	Calculus I	4
MATH 022	Calculus II	4
MATH 023	Calculus III	4
MATH 205	Linear Methods	3
PHY 011 & PHY 012	Introductory Physics I and Introductory Physics Laboratory I	5
PHY 021 & PHY 022	Introductory Physics II and Introductory Physics Laboratory II	5
ENGR 010	Applied Engineering Computer Methods	2
or CSE 002	Fundamentals of Programming	

#### Specialization Courses

CHM 334	Advanced Chemistry Laboratory I	3
CHM 335	Advanced Chemistry Laboratory II	3
CHM 341	Molecular Structure, Bonding and Dynamics	3
CHM 342	Thermodynamics & Kinetics	3
CHM 343	Physical Chemistry Laboratory	2
MAT 033	Engineering Materials and Processes	3
<b>Total Credits</b>		<b>72-77</b>

<sup>1</sup> Other writing intensive courses may be substituted with the approval of the advisor but any substitute course should have a science focus.

<sup>2</sup> CHM 301 may be substituted by any course having a major presentation component with the approval of the major advisor.

### B.A. Chemistry

#### Common Core

Select one of the following: 8

CHM 040 & CHM 041	Concepts, Models and Experiments I and Concepts, Models and Experiments II	8
CHM 030 & CHM 031	Introduction to Chemical Principles and Chemical Equilibria in Aqueous Systems	4
CHM 110 & CHM 111	Organic Chemistry I and Organic Chemistry Laboratory I	4
CHM 112 & CHM 113	Organic Chemistry II and Organic Chemistry Laboratory II	4
CHM 332	Analytical Chemistry	3
See Concentrations - Physical chemistry		3-8
CHM 201	Technical Writing <sup>1</sup>	2
CHM 301	Chemistry Seminar <sup>2</sup>	1
CHM 307	Advanced Inorganic Chemistry	3

<b>Collateral Requirement</b>		
Select one of the following:		19-28
<b>Path A</b>		
MATH 021	Calculus I	
MATH 022	Calculus II	
MATH 023	Calculus III	
MATH 205	Linear Methods	
PHY 011 & PHY 012	Introductory Physics I and Introductory Physics Laboratory I	
PHY 021 & PHY 022	Introductory Physics II and Introductory Physics Laboratory II	
ENGR 010	Applied Engineering Computer Methods	2
or CSE 002	Fundamentals of Programming	
<b>Path B</b>		
MATH 051	Survey of Calculus I	
MATH 052	Survey of Calculus II	
MATH 043	Survey of Linear Algebra	
PHY 010 & PHY 012	General Physics I and Introductory Physics Laboratory I	
PHY 013 & PHY 022	General Physics II and Introductory Physics Laboratory II	
<b>Specialization Courses</b>		
Select one of the following:		3
CHM 341	Molecular Structure, Bonding and Dynamics	
CHM 342	Thermodynamics & Kinetics	
CHM 194	Physical Chemistry for Biological Sciences	
CHM 343	Physical Chemistry Laboratory	2
CHM elective		3
<b>Total Credits</b>		<b>65-79</b>

1 Other writing intensive courses may be substituted with the approval of the advisor but any substitute course should have a science focus.

2 CHM 301 may be substituted by any course having a major presentation component with the approval of the major advisor.

### B.A. Chemistry - Business Concentration

<b>Common Core</b>		
Select one of the following:		8
CHM 040 & CHM 041	Concepts, Models and Experiments I and Concepts, Models and Experiments II	4
CHM 030 & CHM 031	Introduction to Chemical Principles and Chemical Equilibria in Aqueous Systems	4
CHM 110 & CHM 111	Organic Chemistry I and Organic Chemistry Laboratory I	4
CHM 112 & CHM 113	Organic Chemistry II and Organic Chemistry Laboratory II	4
CHM 332	Analytical Chemistry	3
See Concentrations - Physical chemistry		3-8
CHM 201	Technical Writing <sup>1</sup>	2
CHM 301	Chemistry Seminar <sup>2</sup>	1
CHM 307	Advanced Inorganic Chemistry	3

### Collateral Requirement

Select one of the following:		19-28
<b>Path A</b>		
MATH 021	Calculus I	
MATH 022	Calculus II	
MATH 023	Calculus III	

MATH 205	Linear Methods	
PHY 011 & PHY 012	Introductory Physics I and Introductory Physics Laboratory I	
PHY 021 & PHY 022	Introductory Physics II and Introductory Physics Laboratory II	
ENGR 010	Applied Engineering Computer Methods	
or CSE 002	Fundamentals of Programming	
<b>Path B</b>		
MATH 051	Survey of Calculus I	
MATH 052	Survey of Calculus II	
MATH 043	Survey of Linear Algebra	
PHY 010 & PHY 011	General Physics I and Introductory Physics I	
PHY 013 & PHY 022	General Physics II and Introductory Physics Laboratory II	
<b>Specialization Courses</b>		
CHM elective		3
Select one of the following:		3
CHM 341	Molecular Structure, Bonding and Dynamics	
CHM 342	Thermodynamics & Kinetics	
CHM 194	Physical Chemistry for Biological Sciences	
CHM 343	Physical Chemistry Laboratory	2
ECO 001	Principles of Economics	4
BUS 125	Behavioral Skills Workshop	1
BUS 126	Information Analysis and Financial Decision Making I	3
BUS 127	Information Analysis and Financial Decision Making II	3
BUS 225	Developing, Producing, and Marketing Products and Services I	3
BUS 226	Developing, Producing, and Marketing Products and Services II	3
BUS 326	Business Strategy	1
MATH 012	Basic Statistics <sup>3</sup>	4
<b>Total Credits</b>		<b>85-99</b>

1 Other writing intensive courses may be substituted with the approval of the advisor but any substitute course should have a science focus.

2 CHM 301 may be substituted by any course having a major presentation component with the approval of the major advisor.

3 MATH 012 may be substituted by any statistics course.

### B.A. Chemistry - Health Professions Concentration

<b>Common Core</b>		
Select one of the following:		8
CHM 040 & CHM 041	Concepts, Models and Experiments I and Concepts, Models and Experiments II	4
CHM 030 & CHM 031	Introduction to Chemical Principles and Chemical Equilibria in Aqueous Systems	4
CHM 110 & CHM 111	Organic Chemistry I and Organic Chemistry Laboratory I	4
CHM 112 & CHM 113	Organic Chemistry II and Organic Chemistry Laboratory II	4
CHM 332	Analytical Chemistry	3
See Concentrations - Physical chemistry		3-8
CHM 201	Technical Writing <sup>1</sup>	2
CHM 301	Chemistry Seminar <sup>2</sup>	1
CHM 307	Advanced Inorganic Chemistry	3



**Collateral Requirement**

Select one of the following: 19-28

**Path A**

MATH 021	Calculus I
MATH 022	Calculus II
MATH 023	Calculus III
MATH 205	Linear Methods
PHY 011 & PHY 012	Introductory Physics I and Introductory Physics Laboratory I
PHY 021 & PHY 022	Introductory Physics II and Introductory Physics Laboratory II
ENGR 010	Applied Engineering Computer Methods
or CSE 002	Fundamentals of Programming

**Path B**

MATH 051	Survey of Calculus I
MATH 052	Survey of Calculus II
MATH 043	Survey of Linear Algebra
PHY 010 & PHY 012	General Physics I and Introductory Physics Laboratory I
PHY 013 & PHY 022	General Physics II and Introductory Physics Laboratory II

**Specialization Courses**

CHM elective 3

Select one of the following: 3

CHM 341	Molecular Structure, Bonding and Dynamics	
CHM 342	Thermodynamics & Kinetics	
CHM 194	Physical Chemistry for Biological Sciences	
CHM 343	Physical Chemistry Laboratory	2
BIOS 115 & BIOS 116	Biology Core II: Genetics and Biology Core II: Genetics Laboratory	4
BIOS 041 & BIOS 042	Biology Core I: Cellular and Molecular and Biology Core I: Cellular and Molecular Lab	4
MATH 012	Basic Statistics <sup>3</sup>	4

Additional courses in BioS are recommended.

Total Credits 75-89

1 Other writing intensive courses may be substituted with the approval of the advisor but any substitute course should have a science focus.

2 CHM 301 may be substituted by any course having a major presentation component with the approval of the major advisor.

3 MATH 012 may be substituted by any statistics course.

**B.S. Pharmaceutical Chemistry****Common Core**

Select one of the following: 8

CHM 040 & CHM 041	Concepts, Models and Experiments I and Concepts, Models and Experiments II	4
CHM 030 & CHM 031	Introduction to Chemical Principles and Chemical Equilibria in Aqueous Systems	4
CHM 110 & CHM 111	Organic Chemistry I and Organic Chemistry Laboratory I	4
CHM 112 & CHM 113	Organic Chemistry II and Organic Chemistry Laboratory II	4
CHM 332	Analytical Chemistry	3
See Concentrations - Physical Chemistry		3-8
CHM 201	Technical Writing <sup>1</sup>	2

CHM 301 Chemistry Seminar <sup>2</sup> 1

CHM 307 Advanced Inorganic Chemistry 3

**Collateral Requirement**

Select one of the following: 19-28

**Path A**

MATH 021	Calculus I
MATH 022	Calculus II
MATH 023	Calculus III
MATH 205	Linear Methods
PHY 011 & PHY 012	Introductory Physics I and Introductory Physics Laboratory I
PHY 021 & PHY 022	Introductory Physics II and Introductory Physics Laboratory II
ENGR 010	Applied Engineering Computer Methods
or CSE 002	Fundamentals of Programming

**Path B**

MATH 051	Survey of Calculus I
MATH 052	Survey of Calculus II
MATH 043	Survey of Linear Algebra
PHY 010 & PHY 012	General Physics I and Introductory Physics Laboratory I
PHY 013 & PHY 022	General Physics II and Introductory Physics Laboratory II

**Specialization Courses**

Select one of the following: 3

CHM 194	Physical Chemistry for Biological Sciences	
CHM 341	Molecular Structure, Bonding and Dynamics	
CHM 342	Thermodynamics & Kinetics	
CHM 358	Advanced Organic Chemistry	3
CHM 371	Elements of Biochemistry I	1-3
CHM 372	Elements of Biochemistry II	3
Advanced CHM Electives		3
BIOS 041 & BIOS 042	Biology Core I: Cellular and Molecular and Biology Core I: Cellular and Molecular Lab	4
BIOS 115	Biology Core II: Genetics	3
MATH 012	Basic Statistics <sup>3</sup>	4

Total Credits 79-95

1 Other writing intensive courses may be substituted with the approval of the advisor but any substitute course should have a science focus.

2 CHM 301 may be substituted by any course having a major presentation component with the approval of the major advisor.

3 MATH 012 may be substituted by any statistics course.

**Model Roster When Path A is Followed**

First Year	CR
College Seminar	3-4
CHM 040	4
CHM 041	4
ENGL 001	3
ENGL 002	3
MATH 021	4
MATH 022	4
PHY 010 & PHY 012	5

**30-31**

<b>Second Year</b>		<b>CR</b>
CHM 110 & CHM 111	4	
CHM 112 & CHM 113	4	
PHY 021 & PHY 022	5	
MATH 023	4	
MATH 043	3	
ENGR 010 or CSE 012	2	
distribution requirements - free electives	9	
	<b>31</b>	

Total Credits: 61-62

Note that some concentrations would insert courses such as MATH 012, BIOS 041/BIOS 042 (B.S. Pharmaceutical Chemistry), ECO 001 (B.A.-Business), etc.

#### junior year/senior year (30-32 credits)

Student will need to meet with major advisor in order to formulate courses to be taken.

#### Model Roster When Path B is Followed

<b>First Year</b>		<b>CR</b>
College Seminar	3-4	
CHM 040	4	
CHM 041	4	
ENGL 001	3	
ENGL 002	3	
MATH 051	4	
MATH 052	3	
PHY 010 & PHY 012	5	
	<b>29-30</b>	
<b>Second Year</b>		<b>CR</b>
CHM 110 & CHM 111	4	
CHM 112 & CHM 113	4	
PHY 013 & PHY 022	4	
MATH 043	3	
distribution requirements - free electives	15	
	<b>30</b>	

Total Credits: 59-60

Note that some concentrations would insert courses such as MATH 012, BIOS 041/BIOS 042 (B.S. Pharmaceutical Chemistry), ECO 001 (B.A.-Business), etc.

#### junior year/senior year (30-32 credits)

Student will need to meet with major advisor in order to formulate courses to be taken.

#### B.S. Degree in Chemistry, College of Engineering & Applied Science Summary of Requirements

College distribution	24
Physics, math, and computing	28
Chemistry	46
Unrestricted electives	25
<b>Total Credits</b>	<b>123</b>

#### Model Roster

<b>First Year</b>		<b>CR</b>
<b>First Semester</b>	<b>CR Second Semester</b>	
ENGL 001	3 ENGL 002	3

MATH 021	4 MATH 022	4
ENGR 010	2 ENGR 005	2
Select one of the following:	4-5 Select one of the following:	4-5
CHM 030 <sup>1</sup>	4 CHM 030 <sup>1</sup>	4
PHY 011 & PHY 012 <sup>1</sup>	5 PHY 011 & PHY 012 <sup>1</sup>	5
	<b>22-23</b>	<b>22-23</b>

#### Second Year

<b>First Semester</b>	<b>CR Second Semester</b>	<b>CR</b>
CHM 110 & CHM 111	4 CHM 112 & CHM 113	4
PHY 021 & PHY 022	5 MATH 205	3
MATH 023	4 ECO 001	4
modern foreign language requirement (See details in introduction)	4 Humanities/Social Science requirement	4
	<b>17</b>	<b>15</b>

#### Third Year

<b>First Semester</b>	<b>CR Second Semester</b>	<b>CR</b>
Select one of the following:	2-3 CHM 307 & CHM 335	6
CHM 201	2 CHM 342 & CHM 343	5
Or approved writing-intensive course	3 modern foreign language requirement	4
CHM 332 & CHM 334	6 free electives	4
CHM 341	3	
Distribution requirement/ elective	4	
modern foreign language requirement (See details in introduction)	4	
	<b>24-25</b>	<b>19</b>

#### Fourth Year

<b>First Semester</b>	<b>CR Second Semester</b>	<b>CR</b>
CHM 301	1 Advanced chemistry elective	3
CHM 371	3 free electives	11
Advanced chemistry elective	3	
Distribution requirement	7	
	<b>14</b>	<b>14</b>

Total Credits: 147-150

- 1 Required natural science courses, one taken fall semester and the other taken in spring
- 2 Note: It is recommended that, where possible, students planning to major in chemistry take CHM 040 in the fall semester and CHM 041 in the spring semester of the freshman year. For such students the elective in the spring semester is displaced to a subsequent semester. The CHM 030/CHM 031 sequence may be substituted.
- 3 See list of choices for the advanced chemistry elective requirement under the B.S. degree in chemistry/College of Arts and Sciences.
- 4 This becomes a free elective if the advanced chemistry elective requirement was taken in the fall of the senior year.

#### Five-Year Bachelor's/Master's Programs

Five-year programs may be arranged for students to receive B.S. or B.A. degrees and the M.S. degrees in chemistry with a concentration in one of several fields of chemistry (inorganic, organic, analytical, physical, polymers, and biochemistry).

#### B.S. in Biochemistry

An interdepartmental B.S. in Biochemistry major is offered in the College of Arts and Sciences. Faculty in both Chemistry (Schray) and Biological Sciences (Lowe-Krentz and Iovine) serve as advisors depending on student interest. Majors should be declared in the Department of

Biological Sciences. Please see the section on Biochemistry (p. 80) for details of the major.

### Minor in Chemistry

A minor in chemistry may be achieved by completing the following requirements:

CHM 031	Chemical Equilibria in Aqueous Systems	4
or CHM 041	Concepts, Models and Experiments II	
CHM 110 & CHM 111	Organic Chemistry I and Organic Chemistry Laboratory I	4
CHM 332	Analytical Chemistry	3
CHM 341	Molecular Structure, Bonding and Dynamics	3
or CHM 342	Thermodynamics & Kinetics	
CHM 343	Physical Chemistry Laboratory	2
Total Credits		16

Necessary pre- or co-requisites for the above would be CHM 030 or CHM 040 and MATH 021.

Students who wish to minor in chemistry but whose major program requires any of the above courses may achieve the minor with substitutions approved by the department chair.

### Graduate Programs in Chemistry

The department of chemistry offers graduate studies leading to several advanced degrees. Master of science and doctor of philosophy degrees in chemistry may be obtained by study and research in any appropriate area of chemistry.

The following information on admissions, proficiency examinations and other policies applies to both the master of science and doctor of philosophy degrees in chemistry.

Admission to graduate study in chemistry assumes that a student has met, or is willing to meet through further study, minimum undergraduate requirements for a bachelor's degree in chemistry. This would include (beyond two semesters of introductory chemistry) two semesters of organic chemistry, two semesters of physical chemistry, two semesters of analytical chemistry and one semester of inorganic chemistry. A promising student whose degree is in a field related to chemistry (e.g., biology, chemical engineering) may be admitted to graduate study in chemistry provided that any deficiencies in basic chemistry preparation are made up in the first year of graduate study, noting that some of the courses required for this may not carry graduate credit.

The chemistry department administers proficiency examinations at the advanced undergraduate level in analytical, biochemistry, inorganic, organic and physical chemistry to all regular graduate students at the time of matriculation. Each student is required to take three examinations. Information regarding material to be covered on these examinations will be sent to each student several months in advance of matriculation. It is expected that each student will prepare diligently for these tests. A student who performs well on one or more of these tests has an opportunity to take advanced level and special topics courses at an earlier than normal time and may in fact begin graduate research during the first year. A Ph.D. candidate must show proficiency in three areas and an M.S. candidate in two areas within the first year in residence. A student who fails one or more of the proficiency examinations will meet with Professor Miller, faculty graduate administrator, to determine an appropriate course of action in light of the exam performance, projected major and degree aspiration. Two optional routes are available for demonstration of proficiency. (1) The student through self-study and auditing of appropriate courses may prepare for a retaking of a proficiency examination at the beginning of the second semester in residence. (2) Alternatively, the student may enroll in appropriate 400 level courses during the first year in residence. A grade of B- or better in an appropriate 400 level course will be considered equivalent to passing the proficiency examination in that area. Courses taken as a means of demonstrating proficiency will be acceptable for the M.S. or Ph.D. graduate program.

### Master of Science in Chemistry degree

The Master of Science in Chemistry degree requires a total of 30 credits.

Select one of the following options: 30

#### Option A

A minimum of 30 course credits

#### Option B

A minimum of 27 course credits

CHM 421	Chemistry Research (literature review paper)
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#### Option C

A minimum of 24 course credits

CHM 421	Chemistry Research (experimental research)
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Each option requires:

A minimum of 18 credits at the 400 level (15 of which must be in chemistry)

CHM 481	Chemistry Seminar (one credit)
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Total Credits 30

There are no other specifically required courses for the M.S. degree, allowing each student to design a curriculum that fits their needs and interests. Normally, work for the master's degree can be completed in 18 calendar months of full-time study.

### Doctor of Philosophy Degree

Completion of a doctor of philosophy degree program normally requires a minimum of four years fulltime work after entrance with a bachelor's degree. There are few specific course credit requirements for the Ph.D.; however, approved degree programs generally have at least 24 hours of course work (including any applied toward a master's degree) and 6 credits of research. Thus, the program consists of approximately one-third formal course work and two-thirds independent study and research. There is a two-credit seminar requirement (CHM 481). After Ph.D. proficiency has been established and the research advisor selected (this must be done by the end of the first year in residence), the major hurdles are the doctoral examination in the student's area of concentration. This exam must be passed by the end of 2 1/2 years of residence. If this hurdle is surmounted, the remaining time is spent completing (and ultimately defending) the dissertation research under the guidance of the research advisor and the dissertation committee.

Course Work <sup>1</sup>		16
CHM 421	Chemistry Research	6
CHM 481	Chemistry Seminar	2
Total Credits		24

<sup>1</sup> Including any applied toward a master's degree.

### Current Research Projects

Current research projects of interest are listed below.

#### Analytical Chemistry

NMR studies of organic solids and polymers; electrochemical reduction and oxidation mechanisms of organic compounds; development of novel immunoassays.

#### Biochemistry

Membrane protein interactions; structural characterization of membrane proteins; production of membrane proteins; biophysical characterization of membrane proteins; medicinal assay development; medical diagnostics; cryogenics; microfluids; biomaterials; multidrug resistance; drug delivery.

#### Inorganic Chemistry

Synthesis, characterization, and reactivity of transition metal complexes and nanoparticles; coordination chemistry and molecular self-assembly at metal surfaces; electrochemistry at metal and metal-oxide electrodes; synthesis and characterization of mesoporous solids from transition metal and main-group element precursors; applications of mesoporous solids for carbon sequestration; formation of multilayered thin films of

inorganic and organic-inorganic hybrid materials; and application of lanthanide catalysis in organic synthesis.

#### Materials and Polymer Chemistry

Inorganic and organometallic chemistry in the synthesis of thin-film materials; synthesis at and dynamics of polymer interfaces; acoustic, optical, permeability, dielectric and mechanical behavior of thin films; laser light scattering and small-angle X-ray scattering studies on polymer solutions; polyelectrolytes and ion-containing solutions; nanofabrications in polymer systems; organic-inorganic hybrid solid state materials; synthesis and characterization of novel mesoporous materials.

#### Organic Chemistry

Synthesis of medicinal agents, correlation of molecular structure with pharmacological behavior; chemical models for biochemical reactions; chemistry of monolayers and organized molecule assemblages; drug carriers; synthetic ion conductors; Langmuir-Blodgett films; organometallic reaction mechanisms; organofluorine chemistry; protein folding and renaturation; molecular recognition; calorimetry; electrochemical studies of electron transfer reactions.

#### Physical Chemistry

Chemistry at surfaces and interfaces of catalysts, alloys, electrodes, thin films, and biosensors using an array of surface sensitive methods; spectroscopic ellipsometry, scanning probe and electron microscopy, angle resolved X-ray photoelectron spectroscopy, electrochemistry; exploration of complex solution systems using light scattering techniques; physical chemistry of polymer solutions and colloidal suspensions; novel behavior of solutions and self-assembly of nanoscopic hydrophilic macro-ions and biomolecules; intermolecular interactions in soft matter; single-molecule force spectroscopy; chemical force microscopy; cryogenic spectroscopy; reaction mechanisms in catalysis by metal nanoclusters; theory including ab initio DFT calculations for molecular systems and interpretation of optical, IR, and Raman spectra.

#### Major Instrumentation

Chemistry research spans all areas: analytical, biochemistry, inorganic, organic, and physical. Special equipment available for graduate research in chemistry is as follows.

#### Research facilities

LC/MS/MS, GC-MS, MALDI-TOF-MS, HPLCs, GCs, ultracentrifuges, cold rooms, cell disintegrator, zone and disc electrophoresis apparatus, column chromatograph, autoclave, freezers (-80C), rotary vaporator, Milli-Q water purification system, shaking heated water baths, spectropolarimeter with circular dichroism capability. Cell culture facilities – complete with optical microscopes having fluorescent and photographic capabilities. Catalysis facility – fully automated high pressure reactors with on-line gas chromatographs. Electron optical facilities – transmission electron microscopy with x-ray fluorescence analysis capability, scanning electron microscope, and scanning electron microprobe. Gas chromatographs. Liquid chromatographs – high performance for analytical and preparative work. NMR spectrometers – 300 MHz for both solids and solutions, and 500 MHz for solutions. Photochemistry equipment – lamps and filters for selected wavelength work. Polarographs, chronopotentiometers, electrophoresis apparatus, electrochemical impedance, electrochemical scanning tunneling microscope, potentiostats, and rotating disk electrode. Portable data interface (8-channel 50 KHz), digital readout polarimeter, Vibron elastoviscometers, differential refractometer.

#### Spectrometers

UV/visible double beam automated, fluorescence, UV/visible/near IR, Fourier transform IR with diffuse reflectance, photoacoustic and attenuated reflectance capability, and GC mass spectrometers. Surface analysis facilities – rotating anode high-sensitivity high-energy resolution ESCA with imaging capability (ESCA is equipped with automated angular data acquisition). Surface science facility – Low energy electron diffraction (LEED), photocalorimetry for submicron particle analysis. Ellipsometer, contact angle capabilities, gas adsorption apparatus (BET), atomic force microscope, instructional scanning tunneling microscope, and light scanning. Microcalorimeter (flowing with UV and refractive index detectors), differential scanning calorimeter (DSC).

#### Courses

##### CHM 030 Introduction to Chemical Principles 4 Credits

An introduction to important topics in chemistry: atomic structure, properties of matter, chemical reactions, energy, structure and bonding in organic and inorganic compounds, chemical equilibrium. The course features a lecture tightly linked to a three-hour studio experience that combines laboratory work and recitation.

**Attribute/Distribution:** NS

##### CHM 031 Chemical Equilibria in Aqueous Systems 4 Credits

A study of the theoretical basis and practical applications of equilibria in aqueous solutions, including acid-base, precipitation-solubility, metal-ligand, oxidation-reduction and distribution equilibria. Introduction to chemical thermodynamics, spectrophotometry, potentiometry and chromatography. The laboratory work emphasizes the qualitative and quantitative analysis of equilibria in aqueous media. Three lectures and one three-hour laboratory period. Prerequisites as noted below.

**Prerequisites:** (CHM 030 or CHM 075 or CHM 040) and (MATH 021 or MATH 031 or MATH 051 or MATH 076 or MATH 097)

**Can be taken Concurrently:** MATH 021, MATH 031, MATH 051, MATH 076, MATH 097

**Attribute/Distribution:** NS

##### CHM 040 Concepts, Models and Experiments I 4 Credits

A first-semester course in chemistry for students planning to major in chemistry, biochemistry, chemical engineering, materials science, or other chemistry-related fields. Chemical and physical properties, structures, bonding concepts, and quantitative analysis. Laboratory includes synthesis, separation and analysis procedures; computer applications to chemistry. Three lectures, one laboratory.

**Attribute/Distribution:** NS

##### CHM 041 Concepts, Models and Experiments II 4 Credits

Continuation of Chemistry 40. Three lectures, one laboratory. Prerequisites as noted below or consent of department.

**Prerequisites:** (CHM 040 or CHM 030 or CHM 075) and (MATH 021 or MATH 031 or MATH 051)

**Attribute/Distribution:** NS

##### CHM 110 Organic Chemistry I 3 Credits

Systematic survey of the typical compounds of carbon, their classification, and general relations; study of synthetic reactions. Prerequisites as noted below.

**Prerequisites:** CHM 030 or CHM 040

**Attribute/Distribution:** NS

##### CHM 111 Organic Chemistry Laboratory I 1 Credit

Preparation of pure organic compounds. Modern techniques of characterization. Prerequisites as noted below.

**Prerequisites:** CHM 110

**Can be taken Concurrently:** CHM 110

**Attribute/Distribution:** NS

##### CHM 112 Organic Chemistry II 3 Credits

Continuation of CHM 110. Prerequisites as noted below.

**Prerequisites:** CHM 110

**Attribute/Distribution:** NS

##### CHM 113 Organic Chemistry Laboratory II 1 Credit

Continuation of Organic Chemistry Laboratory I. Prerequisites as noted below.

**Prerequisites:** CHM 111 and CHM 112

**Can be taken Concurrently:** CHM 111, CHM 112

**Attribute/Distribution:** NS

##### CHM 177 Introduction to Research 1-2 Credit

For advanced freshmen and sophomore chemistry majors. May be repeated for credit. Consent of department chair required.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** NS

**CHM 194 Physical Chemistry for Biological Sciences 3 Credits**

The principles and applications of physical chemical concepts to systems of biological interest, including the gas laws, thermodynamics of metabolic reactions, colligative properties, electrochemical equilibria, reaction kinetics and enzyme catalysis, and transport of macromolecules and viruses. Prerequisites as noted below.

**Prerequisites:** CHM 075 or CHM 030 or CHM 040 or CHM 025 and (CHM 031 or CHM 041 or CHM 076)

**Attribute/Distribution:** NS

**CHM 201 Technical Writing 2 Credits**

Principal types of written communications used by professional chemists including informative abstracts, research proposals, progress reports, executive summaries for nonchemist decision makers and proper written experimental procedures, tables, schemes and figures. Must have junior standing in chemistry major or consent of the department chair.

**Attribute/Distribution:** ND

**CHM 250 Special Topics 1-4 Credit**

Selected topics in chemistry. May be repeated for credit when different topics are offered.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** NS

**CHM 300 Apprentice Teaching 3 Credits**

**Repeat Status:** Course may be repeated.

**CHM 301 Chemistry Seminar 1 Credit**

A course designed for seniors will involve the literature research of a topic of the student's choosing followed by a 35 minute oral presentation to the class and professor. Must have senior standing.

**CHM 307 Advanced Inorganic Chemistry 3 Credits**

Introduction to transition metal complexes; theories of bonding; kinetics and mechanisms of transition metal complex reactions; selected aspects of organometallic chemistry; bioinorganic chemistry. Prerequisites as noted below.

**Prerequisites:** CHM 341 or CHM 194

**Attribute/Distribution:** NS

**CHM 332 Analytical Chemistry 3 Credits**

Theory and practice of chemical analysis. Principles of quantitative separations and determinations; theory and application of selected optical and electrical instruments in analytical chemistry; interpretation of numerical data, design of experiments, solute distribution in separation methods. Prerequisites as noted below.

**Prerequisites:** (CHM 031 or CHM 041) and (CHM 051 or CHM 110)

**Attribute/Distribution:** NS

**CHM 334 Advanced Chemistry Laboratory I 3 Credits**

Exploration of synthetic methods and analysis techniques for inorganic and organic compounds. Determination of product structures and quantitative analysis using modern chemical analysis techniques, including NMR, GC-MS, GC, HPLC, FT-IR, and XPS. Prerequisites as noted below.

**Prerequisites:** (CHM 110 and CHM 111 and CHM 112 and CHM 113 and CHM 332)

**Can be taken Concurrently:** CHM 332

**Attribute/Distribution:** NS

**CHM 335 Advanced Chemistry Laboratory II 3 Credits**

Content related to CHM 334. Prerequisites as noted below.

**Prerequisites:** (CHM 334)

**CHM 336 Clinical Chemistry 3 Credits**

Applications of analytical chemistry to clinical problems. Discussion of methods in common use and the biochemical/medical significance of the results. Prerequisites as noted below.

**Prerequisites:** CHM 332 or CHM 112

**Attribute/Distribution:** NS

**CHM 337 Crystallography and Diffraction 3 Credits**

Introduction to crystal symmetry, point groups, and space groups. Emphasis on materials characterization by X-ray diffraction and electron diffraction. Specific topics include crystallographic notation, stereographic projections, orientation of single crystals, textures, phase identification, quantitative analysis, stress measurement, electron diffraction, ring and spot patterns, convergent beam electron diffraction (CBED), and space group determination. Applications in mineralogy, metallurgy, ceramics, microelectronics, polymers, and catalysts. Lectures and laboratory work. Prerequisites may be waived if student has senior standing in chemistry. Prerequisites as noted below.

**Prerequisites:** MAT 203 or EES 131

**Attribute/Distribution:** NS

**CHM 341 Molecular Structure, Bonding and Dynamics 3 Credits**

Nature of chemical bonding as related to structure and properties of molecules and extended systems. Quantum chemistry of atoms and molecules applied to chemical transformations and spectroscopic transitions. Symmetry analysis and selection rules. Interpretation of electronic, vibrational and rotational spectra. Prerequisites as noted below.

**Prerequisites:** (MATH 022 or MATH 032) and (PHY 011 or PHY 013) and (CHM 031 or CHM 041)

**Attribute/Distribution:** NS

**CHM 342 Thermodynamics & Kinetics 3 Credits**

Development of the principles of classical and statistical thermodynamics and their application to chemical systems. In classical thermodynamics emphasis will be on systems in which composition is of major concern: solutions, chemical and phase equilibria. Kinetic theory of gases; chemical reaction kinetics; chemical reaction dynamics. Prerequisites as noted below.

**Prerequisites:** (CHM 031 or CHM 041) and (PHY 013 or PHY 021) and (MATH 022 or MATH 023)

**CHM 343 Physical Chemistry Laboratory 2 Credits**

Laboratory studies that illustrate and extend the various fields of study in experimental physical chemistry as discussed in CHM 341 and CHM 342. This course fulfills the junior year writing intensive course requirement in CAS. Prerequisites as noted below.

**Prerequisites:** (CHM 194 or CHE 210 or CHM 342) or (CHM 341 and CHM 342)

**Can be taken Concurrently:** CHM 342, CHM 342

**CHM 345 Thermodynamics and Kinetics 3 Credits**

Development of the principles of classical and statistical thermodynamics and their application to chemical systems. In classical thermodynamics emphasis will be on systems in which composition is of major concern: solutions, chemical and phase equilibria, and electrochemistry. Kinetic theory of gases; chemical reaction dynamics. Department permission required. This course is intended as a course for graduate students achieving their proficiency in physical chemistry and will consist of the lectures only of CHM 342.

**CHM 350 Special Topics 1-3 Credit**

Selected advanced topics in chemistry. May be repeated for credit when different topics are offered.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** NS

**CHM 358 Advanced Organic Chemistry 3 Credits**

Reaction mechanism types and supporting physical-chemical data. Classes of mechanisms include elimination, substitution, rearrangement, oxidation-reduction, enolate alkylations, and others. Must have completed one year of organic chemistry.

**Prerequisites:** CHM 052 or CHM 112

**Attribute/Distribution:** NS

**CHM 371 Elements of Biochemistry I 1-3 Credit**

A general study of carbohydrates, proteins, lipids, nucleic acids, and other biological substances and their importance in life processes. Protein and enzyme chemistry are emphasized. Must have completed one year of organic chemistry.

**Prerequisites:** CHM 112

**Attribute/Distribution:** NS

**CHM 372 Elements of Biochemistry II 3 Credits**

Dynamic aspects of biochemistry: enzyme reactions including energetics, kinetics and mechanisms, metabolism of carbohydrates, lipids, proteins and nucleic acids, photosynthesis, electron transport mechanisms, coupled reactions, phosphorylations, and the synthesis of biological macromolecules. Prerequisites as noted below or consent of instructor.

**Prerequisites:** (BIOS 371 or CHM 371 or CHM 371) and BIOS 041

**Attribute/Distribution:** NS

**CHM 375 Research Chemistry Laboratory 1-3 Credit**

An introduction to independent study or laboratory investigation under faculty guidance. Consent of instructor required.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** NS

**CHM 376 Advanced Research Chemistry Laboratory 1-6 Credit**

Advanced independent study or laboratory investigation under faculty guidance. Consent of faculty research supervisor.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** NS

**CHM 377 Biochemistry Laboratory 3 Credits**

Laboratory studies of the properties of chemicals of biological origin and the influence of chemical and physical factors on these properties. Laboratory techniques used for the isolation and identification of biochemicals. Prerequisites as noted below or consent of instructor.

**Prerequisites:** (BIOS 371 or CHM 371) and (BIOS 031 or BIOS 041)

**Can be taken Concurrently:** BIOS 371, CHM 371

**Attribute/Distribution:** NS

**CHM 378 Biochemical Preparations 1-3 Credit**

A laboratory course involving the preparation or isolation, purification and identification of chemicals of biological origin. Prerequisites as noted below.

**Prerequisites:** CHM 377 or CHM 372

**Can be taken Concurrently:** CHM 377, CHM 372

**Attribute/Distribution:** NS

**CHM 388 Polymer Synthesis and Characterization Laboratory 3 Credits**

Techniques include: free radical and condensation polymerization; molecular weight distribution by gel chromatography; crystallinity and order by differential scanning calorimetry; pyrolysis and gas chromatography; dynamic mechanical and dielectric behavior; morphology and microscopy; surface properties. Prerequisites as noted below.

**Prerequisites:** (CHM 341 or CHE 210 or CHM 342 and CHM 051 or CHM 110)

**Attribute/Distribution:** NS

**CHM 389 Honors Project 1-6 Credit**

**Repeat Status:** Course may be repeated.

**CHM 391 Colloid and Surface Chemistry 3 Credits**

Physical chemistry of everyday phenomena. Intermolecular forces and electrostatic phenomena at interfaces, boundary tensions and films at interfaces, mass and charge transport in colloidal suspensions, electrostatic and London forces in disperse systems, gas adsorption and heterogeneous catalysis. Prerequisites as noted below.

**Prerequisites:** CHM 342

**Attribute/Distribution:** NS

**CHM 393 Physical Polymer Science 3 Credits**

Structural and physical aspects of polymers (organic, inorganic, natural). Molecular and atomic basis for polymer properties and behavior.

Characteristics of glassy, crystalline and paracrystalline states (including viscoelastic and relaxation behavior) for single- and multi-component systems. Thermodynamics and kinetics of transition phenomena.

Structure, morphology and behavior. Must have completed one year of physical chemistry.

**Attribute/Distribution:** NS

**CHM 394 Organic Polymer Science I 3 Credits**

Organic chemistry of synthetic high polymers. Polymer nomenclature, properties, and applications. Functionality and reactivity of monomers and polymers. Mechanism and kinetics of step-growth and chain-growth polymerization in homogeneous and heterogeneous media. Brief description of emulsion polymerization, ionic polymerization, and copolymerization. Must have completed one year of physical chemistry and one year of organic chemistry.

**Prerequisites:** CHM 112 or CHM 342 or CHE 210

**Attribute/Distribution:** NS

**CHM 400 First Year Graduate Student Seminar 0 Credits**

First year graduate student seminar course and introduction to research. Topics include: research opportunities in the department, introduction to instrumentation facilities, ethics in science, use of library facilities, effective teaching methods.

**CHM 405 Organometallic Chemistry 3 Credits**

The chemistry of compounds containing carbon to metal bonds.

Among topics covered are the following: organic compounds of the representative elements from Group I to IV; the chemistry of ferrocene and related pi-bonded organometallic complexes; metal carbonyl and nitrosyl complexes; dioxygen and dinitrogen complexes; organic synthesis utilizing organometallic catalysts.

**CHM 407 Advanced Inorganic Chemistry 3 Credits**

Introduction to transition metal complexes; theories of bonding; kinetics and mechanisms of transition metal complex reactions; selected aspects of organometallic chemistry; bio-inorganic chemistry. Must have completed one semester of physical chemistry and have CAS graduate student status.

**CHM 421 Chemistry Research 1-6 Credit**

Research in one of the following fields of chemistry: analytical, inorganic, organic, physical, polymer, biochemistry.

**CHM 423 Bio-Organic Chemistry 3 Credits**

An examination of biochemistry on the basis of organic chemical principles. Emphasis on reaction mechanisms of biochemical transformations and methods for elucidation of these mechanisms, i.e., kinetics, isotope effects, exchange techniques, inhibition studies, substrate analog effects and organic model studies.

**CHM 424 Medicinal and Pharmaceutical Chemistry 3 Credits**

Principles of drug design, structure-activity relationships in antibacterial, antimalarial, anti-inflammatory and psychoactive drugs; synthesis and modes of action of pharmacologically active agents radioactive pharmaceuticals. Prerequisites as noted below.

**Prerequisites:** CHM 358

**CHM 425 Pharmaceutical Regulatory Affairs 1: Drug Discovery to Approval 3 Credits**

Coverage includes the stages of the drug approval process and how these relate to the laboratory activities that provide the scientific basis of the New Drug Application (NDA). Lectures treat drug discovery, chemical process development of the active pharmaceutical ingredient (API), and pharmaceutical process development of the drug product. Regulatory issues in screening and testing, the management of the preclinical trials, and the management of clinical trials will be covered.

**Attribute/Distribution:** NS

**CHM 428 Pharmaceutical Regulatory Affairs-II-Biomarkers for Pharmaceuticals and Diagnostics: Laws & Regulation 3 Credits**

For decades diagnostic products and technologies have been used to monitor or detect a variety of indicators for disease and infection. Each year, over 4,000 devices are reviewed by the U.S. Food & Drug Administration for safety and efficacy before being allowed to enter the marketplace. Today, regulations have set in motion the use of Biomarkers as a key element for new pharmaceutical development. Biomarkers in a way similar to Diagnostic markers will become a method to demonstrate safety and efficacy of experimental drugs during human trials. This course will review the history of Biomarker and medical device law and regulations in the United States. It will also define the current scientific requirements for Biomarkers to meet the new regulations. Case studies will be used to educate participants on the use of Biomarkers in pharmaceutical development as well as Design Controls, Quality System Regulations, Manufacturing Requirements for diagnostic testing technologies. Specific examples include Nucleic Acid Diagnostics, Cardiovascular Stents, Drug Delivery, Cancer Diagnostics, and Consumer Self-Testing. Students will also use knowledge gained to prepare class presentations to address current issues within the field. This course is one of four courses required to fulfill the requirements for a Certificate in Regulatory Affairs. It may be applied as a 400-level credit in the Masters of Chemistry degree program.

**Attribute/Distribution:** NS

**CHM 430 Chemical and Biochemical Separations 3 Credits**

Theory and applications of equilibrium and nonequilibrium separation techniques at both the analytical and preparative levels. Solvent and buffer extractions, chromatographic separations (e.g., thin layer, partition, gas liquid, gel filtration, ion exchange, affinity, supercritical fluid), electrophoretic separations (e.g., gel, capillary, isoelectric focusing, immunoelectrophoresis), centrifugal separations (e.g., differential, velocity sedimentation, density gradient) and other separation methods (e.g., dialysis, ultrafiltration). Examples will focus on biological applications.

**CHM 431 Contemporary Topics in Analytical Chemistry 1 Credit**

Discussion of the current literature in analytical chemistry, including spectroscopy, separations, and electrochemistry. Students find current papers and lead discussions. May be repeated for credit.

**CHM 432 Chemometrics 3 Credits**

Mathematical and statistical methods for experimental design, calibration, signal resolution, and instrument control and optimization.

**CHM 434 Advanced Topics in Spectroscopy 3 Credits**

Fundamentals of interactions of electromagnetic radiation with matter: electronic, vibrational, scattering based spectroscopies, instrumentation and signal processing. Advanced applications to the analysis of molecular structure and chemical processes including surface analysis, time-resolved spectroscopies, and ultrasensitive spectroscopic techniques.

**CHM 436 Special Topics in Analytical Chemistry 1-3 Credit**

Topics of contemporary interest in analytical chemistry. May be repeated for credit when a different topic is offered.

**Repeat Status:** Course may be repeated.

**CHM 437 Pathophysiological Chemistry 3 Credits**

Biochemical basis of human diseases involving abnormal metabolism of proteins, nucleic acids, carbohydrates, and lipids. Emphasis on the correlation of the clinical presentation of disease processes seen as physiological dysfunctions with clinical laboratory methods. Lectures, student presentations, and clinical case discussions. Must have completed one semester of biochemistry.

**CHM 438 Analytical Chemistry 3 Credits**

Theory and practice of chemical analysis. Principles of quantitative separations and determinations; theory and application of selected optical and electrical instruments in analytical chemistry; interpretation of numerical data; design of experiments; solute distribution in separation methods. Must have CAS graduate student status.

**CHM 442 Pharmaceutical Regulatory Affairs 3: Analytical Methods, Validation, and Data Manipulation 3 Credits**

A review of the FDA guidance and common industry practices. A presentation of the more user-friendly and higher accuracy analytical methods, which are supplanting traditional analyses. Lectures will cover the eight fundamentals of analytical method validation: accuracy, linearity, precision, limits of detection, selectivity, limits of quantification, specificity, and ruggedness of method. In addition, the student will be taught what to do when the results do not meet the Acceptance Criteria. Lectures also cover evaluation of data streams for supporting conclusions.

**CHM 443 Solid-State Chemistry 3 Credits**

Crystal structure, diffraction in crystals and on surfaces, bonding and energy spectra in solids dielectrics, surface states and surface fields in crystals. Must have completed one course in linear algebra and one course in quantum mechanics.

**CHM 444 Molecular Structure, Bonding and Dynamics 3 Credits**

Nature of chemical bonding as related to structure and properties of molecules and extended systems. Quantum chemistry of atoms and molecules applied to chemical transformations and spectroscopic transitions. Symmetry analysis and selection rules. Interpretation of electronic, vibrational and rotational spectra. Must have CAS graduate student status.

**CHM 452 Advanced Organic Chemistry 3 Credits**

Reaction mechanism types and supporting physical chemical data. Classes of mechanisms include elimination, substitution, rearrangement, oxidation reduction, enolate alkylations, and others. Must have completed one year of organic chemistry and have CAS graduate student status.

**CHM 453 Heterocyclic Compounds 3 Credits**

An intensive study of the syntheses, reactions and properties of heteroaromatic compounds including derivatives of thiophene, pyrrole, furan, indole, pyridine, quinoline, the azoles and the diazines all considered from the viewpoint of modern theories of structure and reaction mechanisms. Prerequisites as noted below.

**Prerequisites:** CHM 358 or CHM 358

**CHM 455 Organic Reactions 3 Credits**

Intensive survey of modern synthetic organic chemistry from a mechanistic standpoint. Classical Namereactions, olefin synthesis, organometallic reagents in synthesis, Woodward-Hoffmann rules, electrocyclic processes, enolate chemistry, and related reactions. Prerequisites as noted below.

**Prerequisites:** CHM 358

**CHM 456 Spectral Analysis 3 Credits**

Use of data from nuclear magnetic resonance, infrared, ultraviolet, and mass spectrometric techniques for the determination of structure of organic compounds. Emphasis on information from one- and two-dimensional proton and carbon NMR, and a mechanistic interpretation of data from mass spectrometry.

**CHM 457 Organic Reaction Mechanisms 3 Credits**

Intensive in class problem solving that involves the formulation of reasonable reaction mechanisms for complex multistep pathways, i.e. organic transformations that proceed via highly energetic intermediates such as carbocations, carbanions, free radicals, carbenes, and nitrenes.

**CHM 458 Topics in Organic Chemistry 1-3 Credit**

An intensive study of limited areas in organic chemistry. May be repeated when a different topic is offered.

**Repeat Status:** Course may be repeated.

**CHM 463 Pharmaceutical Regulatory Affairs 4: Commercial Production, Validation, and Process Qualification 3 Credits**

This course covers the scientific principles and the registry requirements for polymeric implants, controlled-release drug depot units, pumps, point-of-care testing kits, contrast media for MRI, x-ray, and ultrasound and all FDA controlled products not defined as therapeutic pharmaceuticals.

**CHM 467 Principles of Nucleic Acid Structure 3 Credits**

An examination of the principles underlying nucleic acid structure including stereochemistry, electrostatics, hydration, torsional constraints, sequence specific effects, and interaction with nuclear proteins. Special emphasis will be placed on DNA structure. Must have completed one year of biochemistry and one year of physical chemistry or have consent of the department chair.

**CHM 468 Principles of Protein Structure 3 Credits**

An examination of the principles underlying protein structure including stereochemistry, preferred tertiary structures, protein homology, excluded volume effects, time dependent structural fluctuations, and prediction of protein structure from sequence information. Must have completed one year of biochemistry and one year of physical chemistry or consent of department required.

**CHM 469 Biochemical Problem Solving I 1 Credit**

Applications of material covered in BIOS/CHM 371 including techniques used in research.

**CHM 470 Biochemical Problem Solving II 1 Credit**

Applications of concepts covered in BIOS/CHM 372 including techniques used in research.

**CHM 472 Lipids and Membranes 3 Credits**

Structure, physical properties and functions of lipids and their biological aggregates. Techniques for studying lipid assemblies, enzymes which act on lipids, membrane proteins and lipoproteins will also be discussed. Prerequisites as noted below or consent of department chair.

**Prerequisites:** BIOS 372 or CHM 372

**CHM 474 Pharmaceutical Regulatory Affairs 5: Pharmaceutics 3 Credits**

This course covers the development of therapeutic products subsequent to the initial discovery of the active pharmaceutical ingredient (API) through to the final dosage form. Both small molecule drugs and biotechnological pharmaceuticals will be included. Issues of API formulation, choice of excipients, control of release, target specificity, mode of delivery, drug-drug interactions, and product stabilization will be addressed with special reference to the regulatory issues involved at that stage of drug development. This course builds upon a foundation in organic, analytical, and biochemistry.

**CHM 475 Advanced Topics in Chemistry 1 Credit**

Audiovisual courses in topics such as acid-base theory, NMR, chromatography, electroanalytical chemistry and mass-spectroscopy interpretation; course material obtained from the American Chemical Society. May be repeated for credit.

**CHM 477 Topics In Biochemistry 1-3 Credit**

Selected areas of biochemistry, such as mechanisms of enzyme action, new developments in the chemistry of lipids, nucleic acids, carbohydrates and proteins. May be repeated for credit when different topics are offered. Must have completed one semester of biochemistry.

**Repeat Status:** Course may be repeated.

**CHM 479 Biochemical Techniques 3 Credits**

Laboratory studies of the techniques and principles involved in the isolation, identification, and biochemical transformation of carbohydrates, lipids, nucleic acids and proteins.

**CHM 480 Advanced Biochemical Preparations 1-3 Credit**

An advanced laboratory course in the preparation, isolation, purification, and identification of biochemically produced materials. Emphasis is placed on materials and procedures of current interest in biochemistry. Must have completed two semesters of biochemistry.

**CHM 481 Chemistry Seminar 1-6 Credit**

Student presentations on current research topics in the student's discipline but not on subjects close to the thesis. A one-hour presentation and attendance at other presentations are required for credit. May be repeated for credit, up to six times.

**Repeat Status:** Course may be repeated.

**CHM 482 Mechanical Behaviors of Polymers 3 Credits**

Mechanical behavior of polymers. Characterization of experimentally observed viscoelastic response of polymeric solids with the aid of mechanical model analogs. Topics include time-temperature superposition, experimental characterization of large deformation and fracture processes, polymer adhesion, and the effects of fillers, plasticizer, moisture, and aging on mechanical behavior.

**CHM 483 Emulsion Polymers 3 Credits**

Fundamental concepts important in manufacture, characterization, and application of polymer latexes. Topics include colloidal stability, polymerization mechanisms and kinetics, reactor design, characterization of particle surfaces, latex rheology, morphology considerations, polymerization with functional groups, film formation and various application problems.

**CHM 485 Polymer Blends and Composites 3 Credits**

Synthesis, morphology, and mechanical behavior of polymer blends and composites. Mechanical blends block and graft copolymers, interpenetrating polymer networks, polymer impregnated solids and fiber and particulate-reinforce polymers are emphasized.

**CHM 487 Topics in Colloid and Surface Chemistry 3 Credits**

Applications of colloid chemistry; special topics in surface chemistry. Lectures and seminar.

**Repeat Status:** Course may be repeated.

**CHM 488 Advanced Topics in Physical Chemistry 1-3 Credit**

Advanced topics in physical chemistry, such as photochemistry and molecular beam dynamics, Fourier transform spectroscopy, kinetics of rapid reactions, theory of magnetic resonance, liquids and solutions. May be repeated for credit when different topics are offered.

**Repeat Status:** Course may be repeated.

**CHM 489 Organic Polymer Science II 3 Credits**

Continuation of CHM 394. Theory and mechanism of ionic vinyladdition chaingrowth polymerization. Chain copolymerization by radical and ionic mechanism. Mechanism of ring-opening polymerization, stereochemistry of polymerization including ionic, coordination, and Ziegler-Natta mechanisms. Reactions of polymers, including crosslinking, reaction of functional groups, graft and block copolymers, and polymer carriers and supports.

**CHM 490 Thesis 1-6 Credit**

**Repeat Status:** Course may be repeated.

**CHM 492 Topics in Polymer Science 3 Credits**

Intensive study of topics selected from areas of current research interest such as morphology and mechanical behavior, thermodynamics and kinetics of crystallization, new analytical techniques, molecular weight distribution, non-Newtonian flow behavior, second-order transition phenomena, novel polymer structures. Credit above three hours is granted only when different material is covered.

**CHM 494 Quantum Chemistry 3 Credits**

Principles and applications of quantum mechanics to chemical problems. Applications to chemical bonding, molecular structure, reactivity and spectroscopy.

**CHM 499 Dissertation 1-15 Credit**

**Repeat Status:** Course may be repeated.

**Classical Studies**

**Program Director: Barbara Pavlock, Ph. D. (Cornell)** (<http://english.cas2.lehigh.edu/barbara-pavlock>)

**Email:** [bp01@lehigh.edu](mailto:bp01@lehigh.edu) # **Phone:** 610-758-3309

**Website:** <http://classics.cas2.lehigh.edu/>

*Supported by the Office of Interdisciplinary Programs 610-758-3996; [incasip@lehigh.edu](mailto:incasip@lehigh.edu)*

The study of Classics examines first the origins and growth of Greek and Roman culture in the Mediterranean area and second its impact on that area (and others) until the present. This study is by nature interdisciplinary: the study of language and literature, history, philosophy



and religion, archaeology, economics and science all contribute to an appreciation of Greco-Roman civilization.

Students in either major or minor programs may concentrate in various combinations of these and other disciplines as they relate to ancient civilization. The diversity of the program should encourage the student to follow her or his special interests while simultaneously gaining an overview of classical civilization.

Courses in ancient Greek and Latin lead to proficiency in language while introducing the student to major literary texts. The Joseph A. Maurer Classics Prize is awarded yearly, at the discretion of the program, to the senior(s) who has demonstrated outstanding achievement in Classics (ancient Greek or Latin) and/or classical civilization. Courses in classical civilization require no knowledge of the ancient languages; they offer introductions to various disciplines of Classics with frequent reference to modern perspectives. Upper-level courses tend to be small, fostering closeness between faculty and students.

Petitions are required for freshmen to take 100-level or higher courses and for sophomores to take 200-level or higher courses.

#### Major Programs

Students may major either in classical civilization or in Classics. The Classics major offers a comprehensive view of language and culture; it is possible to begin an ancient language at Lehigh and to complete the major program successfully. The classical civilization major enables the student to gain a broad perspective on Greek and Roman civilization. The program welcomes double majors and the educational perspectives to be derived from combining ancient and modern studies.

Classics as a major has stood the test of time, offering helpful preparation for careers in widely diverse fields in the professions, business, and public service. Lehigh Classics majors have gone on to law school, to the ministry, to business school, with appropriate science courses to medical school, to graduate work in Classics, and to all kinds of entry-level employment.

#### Departmental Honors

A student may be recommended for program honors by vote of the program based on the student's course work.

#### Minor Program

The program has three minors: Classics, Latin, and Classical Civilization. The minor in Classics combines language study and civilization courses (with a minimum of two courses in the languages). The minor in Latin focuses exclusively on the study of Latin. For the minor in Classical Civilization, students may take any combination of courses in Classical Civilization (any courses designated CLSS). All the minors require a minimum of 16 credits. The program can arrange individual courses of study.

#### Study Abroad

Lehigh University is a cooperating institution of the Intercollegiate Center for Classical Studies at Rome. Lehigh students are eligible for tuition grants in Athens and Rome.

**Emeritus.** Douglas Feaver, PhD (Johns Hopkins University)

#### Major Programs

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#### Major in Classical Civilization

This major allows the student to gain an overview of Greco-Roman culture through the literature, archaeology, and history along with basic

language study. A minimum of 36 credits is expected, but adjustments may be made for prior language study. Students need to consult the Program Director to determine appropriate adjustments to the guidelines for major requirements.

Select four of the following:	16
CLSS/ENGL 052	Classical Epic
CLSS/ENGL/THTR 054	Greek Tragedy
CLSS/ENGL 056	Topics in Greek and Roman Literature
CLSS/ENGL/THTR 058	Greek and Roman Comedy
CLSS/ANTH/ART/ARCH 174	Greek Archaeology
CLSS/ANTH/ART/ARCH 176	Roman Archaeology
Any two courses in ancient history	8
At least one elective from the remaining program offerings (ANTH 178 may be included)	4
Two semesters of elementary Latin or Greek	8
<b>Total Credits</b>	<b>36</b>

#### Major in Classics

This major allows the student to concentrate in ancient Greek, Latin or both. Specific programs for this major are worked out for each student with due consideration for the individual's particular previous study of the language(s). Thus a student may begin ancient Greek or Latin at Lehigh and successfully complete a major in it. A minimum of 36 credits is expected, but adjustments may be made for prior language study. Students need to consult the Program Director to determine appropriate adjustments to the guidelines for major requirements.

#### Required Major Courses

Select one of the following: <sup>1</sup>	8
LAT 001 & LAT 002	Elementary Latin I and Elementary Latin II
GRK 001 & GRK 002	Elementary Ancient Greek I and Elementary Ancient Greek II
Select one of the following: <sup>1</sup>	8
LAT 011 & LAT 012	Intermediate Latin and Intermediate Latin
GRK 011 & GRK 012	Intermediate Ancient Greek and Intermediate Ancient Greek
Three advanced courses in the major language minimum. <sup>2</sup>	12
Any two ancient history courses.	8
At least one elective from the remaining program offerings.	4
<b>Total Credits</b>	<b>40</b>

<sup>1</sup> Depending on prior preparation.

<sup>2</sup> Depending on prior preparation and on the extent of coursework in the second Classical language. Students entering with significant previous language study in their major language (Latin or Greek) will be expected to take four or more advanced courses. The specific number of credits for language study will be determined in consultation with the Program Director.

#### Departmental Honors

A student may be recommended for program honors by vote of the program based on the student's course work.

#### Minor Programs

The program has three minors: Classics, Latin, and Classical Civilization. The minor in Classics combines language study and civilization courses (with a minimum of two courses in the languages). The minor in Latin focuses exclusively on the study of Latin. For the minor in Classical Civilization, students may take any combination of courses in Classical Civilization (any courses designated CLSS). All the minors require a minimum of 16 credits. The program can arrange individual courses of study.

Classics Minor	16 credits
Latin Minor	16 credits
Classical Civilizations Minor	16 credits

### Study Abroad

Lehigh University is a cooperating institution of the Intercollegiate Center for Classical Studies at Rome. Lehigh students are eligible for tuition grants in Athens and Rome.

### Classics Courses

#### CLSS 021 Greek History 4 Credits

The development of civilization from palaeolithic times to the world empire of Alexander the Great. The social, economic, religious, philosophic, artistic and literary development of the ancient world; the origin of political institutions.

**Attribute/Distribution:** SS

#### CLSS 022 Roman History 4 Credits

Rome from its origins to A.D. 476. Political, social and religious developments. Transformation of the late Roman Empire to the early medieval period.

**Attribute/Distribution:** SS

#### CLSS 050 Mythology 4 Credits

Introduction to the study of the Greco-Roman myths in their social, political, and historical contexts. Equal emphasis on learning the myths and strategies for interpreting them as important evidence for studying classical antiquity.

**Attribute/Distribution:** SS

#### CLSS 052 Classical Epic 4 Credits

Study of major epic poems from Greece and Rome. Works include Homer's Iliad and Odyssey, Apollonius' Argonautica, Vergil's Aeneid, and Ovid's Metamorphoses.

**Attribute/Distribution:** HU

#### CLSS 054 Greek Tragedy 4 Credits

Aspects of Greek theater and plays of Aeschylus, Sophocles, and Euripides in their social and intellectual contexts.

**Attribute/Distribution:** HU

#### CLSS 056 Topics in Greek and Roman Literature 4 Credits

Classical literature in translation, including themes or specific periods in Greek or Roman literature. May be repeated for credit, as topics vary.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

#### CLSS 058 Greek and Roman Comedy 4 Credits

Study of comedy as a social form through plays of Aristophanes, Menander, Plautus, and Terence.

**Attribute/Distribution:** HU

#### CLSS 091 Independent Study 1-4 Credit

#### CLSS 112 Doing Archaeology 4 Credits

Principles of archaeological method and theory. Excavation and survey methods, artifact analysis, dating techniques, and cultural reconstruction. Course includes field project.

**Attribute/Distribution:** SS

#### CLSS 114 Christian Origins: New Testament and the Beginnings of Christianity 4 Credits

Early Christianity from its beginnings until the end of the second century. Coverage includes the Jewish and Hellenistic matrices of Christianity, traditions about the life of Jesus and his significance, and the variety of belief and practice of early Christians. Emphasis on encountering primary texts.

**Attribute/Distribution:** HU

#### CLSS 127 Early Civilizations 4 Credits

Introduction to early civilizations in the Near East, Mediterranean, Africa, Europe, and the New World. Similarities and differences in economics, politics, social organization, and religion.

**Prerequisites:** ANTH 001 or ANTH 011

**Attribute/Distribution:** SS

#### CLSS 131 Ancient Philosophy 4 Credits

Historical survey of selected texts and issues in the classical world, from the pre-Socratics through Aristotle, with emphasis on the origins of the western philosophical traditions in ethics, metaphysics, and epistemology.

**Attribute/Distribution:** HU

#### CLSS 132 Hellenistic Philosophy 4 Credits

Historical survey of selected texts and issues in Post-Aristotelian Greek and Roman philosophy from the fourth century B.C. to the third century A.D. Areas of focus may include epicureanism, stoicism, academic and pyrrhonian scepticism, and neoplatonism.

**Attribute/Distribution:** HU

#### CLSS 161 Roman Law 4 Credits

Examination of Roman legal systems from the Twelve Tables to the Digest of Justinian. Emphasis on development of legal concepts and their historical context. Readings in primary sources; lectures; discussion.

**Attribute/Distribution:** SS

#### CLSS 171 Independent Study 1-4 Credit

#### CLSS 174 Greek Archaeology 4 Credits

Ancient Greek culture from the neolithic to Hellenistic periods. Reconstructions of Greek social dynamics from the study of artifacts.

**Attribute/Distribution:** SS

#### CLSS 176 Roman Archaeology 4 Credits

Cultures of the Roman Empire. Reconstructions of social, political, and economic dynamics of the imperial system from the study of artifacts.

**Attribute/Distribution:** SS

#### CLSS 191 Special Topics 1-4 Credit

#### CLSS 213 Ancient Roman Religion 4 Credits

Religious experience of the Roman people from prehistory to end of the empire. Nature of polytheism and its interactions with monotheism (Christianity, Judaism). Theories of religion. Emphasis on primary source materials.

**Attribute/Distribution:** SS

#### CLSS 231 Figures/Themes in Ancient Philosophy 4 Credits

This seminar course will involve in-depth focus upon a major ancient thinker (e.g. Plato, Aristotle, Sextus Empiricus, Plotinus, etc.) or the classical treatment of a particular theme (e.g., "human nature," "the good life," ethical or political theory, etc.). Content varies. May be repeated more than once for credit. Must have completed one HU designated course in Philosophy.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

#### CLSS 232 Figures/Themes in Hellenistic Philosophy 4 Credits

This seminar will involve an in-depth focus upon a major movement in Hellenistic philosophy (roughly 4th century B.C.E. to the second century C.E.), such as Epicureanism, Stoicism, ancient skepticism, or Neoplatonism, or the Hellenistic treatment of a particular theme (e.g., freedom from anxiety, the nature of the cosmos and our place within it, or human nature). Content varies. May be repeated more than once for credit. Must have completed one HU designated course in Philosophy.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

#### CLSS 251 Classical Mythology 4 Credits

Myth, religion, and ritual in ancient Greece and Rome. Emphasis on primary sources; introduction to ancient and modern theories of religion. Cross-cultural material.

**Attribute/Distribution:** SS

#### CLSS 281 Readings 4 Credits

Advanced study of a historical period or theme. Emphasis on primary sources. Consent of program head required. Prerequisites as noted below.

**Prerequisites:** CLSS 021 or CLSS 022

**Attribute/Distribution:** ND

**CLSS 282 Readings 4 Credits**

Advanced study of a historical period or theme. Emphasis on primary sources. Consent of program head required. Prerequisites as noted below.

**Prerequisites:** CLSS 021 or CLSS 022

**Attribute/Distribution:** ND

**CLSS 291 Independent Study 1-4 Credit****CLSS 300 Apprentice Teaching 3 Credits****CLSS 311 Twins and Sins: The Rise of Rome 4 Credits**

Rome from its origins to the mid-third century B.C. Emphasis on foundation legends, the power of the monarchy, and development of Roman political and religious institutions. Papers, quizzes, discussions.

**Attribute/Distribution:** SS

**CLSS 312 Decline and Fall of the Roman Empire 4 Credits**

Political, social, and economic history of the Roman Empire, A.D. 117- A.D. 565. Romanization of the provinces, diffusion of Christianity, and special attention to transformation to medieval period. Includes readings in translation of primary sources.

**Attribute/Distribution:** SS

**CLSS 314 Age of Caesar and Christ 4 Credits**

Roman history of the first century A.D. Political, cultural, and socio-economic changes; special attention to the evolution of absolute power. Lectures, discussions, papers.

**Attribute/Distribution:** SS

**CLSS 345 Evolution of the State 4 Credits**

Theories of state formation. Comparison of evolutionary trajectories of early states in the Near East, Mediterranean, and the New World.

**Prerequisites:** ANTH 001 or ANTH 011

**Attribute/Distribution:** SS

**CLSS 389 Honors Project 1-8 Credit****Greek Courses****GRK 001 Elementary Ancient Greek I 4 Credits**

Fundamentals of the Greek language. Grammatical exercises and short passages of easy prose.

**Attribute/Distribution:** HU

**GRK 002 Elementary Ancient Greek II 4 Credits**

Continued work in Greek vocabulary, forms, and syntax. Selected readings in Greek. Students should have completed one semester of elementary ancient Greek or the equivalent.

**Prerequisites:** GRK 001

**Attribute/Distribution:** HU

**GRK 011 Intermediate Ancient Greek 4 Credits**

Readings in Herodotus, Homer, or Xenophon. Grammar review. Students should have completed two semesters of elementary ancient Greek or the equivalent.

**Attribute/Distribution:** HU

**GRK 012 Intermediate Ancient Greek 4 Credits**

May include Plato: Euthyphro, Apology and Crito, or other dialogues. Students should have completed two semesters of elementary Greek or the equivalent.

**Attribute/Distribution:** HU

**GRK 091 Independent Study 1-4 Credit**

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**GRK 111 Greek Drama 4 Credits**

Representative plays of Sophocles, Euripides and Aristophanes. Literary study of the drama. Students should have completed four semesters of ancient Greek or the equivalent.

**Prerequisites:** GRK 012

**Attribute/Distribution:** HU

**GRK 112 Readings in Ancient Greek 4 Credits**

Readings of Greek prose and poetry, authors will vary. May be repeated for credit. Students should have completed four semesters of ancient Greek or the equivalent.

**Repeat Status:** Course may be repeated.

**Prerequisites:** GRK 012

**Attribute/Distribution:** HU

**GRK 113 Greek Historians 4 Credits**

Selections from Herodotus, Thucydides or Xenophon. Study of Greek historiography. Students should have completed four semesters of ancient Greek or the equivalent.

**Attribute/Distribution:** HU

**GRK 171 Independent Study 1-4 Credit**

**Attribute/Distribution:** HU

**GRK 271 Readings 4 Credits**

Intensive readings in one author or in a selected genre. Must have completed six credit hours at the 100 level and consent of the program head.

**Attribute/Distribution:** HU

**GRK 272 Readings 4 Credits**

Intensive readings in one author or in a selected genre. Must have completed six credit hours of courses at the 100 level. Consent of the program head required.

**Attribute/Distribution:** HU

**GRK 291 Independent Study 1-4 Credit****Latin Courses****LAT 001 Elementary Latin I 4 Credits**

Fundamentals of grammar and syntax. Emphasis on language structure and vocabulary building.

**Attribute/Distribution:** HU

**LAT 002 Elementary Latin II 4 Credits**

Continuation of grammar, easy Latin prose and poetry. Students should have completed one semester of elementary Latin or the equivalent.

**Attribute/Distribution:** HU

**LAT 011 Intermediate Latin 4 Credits**

Readings in Latin prose or poetry. Consolidation of reading ability; introduction to literary analysis. Students should have completed two semesters of elementary Latin or the equivalent.

**Attribute/Distribution:** HU

**LAT 012 Intermediate Latin 4 Credits**

Readings in Latin prose or poetry. Consolidation of reading ability; introduction to literary analysis. Students should have completed two semesters of elementary Latin or the equivalent.

**Attribute/Distribution:** HU

**LAT 091 Independent Study 1-4 Credit****LAT 111 Catullus and Horace 4 Credits**

Translation and analysis of selected lyrics, focusing on imagery systems. Introduction to metrics. May be repeated for credit. Students should have completed four semesters of Latin or the equivalent.

**Prerequisites:** LAT 012

**Attribute/Distribution:** HU

**LAT 112 Latin Prose 4 Credits**

Readings from Latin prose literature of the late republic and early empire; selections may include Cicero's letters, Sallust, Pliny's letters. May be repeated for credit as content changes. Students should have completed four semesters of Latin or the equivalent.

**Repeat Status:** Course may be repeated.

**Prerequisites:** LAT 012

**Attribute/Distribution:** HU

**LAT 113 Vergil 4 Credits**

Selections from the Aeneid. Vergil's creation of a Latin epic and its complex perspective. Metrics. May be repeated for credit. Students should have completed four semesters of Latin or the equivalent.

**Repeat Status:** Course may be repeated.

**Prerequisites:** LAT 012

**Attribute/Distribution:** HU

**LAT 114 Livy 4 Credits**

Selections from the early books of Livy's histories focusing on his creation of a Roman mythos. Students should have completed four semesters of Latin or the equivalent.

**Prerequisites:** LAT 012

**Attribute/Distribution:** HU

**LAT 115 Ovid 4 Credits**

May include selections from the *Ars Amatoria*, *Fasti*, and the *Metamorphoses*, with attention to the problem of the ideology of Augustan Rome. May be repeated for credit. Students should have completed four semesters of Latin or the equivalent.

**Repeat Status:** Course may be repeated.

**Prerequisites:** LAT 012

**Attribute/Distribution:** HU

**LAT 116 Petronius 4 Credits**

Selections from the *Satyricon*, focusing on language usage and epic parody. Students should have completed four semesters of Latin or the equivalent.

**Prerequisites:** LAT 012

**Attribute/Distribution:** HU

**LAT 171 Independent Study 1-4 Credit**

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**LAT 211 Readings 4 Credits**

Intensive readings in one author or in a selected genre. Must have completed six hours of courses at the 100 level. Consent of the program head required.

**Attribute/Distribution:** HU

**LAT 212 Readings 4 Credits**

Intensive reading in one author or in a selected genre. Must have completed six hours of courses at the 100 level. Consent of the program head required.

**Attribute/Distribution:** HU

**LAT 291 Independent Study 1-4 Credit**

**Attribute/Distribution:** HU

**LAT 300 Apprentice Teaching 3 Credits****Cognitive Science**

**Program Director: Padraig G. O'Seaghda, Ph.D. (Toronto)** (<http://psychology.cas2.lehigh.edu/content/pgo0>)

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*Supported by the Office of Interdisciplinary Programs 610-758-3996; [incasip@lehigh.edu](mailto:incasip@lehigh.edu)*

The mission of the Cognitive Science Program is to advance the interdisciplinary study of mind, in all its aspects, through research and teaching. The interdisciplinary study of cognition in the fields of psychology, linguistics, computer science, philosophy, anthropology, and neuroscience provides excellent preparation for life in the age of information. Consistent with the mission of a liberal arts education, the program aims to instill in students a solid grasp of the intellectual problems, frameworks, and methodologies currently available; to provide experience exploring these through guided research; and to foster the desire to create, develop, and disseminate new knowledge. With this foundation, students are well prepared for graduate or professional studies in Cognitive Science or the contributing disciplines, or for a wide variety of careers with the bachelor's degree.

We offer an undergraduate major in Cognitive Science, an undergraduate minor, a graduate minor, and a graduate certificate. The courses required for the major readily lend themselves to a double major for those students in the humanities, natural sciences, social sciences, or computer science who have overlapping interests in cognitive science.

The B.A. with a major in Cognitive Science requires a minimum of 13 courses: 11 within the major itself and 2 in collateral areas. All majors are required to take COGS 7, an introduction to cognitive

science. The remainder of the major is built around a core of four second-tier courses from cognitive psychology, philosophy, artificial intelligence, and neuroscience. In addition, majors must complete five major electives selected from three tracks within cognitive science. A capstone integration occurs in the required two-semester senior thesis (COGS 301 and 399), in which students focus on a topic of their choice spanning at least two cognitive science sub-disciplines.

**B.A. in Cognitive Science****Collateral Requirements**<sup>1</sup>

CSE 001	Breadth of Computing	2
CSE 002	Fundamentals of Programming	2
MATH 021 or MATH 051	Calculus I (preferred) Survey of Calculus I	4

**Introductory Course**

COGS 007	Introduction to Cognitive Science	4
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**Disciplinary Core Courses**

COGS/PSYC 117	Cognitive Psychology	4
COGS/PSYC 176	Mind and Brain	4
COGS/PHIL 250	Philosophy of Mind	4
COGS/CSE 327	Artificial Intelligence Theory and Practice	3

**Major Electives**

Select a minimum of five of the following, with at least one course from each of the three tracks: 16-20

**Artificial Intelligence and Formal Models**

CSE 017	Programming and Data Structures
CSE 042	Game Design
CSE/MATH 261	Discrete Structures
CSE 262	Programming Languages
CSE 318	Introduction to the Theory of Computation
CSE 326	Pattern Recognition
CSE 335	Topics on Intelligent Decision Support Systems
CSE 337	Reinforcement Learning
CSE 348	AI Game Programming
CSE 360	Introduction to Mobile Robotics
CSE 431	Intelligent Agents (for undergraduate students who qualify)

PHIL 114	Symbolic Logic
PHIL 115	Topics in Philosophical Logic
PHIL 265	Philosophy Of Mathematics
MATH/PHIL 303	Mathematical Logic
MATH/PHIL 304	Axiomatic Set Theory
MATH 329	Computability Theory

**Language, Culture, and Meaning**

COGS/ANTH/MLL 140	Introduction to Linguistics
ANTH 376	Culture and the Individual
PHIL 139	Contemporary Philosophy
PHIL 220	Theory Of Knowledge
PHIL 260	Philosophy Of Language
PSYC 307	Higher Order Cognition
PSYC 313	Person Perception
PSYC/SSP 314	Social Cognition
PSYC 320	Psychology of Language
PSYC 321	Language Development
PSYC/HMS 344	Health Care Reasoning and Decision-Making
PSYC 351	Children's Thinking

PSYC 362	Cognition in Practice & Policy	
PSYC/GS 365	Human Development in Cross-Cultural Perspective	
PSYC 384	Self and Identity	
SSP/JOUR 135	Human Communication	
SSP 302	The Sociology Of Cyberspace	
<b>Cognition and Neuroscience</b> <sup>2</sup>		
ANTH 145	Human Evolution	
BIOS 121	Comparative/Integrative Biology for BIOS Minors	
BIOS 276	Central Nervous System and Behavior	
BIOS 277	Experimental Neuroscience Laboratory	
BIOS 365	Neurobiology of Sensory Systems	
BIOS 366	Diseases of the Nervous System	
BIOS 382	Endocrinology of Behavior	
PSYC 304	Memory Development from Infancy to Old Age	
PSYC 358	Inside the Infant Mind	
PSYC 369	Memory Under Construction	
PSYC 377	Attention and Attentional Failures	
<b>Senior Thesis</b> <sup>3</sup>		
COGS 301 & COGS 399	Senior Project in Cognitive Science: Proposal and Senior Project in Cognitive Science: Thesis	6
<b>Total Credits</b>		<b>49-53</b>

- Additional coursework in mathematics is strongly recommended (particularly CSE 261/MATH 261). Also recommended are non-major courses of its PSYC 001, ANTH 001 and COGS 140 which provide valuable background. These courses may fulfill Social Science Distribution requirements.
- Students who are interested in taking the behavioral neuroscience BIOS courses in the Cognition and Neuroscience track should also take CHM 030 or CHM 040, and BIOS 041, and BIOS 115 with their associated laboratory courses, by the end of their sophomore year.
- After completing the introductory and the core courses, students pursue their individual interests in their selections of major electives. The required senior thesis provides a capstone integration through an individual research project spanning at least two cognitive science sub-disciplines.

**Recommended Timing of Courses**

<b>First Year</b>		<b>CR</b>
COGS 007 (Spring)		4
CSE 001		2
CSE 002		2
MATH 021 or 051		4
		<b>12</b>
<b>Second Year</b>		<b>CR</b>
COGS 117		4
COGS 176		4
1 major elective <sup>1</sup>		3-4
		<b>11-12</b>
<b>Third Year</b>		<b>CR</b>
COGS 250		4
COGS 327		3
2 major electives <sup>1</sup>		6-8
		<b>13-15</b>
<b>Fourth Year</b>		<b>CR</b>
COGS 301 & COGS 399 (thesis)		6
2 major electives <sup>1</sup>		6-8
		<b>12-14</b>
<b>Total Credits: 48-53</b>		

<sup>1</sup> Students must complete a minimum of five major electives totaling at least 16 credits with at least one course from each of the three tracks.

**Minor in Cognitive Science**

The undergraduate minor in Cognitive Science requires five courses:

COGS 007	Introduction to Cognitive Science	4
Four additional courses selected from among the major's core courses and major electives, with at least two of these being Disciplinary Core Courses		12
<b>Total Credits</b>		<b>16</b>

**Program Honors**

Majors seeking to graduate with honors in cognitive science must have a 3.30 GPA in the major, a 3.30 GPA overall, and complete a high quality senior thesis. Theses submitted for honors will be evaluated by a committee of at least three cognitive science faculty.

**For Graduate Students**

There are two concentrations in Cognitive Science available for post-baccalaureate students: a Graduate Minor and a Graduate Certificate. The minor is intended for students currently enrolled in a degree-granting graduate program at Lehigh University. By contrast, the certificate is intended for non-degree students.

**Graduate Minor in Cognitive Science**

The minor gives graduate students who are enrolled in Lehigh University degree programs, such as computer science or psychology, an opportunity to develop expertise in the interdisciplinary study of information processing by humans as well as intelligent machines. Graduate students investigating mental processes such as language processing, reading, perception and action, planning, problem-solving, learning, category formation, or applications such as artificial intelligence or educational technology are encouraged to participate, with the approval of an advisor in their major program, by contacting the Director of the Cognitive Science Program. On completion of the program, the Director of the Cognitive Science Program will issue a letter to the student certifying that he or she has met the requirements of the minor.

The Graduate Minor requires five graduate level courses.

COGS/PSYC 423	Foundations of Cognitive Science	3
A graduate seminar		3

Four electives from the list below (or approved substitutions).<sup>1</sup> 12-16

<b>Computer Science</b>		
CSE 348	AI Game Programming	
CSE 426	Pattern Recognition	
CSE 428	Semantic Web Topics	
CSE 431	Intelligent Agents	
CSE 435	Topics on Intelligent Decision Support Systems	
CSE 447	Data Mining	
CSE 460	Mobile Robotics	
<b>Psychology</b>		
PSYC 402	Developmental Psychology	
PSYC 403	Cognitive Psychology	
PSYC 406	Social Cognition	
PSYC 443	Seminar In Language Acquisition	
PSYC 448	Seminar in Psychology of Language	
PSYC 464	Naive Realism in Social Judgement	
PSYC 476	Seminar In Cognition	
PSYC/COGS 478	Ontological Psychology	
PSYC 480	Seminar in Cognitive Development	
<b>Philosophy</b> <sup>2</sup>		
PHIL/COGS 250	Philosophy of Mind	
PHIL 260	Philosophy Of Language	
<b>Sociology and Anthropology</b>		

ANTH 376	Culture and the Individual	
SSP 403	Sociology Of Cyberspace	
Total Credits		18-22

- At least two of the four electives must be taken outside the student's home department. Special topics courses with a cognitive science emphasis may also count toward the minor, with the approval of the Cognitive Science Supervisory Committee. Courses taken toward the minor may also fulfill requirements of the student's major program, with the approval of the major department.
- Note: 200-level courses may be taken by graduate students if the courses are not in the student's major.

### Graduate Certificate in Cognitive Science

This concentration is intended for people working in technology-related businesses and other qualified individuals with an interest in cognitive science. The purpose of the certificate program is to provide non-degree post-baccalaureate students an interdisciplinary perspective on human and machine intelligence.

The Graduate Certificate requires four graduate level courses.

COGS 423	Foundations of Cognitive Science	3
A graduate seminar		3
Three electives from the list below. <sup>1</sup>		9-12

#### Computer Science

CSE 326	Pattern Recognition	
CSE 327	Artificial Intelligence Theory and Practice	
CSE 337	Reinforcement Learning	
CSE 331	User Interface Systems and Techniques	
CSE 332	Multimedia Design and Development	
CSE 335	Topics on Intelligent Decision Support Systems	
CSE 347	Data Mining	
CSE 348	AI Game Programming	
CSE 360	Introduction to Mobile Robotics	
CSE 426	Pattern Recognition	
CSE 428	Semantic Web Topics	
CSE 431	Intelligent Agents	
CSE 435	Topics on Intelligent Decision Support Systems	
CSE 447	Data Mining	
CSE 460	Mobile Robotics	

#### Psychology

PSYC 304	Memory Development from Infancy to Old Age	
PSYC 307	Higher Order Cognition	
PSYC 313	Person Perception	
PSYC 314	Social Cognition	
PSYC 317	Psychology of Emotion	
PSYC 320	Psychology of Language	
PSYC 321	Language Development	
PSYC 351	Children's Thinking	
PSYC 358	Inside the Infant Mind	
PSYC 362	Cognition in Practice & Policy	
PSYC 365	Human Development in Cross-Cultural Perspective	
PSYC 369	Memory Under Construction	
PSYC 377	Attention and Attentional Failures	
PSYC 402	Developmental Psychology	
PSYC 403	Cognitive Psychology	
PSYC 406	Social Cognition	
PSYC 443	Seminar In Language Acquisition	
PSYC 448	Seminar in Psychology of Language	
PSYC 464	Naive Realism in Social Judgement	

PSYC 476	Seminar In Cognition	
PSYC/COGS 478	Ontological Psychology	
PSYC 480	Seminar in Cognitive Development	
<b>Philosophy <sup>2</sup></b>		
PHIL/COGS 250	Philosophy of Mind	
PHIL 260	Philosophy Of Language	
<b>Sociology and Anthropology</b>		
ANTH 376	Culture and the Individual	
SSP 403	Sociology Of Cyberspace	
Total Credits		15-18

- At least two of the three electives must be at the 400-level, and the three electives must be spread over at least two departments.
- Note: 200-level courses may be taken by graduate students if the courses are not in the student's major.

### Courses

#### COGS 007 Introduction to Cognitive Science 4 Credits

What is a mind? How is the mind related to the brain? Could we make an artificial mind? Issues concerning knowledge representation and intelligence in minds and computers as investigated by psychologists, philosophers, linguists, neuroscientists, and researchers in artificial intelligence.

**Attribute/Distribution:** SS

#### COGS 117 Cognitive Psychology 4 Credits

The architecture and dynamics of the human mind: How we acquire knowledge through perception, represent and activate it in memory, and use it to communicate, make decisions, solve problems, and reason creatively. May not be taken pass/fail. Prerequisites as noted below.

**Prerequisites:** PSYC 001 or COGS 007

**Attribute/Distribution:** SS

#### COGS 140 Introduction to Linguistics 4 Credits

Relationship between language and mind; formal properties of language; language and society; how languages change over time. May not be taken pass/fail.

**Attribute/Distribution:** SS

#### COGS 161 Supervised Research 2-4 Credits

Research under the direct supervision of a faculty member in the cognitive science program. Students must arrange the particular project with a faculty member before enrolling. Consent of program director required.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** ND

#### COGS 176 Mind and Brain 4 Credits

Perception and cognitive neuroscience as the link between mental processes and their biological bases. Visual and auditory perception; the control of action; neuropsychological syndromes of perception, language, memory, and thought; neural network (connectionist) models of mental processes. May not be taken pass/fail. Prerequisites as noted below.

**Prerequisites:** PSYC 001 or COGS 007

**Attribute/Distribution:** NS

#### COGS 250 Philosophy of Mind 4 Credits

An exploration of the mind-body problem. Are the body and mind distinct substances (dualism); or is there only body (materialism); or only mind (idealism)? Other views to be considered include behaviorism (the view that behavior can be explained without recourse to mental states), and the view that the mind is a complex computer. Must have completed one HU course in Philosophy.

**Attribute/Distribution:** HU

#### COGS 301 Senior Project in Cognitive Science: Proposal 3 Credits

Senior year integration of the material from cognitive science begins with the proposal of a substantial review or research project spanning at least two cognitive science disciplines under the direction of a Cognitive Science faculty member. Consent of program director required.

**Attribute/Distribution:** ND

**COGS 327 Artificial Intelligence Theory and Practice 3 Credits**

Introduction to the field of artificial intelligence: Problem solving, knowledge representation, reasoning, planning and machine learning. Use of AI systems or languages. Advanced topics such as natural language processing, vision, robotics, and uncertainty. Prerequisites as noted below.

**Prerequisites:** CSE 015 or CSE 017 or CSE 018 or CSE 002

**COGS 361 Independent Research 2-4 Credits**

Independent research in cognitive science with a faculty advisor. Students must arrange the particular project with a faculty advisor before enrolling. Consent of program director required.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** ND

**COGS 399 Senior Project in Cognitive Science: Thesis 3 Credits**

Research during senior year culminating in senior thesis advised by a member of the Cognitive Science faculty. Execution and written report of project proposed and approved in COGS 301. Theses submitted for honors will be evaluated by a committee of at least three cognitive science faculty. Consent of program director required. Prerequisites as noted below.

**Prerequisites:** COGS 301

**Attribute/Distribution:** ND

**COGS 405 Individual Study in Cognitive Science 1-6 Credit**

Study of a topic not covered in regular course offerings. By arrangement with a consulting faculty member. May be repeated for credit. Consent of program director required.

**Repeat Status:** Course may be repeated.

**COGS 423 Foundations of Cognitive Science 3 Credits**

Survey of fundamental theory and methodologies from artificial intelligence, linguistics, cognitive psychology, philosophy, and neuroscience, as well as salient research problems such as knowledge acquisition and representation, natural language processing, skill acquisition, perception and action, and the philosophical question of intentionality.

**COGS 478 Ontological Psychology 3 Credits**

Principles and constraints for modeling psychological phenomena. Representation; perception; memory; knowing; learning; emotions; consciousness; language; rationality.

**Earth and Environmental Sciences**

The Department of Earth and Environmental Sciences (EES) is Lehigh's home for teaching and research in the areas of ecology, environmental science, and geological sciences. Matters of environmental quality and natural resources will increasingly impact people and society in the years to come, and the EES department offers a range of undergraduate and graduate programs that provide students with an understanding of Earth's biosphere, atmosphere, lithosphere, and hydrosphere, with an emphasis on how these components function as an integrated Earth system. Training in Earth and Environmental Sciences can lead to technical and scientific careers in research, environmental consulting, conservation ecology, government agencies, and the petroleum industry, and can also serve as an excellent liberal arts degree that provides context and preparation for careers such as law, policy, journalism and economics.

Faculty in the EES department have a wide range of interests and strong reputations in the fields of geology, ecology, and environmental sciences. In instruction at all levels, the department emphasizes field experiences, laboratory techniques, and experiential learning, as well as the development of quantitative and communication skills. The EES department maintains a relaxed and personal atmosphere in which students can interact with faculty in many ways, including seminars, special symposia on topics of the students' choice, field research, and departmental field trips.

EES is a core department in the Environmental Initiative Program (EI), which offers students access to interdisciplinary training in Environmental Science, Engineering, and Policy.

At the undergraduate level, students may choose from a B.A. or a B.S. degree in Earth and Environmental Sciences. The flexible B.A. program provides students an opportunity to acquire breadth, design

a specialized program, or find room for a double major. A popular choice is a double major in Earth and Environmental Sciences and in Environmental Studies, a major offered through the Environmental Initiative (<http://www.ei.lehigh.edu>). This degree is well suited to students with career aspirations in areas such as engineering, environmental law, journalism, economics, government, among many other possibilities. The B.S. degree, while still offering considerable flexibility, provides the more in-depth technical training required for graduate school and scientific careers, and is well suited for students seeking science graduate degrees or employment as professionals in the earth and environmental sciences.

An accessible minor program is available for students wishing to add Earth and Environmental Science insight into any number of other technical or non-technical degree programs, helping students distinguish themselves as they prepare to enter today's fast-evolving job markets and graduate programs. The department also offers a five-year program that combines a B.A. or B.S. degree with an M.S. degree in Earth and Environmental Sciences.

For students with strong interests in areas such as hydrology, water and soil remediation, hazards and associated geotechnical strategies, EES, in conjunction with the Department of Civil and Environmental Engineering (CEE), offers a five-year program leading to dual B.S. degrees in EES and CEE (students having these interests may also want to see the description of the B.S. in Environmental Engineering in the catalog entry for the Department of Civil and Environmental Engineering).

EES offers graduate training leading to either M.S. or Ph.D. in Earth and Environmental Sciences. The EES graduate program is marked by close faculty-student collaboration. Graduate students can take advantage of strong externally funded faculty research programs and the extensive analytical and computing facilities available in the department; these facilities and specific EES research programs are described in some detail on the EES departmental web page at [www.ees.lehigh.edu](http://www.ees.lehigh.edu).

**Field Work and Experiential Learning**

Field experiences are a hallmark of the EES undergraduate program. The goal of these experiences is to place students into learning environments that are distinct from the classroom or lab, where all the complexities and subtleties of the field can be appreciated in their natural setting. The Department runs a nationally recognized ~5 week long (6 credit) summer field camp in the Rocky Mountains, which offers intense field training in hydrology, ecology, geology, and field methods including computer-based mapping. As part of the Lehigh in Costa Rica Program, the Department teaches a field course in Costa Rica every winter term that focuses on tropical ecology and natural history. Students can participate in the department's longstanding research programs in limnological and ecological research in the Pocono Lakes region and in the Lehigh River watershed. Supervised internships allow students at all levels to become engaged in projects involving cross-disciplinary research, assessment, and consulting work. Undergraduate students can also become involved in forefront research programs. In recent years, students have played a role in research in the Himalaya, Alaska, California, Idaho, Argentina, and Italy, in addition to more nearby sites in the mid-Atlantic states. We strongly encourage all EES majors to take advantage of the special field programs and opportunities made available by the department. Most EES courses also include field experiences in the form of one-day or weekend-long field trips, and several courses include weekly or bi-weekly field trips.

**Programs in Earth and Environmental Sciences**

The descriptions of the following programs in the Department of Earth and Environmental Sciences are organized as follows:

- Minor in Earth and Environmental Sciences
- Bachelor of Arts Degree in Earth and Environmental Sciences
- Bachelor of Sciences Degree in Earth and Environmental Sciences
- Combined B.A. or B.S. and M.S. Program in Earth and Environmental Sciences
- Department Honors in Earth and Environmental Sciences

- Civil and Environmental Engineering and Earth and Environmental Sciences
- Graduate Studies (p. 113)

**Professors.** David J. Anastasio, PhD (Johns Hopkins University); Edward B. Evenson, PhD (University of Wisconsin); Kenneth P. Kodama, PhD (Stanford University); Frank J. Pazzaglia, PhD (The Pennsylvania State University); Dork Sahagian, PhD (University of Chicago); Zicheng Yu, PhD (University of Toronto); Peter K. Zeitler, PhD (Dartmouth College)

**Associate Professors.** Gray E. Bebout, PhD (University of California Los Angeles); Robert K. Booth, PhD (University of Wyoming); Bruce R. Hargreaves, PhD (University of California Berkeley); Anne S. Meltzer, PhD (Rice University); Donald P. Morris, PhD (University of Colorado Boulder); Stephen C. Peters, PhD (University of Michigan Ann Arbor); Joan Miriam Ramage Macdonald, PhD (Cornell University)

**Assistant Professor.** Benjamin S. Felzer, PhD (Brown University)

**Emeriti.** Bobb Carson, PhD (University of Washington); Paul B. Myers, Jr., PhD (Lehigh University); Hayden N. Pritchard, PhD (Lehigh University); Dale R. Simpson, PhD (California Institute of Technology)

#### Requirements for a Minor in Earth and Environmental Sciences

A minor is designed for students wishing to explore an area of Earth or Environmental Sciences in conjunction with a major program in another field for personal development or career enhancement.

EES 022	Exploring Earth	1
EES Courses at the 100 or higher levels		8
EES Courses		6
<hr/>		
Total Credits		15

Natural science (NS) designated EES College seminars (EES 090) may be used to meet minor requirements.

#### Degree Requirements for a Bachelor of Arts Degree in Earth and Environmental Sciences

The B.A. degree is designed with flexibility in mind and is recommended for students interested in a sound liberal arts degree that will permit them to bring a scientific perspective to a wide variety of careers. The degree also permits students to take a double major, or design a specialized program tailored to specific topics in the earth and environmental sciences. Students who choose the B.A. but are interested in attending graduate school should talk to their faculty advisor and consult the B.S. program descriptions to see the type of requirements that may be required for graduate admission.

#### University and College Requirements

College Seminar	3
English Composition (2 courses)	6
Distribution Requirements: at least 2 Humanities courses	8
Distribution Requirements: at least 2 Social Science courses	8

#### Junior Writing Requirement

EES 200	Earth History <sup>1</sup>	4
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#### MATH and Collateral Science Requirements<sup>2</sup>

1 semester of math equivalent to MATH 012 or above for at least 4 credits	4
1 additional course from Chemistry, Mathematics, or Physics, approved by advisor. <sup>3</sup>	4

#### Gateway Sequence

Any introductory course in EES (except EES 004 and EES 022)	3	
EES 022	Exploring Earth	1

#### Core Sequence in EES Major

EES 100	Earth Systems Science	4
EES 200	Earth History	4
EES 380	The Practice of Science	1

#### Major Electives

Select from EES or cross-listed offerings at the 100-300 levels<sup>4</sup>

#### Free Electives

Courses chosen from anywhere in the University's curriculum, sufficient to bring the total to a minimum of 120 credits.

- 1 The ability to express oneself clearly in writing is a critical skill for success in any chosen career. It is also integral to the learning experience. Students are encouraged to take courses that help develop written skills in their major. To help ensure this, the College of Arts and Sciences requires each student to complete at least one writing intensive course and receive certification from the instructor of that course. EES 200 Earth History is the designated writing intensive course in EES and fulfills the junior writing requirement. Students may also fulfill this requirement by taking writing intensive courses in other departments (although this is not encouraged).
- 2 Students interested in scientific careers or pursuing graduate education in the sciences are recommended to take at least two additional math and collateral science courses chosen in consultation with an advisor.
- 3 Courses cross-listed in EES (e.g., ASTR 105, PHY 105) do not fulfill this requirement.
- 4 Up to 8 credits of EES internship (EES 093, EES 293) and EES research (EES 393) may be used as major electives (no more than 4 of which can be EES 093/EES 293).

#### Degree Requirements for Bachelor of Sciences Degree in Earth and Environmental Sciences

##### University and College Requirements

College Seminar	3
English Composition (2 courses)	6
Distribution Requirements: at least 2 Humanities courses	8
Distribution Requirements: at least 2 Social Science courses	8

##### Junior Writing Requirement

EES 200	Earth History <sup>1</sup>	4
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##### MATH and Collateral Science Requirements

2 courses in Mathematics (one must be a course in Calculus)	7	
CHM 030	Introduction to Chemical Principles	4
or CHM 040	Concepts, Models and Experiments I	
Select one of the following:	5	

PHY 010 & PHY 012	General Physics I and Introductory Physics Laboratory I
PHY 011 & PHY 012	Introductory Physics I and Introductory Physics Laboratory I

At least 2 additional courses in Biology (BIOS 041 or above), Chemistry (CHM 031 or above), or Physics (PHY 013 or above).<sup>2</sup>

##### Gateway Sequence

Any introductory course in EES (except EES 004 and EES 022, but including EES 105)

EES 022	Exploring Earth	1
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##### Core Sequence in EES Major

EES 100	Earth Systems Science	4
EES 200	Earth History	4
EES 380	The Practice of Science	1

##### Field Requirement

Select one of the following:

EES 341	Field Camp in Earth and Environmental Sciences <sup>3</sup>
or EES 042	The Natural History of Costa Rica

A field experience approved by the student's advisor.

Complete 5 of the following 7 courses

EES 089	Geographic Analysis of our Changing World
EES 115	Surficial Processes
EES 152	Ecology
EES 201	Seismology: The Earth and Environment
EES 250	Terrestrial Ecosystems
EES 223	Structural Geology and Tectonics
EES 316	Hydrogeology



**Major Electives**

Select from EES or cross-listed offerings at the 100-300 levels <sup>4</sup> 36

**Free Electives**

Courses chosen from anywhere in the University's curriculum, sufficient to bring the total to a minimum of 120 credits.

- The ability to express oneself clearly in writing is a critical skill for success in any chosen career. It is also integral to the learning experience. Students are encouraged to take courses that help develop written skills in their major. To help ensure this, the College of Arts and Sciences requires each student to complete at least one writing intensive course and receive certification from the instructor of that course. EES 200 Earth History is the designated writing intensive course in EES and fulfills the junior writing requirement. Students may also fulfill this requirement by taking writing intensive courses in other departments (although this is not encouraged).
- Courses cross-listed in EES (e.g., ASTR 105, PHY 105) do not fulfill this requirement.
- Four credits of EES 341 may be applied to major electives; all 6 credits for this course apply to the graduation requirement of 120 total credits.
- At least four of the courses must be at the 300 level. Up to 8 credits of EES internship (EES 093, EES 293) and EES research (EES 393) may be used as major electives (no more than 4 of which can be EES 093/EES 293).

**Combined B.A. or B.S. and M.S. Program in Earth and Environmental Sciences**

The Department of Earth and Environmental Sciences offers a five-year combined B.A. or B.S. and M.S. program. The department offers an M.S. degree in Earth and Environmental Sciences (refer to the description of Graduate Programs in EES following the listing of undergraduate course descriptions). Students working toward the BA or B.S. degrees who are enrolled in this program complete the full requirements for either degree and apply some 300- and 400-level course credits taken as an undergraduate towards the M.S. degree without additional undergraduate tuition cost. The program is designed for those students who:

- will have at least nine credits of appropriate M.S. course credits in excess of undergraduate requirements completed by the end of the senior year, including one EES graduate core course (EES 411, EES 415, EES 426, or EES 484)
- have completed a minimum of three credits of EES 393 Supervised Research in Earth and Environmental Sciences as part of the baccalaureate program
- have demonstrated superior academic achievement.

Application for admission to the program should be made no later than the beginning of the first semester of the senior year and must be approved by the department's Graduate Instruction Committee. The application must include (1) a current baccalaureate degree audit, (2) the proposed M.S. course program, and (3) a letter of recommendation from the proposed M.S. thesis adviser. Students enrolled in this program should make application for admission to full-time graduate status during the first semester of the senior year.

After receiving the bachelor's degree and becoming enrolled in the graduate program students in the dual-degree program become eligible for financial aid including appointment to a teaching or research assistantship or graduate fellowship. Admission to the program does not guarantee financial aid.

**Department Honors in Earth and Environmental Sciences**

Students in either the B.A. or B.S. degree programs may undertake a program that leads to graduation with department honors. To participate, the student must (1) have a minimum major GPA of 3.25 and an overall cumulative GPA of 3.0 expected at graduation, (2) complete at least four credits of EES 393 (Supervised Research in Earth and Environmental Sciences), and (3) prepare a written honors thesis on the EES 393 research project. To graduate with honors students should (1) file a written request with the EES undergraduate instruction coordinator no later than the beginning of the senior year (preferably during the junior year), (2) constitute an advisory committee of two EES faculty plus the student's research supervisor to guide the research, (3) prepare a research proposal for committee's approval, and (4) give an oral presentation of research results and conclusions at a department seminar on or before the last day of classes in the second semester of the senior year. The committee should approve the research proposal

and the honors thesis by signing the required form and cover sheet, which will be filed with the Department.

**Civil and Environmental Engineering and Earth and Environmental Sciences**

This program is designed for students interested in combining programs in two departments: Civil & Environmental Engineering and Earth & Environmental Sciences, leading to two bachelor of science degrees, a civil and environmental engineering B.S. degree and a B.S. degree in earth and environmental sciences. Both degrees would be awarded at the end of the fifth year. This program is one of the dual degree programs mentioned in the Five-Year Programs section. The student will have a primary advisor in the P.C. Rossin College of Engineering and Applied Sciences and a secondary advisor in the College of Arts and Sciences. The program provides alternatives for students who may decide not to complete the dual-degree program. Students who make this decision prior to the beginning of the fourth year may qualify at the end of that year for the bachelor of science in civil or environmental engineering, as well as a minor in earth and environmental sciences. Also, if a student decides after two years to pursue only a B.S. degree in the EES department, it is possible to complete the requirements in four years. If the decision to work toward this degree is made during the fourth year, at least one additional semester is required to qualify for either B.S. degree. Interested students should consult with the respective departmental advisors to create a schedule of courses to resolve conflicts or if a specified course is not offered that semester. Required courses and major electives for the EES B.S. degree are listed in the catalog entry for EES. Crosslisted EES/CEE courses used to satisfy Civil Engineering Approved Electives can reduce the individual semester and total program credits when chosen to satisfy EES program requirements. The dual degree, and a suggested schedule of courses, is described more fully elsewhere in the catalog (p. 319). Additional useful information can be found on the web sites ([www.lehigh.edu/~incee/](http://www.lehigh.edu/~incee/) and [www.ees.lehigh.edu](http://www.ees.lehigh.edu)).

**Graduate Studies**

The Department of Earth & Environmental Sciences offers graduate programs leading to the M.S. and Ph.D. in Earth and Environmental Sciences. These degrees emphasize what we feel is an important and growing trend in ecology, environmental science, and geology, namely the blending of expertise and perspectives from many disciplines. Research is an integral component of all EES graduate programs and leads to an M.S. thesis or Ph.D. dissertation prepared under a research supervisory committee and chaired by a departmental faculty research advisor. An advising commitment by one or more faculty members is required for graduate admission.

The University has outlined the general academic requirements for M.S. and Ph.D. students in its Graduate Student Handbook, and EES has additional Departmental requirements that must also be fulfilled. It is the student's responsibility to insure that all graduation requirements are met. All graduate students work with an advisor who chairs the student's research supervisory committee. Graduate students make annual presentations of their research to the Department. All graduate students are required to take one of the Department's four graduate core courses (EES 411, EES 415, EES 426, and EES 484) and five additional courses (15 credits) at the 400-level. M.S. students complete 30 credits of coursework and thesis research and orally defend a written thesis that encompasses the findings and conclusions of their research. Candidates for the Ph.D. must first pass the qualification evaluation in the first year, then defend their dissertation proposal in the General Exam, and finally, orally defend a dissertation. For more details beyond this brief summary, please see the graduate handbook online at: [www.ees.lehigh.edu/graduate/grad\\_handbook.html](http://www.ees.lehigh.edu/graduate/grad_handbook.html).

**Research Facilities**

Our Department is well equipped for a broad range of field and laboratory investigations in the Environmental, Ecological, and Geological Sciences. Our laboratories and equipment include:

- Petrographic microscopy facilities, rock-crusher, ball mill, rock saws, and cathodoluminescence and camera lucida digitizing capabilities;

- Laboratory for Ar-Ar, U-Th/He, and fission-track geochronology including dual UV and CO<sub>2</sub> lasers, VG 3600 noble-gas mass spectrometer, Balzers quadrupole mass spectrometer, dedicated He and Ar extraction lines with low-blank furnaces, all under full LabVIEW automation;
- A stable isotope geochemistry laboratory equipped with a Finnigan MAT model 252 mass spectrometer (with dual-inlet and carrier gas capabilities), on-line peripherals, and off-line vacuum extraction lines, for O, H, C, and N isotope analyses of silicate minerals and rocks, carbonates, fluid inclusions, and organic matter;
- Equipment for sampling groundwater wells as well as automated samplers for surficial water systems;
- A microbial ecology laboratory (fluorescence and phase contrast microscopy, bioreactors, UV phototron, walk-in controlled environment chambers);
- Field instruments to characterize solar radiation (UV bands, PAR, broadband, and high resolution spectral irradiance with automated shadowband options for diffuse and direct spectral irradiance), water quality & optical properties (Biospherical PUV profilers, YSI datasondes, SCUFA CDOM fluorometers), weather parameters, and hydrology (precise water level, precipitation, wind, humidity, atmospheric pressure, water temperature thermistor chains) plus automated ISCO rain-triggered samplers for applications in aquatic and terrestrial ecosystem studies;
- Aquatic ecology laboratory instruments to characterize water quality and optical properties (pH, specific conductance, dissolved oxygen, UV-VIS spectrophotometers, scanning fluorometer, Turner CDOM/Chlorophyll fluorometer, N & P nutrient analyzer, automated Shimadzu TOC/TN analyzer, CHN analyzer, scintillation counter, photobleaching laboratory, low-carbon water purification system);
- An aqueous geochemistry laboratory with a ThermoElectron X-Series inductively-coupled plasma mass spectrometer with collision cell, and hydride generation apparatus that can be coupled to an HPLC system for species analysis, a Dionex ion chromatograph for simultaneous analysis of anions and cations, a Mercury analyzer for analysis of gaseous and liquid samples, and a Class 100 clean room for ultra trace sample preparation; additional instruments including a Waters computer-assisted ion chromatograph, an ARL 34000 inductively-coupled plasma atomic emission spectrometer, a Netzsch DTA/TGA instrument, and a high-pressure core-holder/column reactor for flow-through experiments;
- A sedimentation and soils analysis laboratory including equipment for particle size analysis;
- A paleomagnetism laboratory with a magnetically shielded room, a 2G superconducting magnetometer and built-in af demagnetizer, Molspin spinner magnetometer, a Schonstedt AF demagnetizer modified to apply pARMS, and an ASC thermal demagnetizer, and a KLY-3S Kappabridge magnetic susceptibility system, and an ASC impulse magnetizer;
- A reflection seismology laboratory has equipment including broadband seismometer linked to global networks; computer workstations for seismic processing, Bison DIFP multi-channel seismograph, various seismic energy sources, and ground-penetrating radar;
- Field geophysical equipment includes a Worden Master gravimeter, and a Geometrics portable proton precession magnetometer;
- Geomorphology lab including a Topcon total station, flow gages, LASCI digitizer, complete airphoto analysis facility, and a flume facility in the CEE hydraulics lab. We also maintain several PC and UNIX computer labs devoted to GIS (ArcGIS) and large spatial digital topographic databases;
- Paleocological laboratories with facilities for the analysis and photo documentation of tree rings, pollen, macrofossils, and other biological and physical parameters of environmental archives, including lake and peatland sediments.
- A sediment core laboratory with facilities for initial core preparation and core storage, including a walk-in cold room, a GeoTek MultiSensor Core Logger, a VirTis AdVantage Freezer Dryer and various corers (Livingstone, Mackereth, Glew Gravity, Russian peat Corers);

- A remote sensing laboratory with image processing software, extensive spatial data collections, as well as equipment for measuring field characteristics of important remotely sensed parameters.

#### Courses

##### **EES 002 Introduction to Environmental Science 3 Credits**

Focuses on natural and human-induced drivers and consequences of environmental change. Exploring options for mitigating and adapting to environmental change in ecosystems, physical and social systems, we will examine such topics as biogeochemical cycles, population pressure, ecosystem diversity, productivity and food security, energy, water resources, climate change, pollution, ozone, urban issues and sustainability. Stresses interactions and interrelationships, using a series of case studies. Intended for any student with an interest in the environment. May be combined with EES 022 or EES 004 for 4 credits.

**Attribute/Distribution:** NS

##### **EES 004 The Science of Environmental Issues 1 Credit**

Analysis of current environmental issues from a scientific perspective. The focus on the course will be weekly discussions based on assigned readings. Prerequisites as noted below.

**Prerequisites:** (EES 002 or ES 002 or EES 028 or GCP 002 or EES 011 or EES 012 or EES 014 or EES 015 or EES 016 or IR 016 or EES 021 or EES 024 or EES 025 or EES 026 or GCP 026 or EES 027 or GCP 027 or GCP 028 or EES 028 or EES 031 or EES 089 or EES 090 or EES 095 or EES 105 or ASTR 105 or PHY 105 or EES 022)

**Can be taken Concurrently:** EES 002, ES 002, EES 028, GCP 002, EES 011, EES 012, EES 014, EES 015, EES 016, IR 016, EES 021, EES 024, EES 025, EES 026, GCP 026, EES 027, GCP 027, GCP 028, EES 028, EES 031, EES 089, EES 090, EES 095, EES 105, ASTR 105, PHY 105, EES 022

**Attribute/Distribution:** NS

##### **EES 011 Environmental Geology 3 Credits**

Analysis of the dynamic interaction of geologic processes and human activities. Catastrophic geologic processes (earthquakes, volcanoes, landslides), pollution of geologic systems, and engineering case studies. May be combined with EES 022 or EES 004 for 4 credits.

**Attribute/Distribution:** NS

##### **EES 012 Glaciers and Glaciation 3-4 Credits**

An investigation of how cold climates and the associated processes of glaciation and periglacial activity have left their imprint on the Earth. May be combined with EES 022 or EES 004 for 4 credits.

**Attribute/Distribution:** NS

##### **EES 014 Lands of the Midnight Sun 3 Credits**

Investigations of polar exploration and science, the environment at high latitudes, and cultures of the Arctic, as well as discussion of issues related to understanding interactions among extreme environments, global change, pollution, and indigenous cultures. Lecture, discussion, classroom activities. May be combined with EES 022 or EES 004 for 4 credits.

**Attribute/Distribution:** NS

##### **EES 015 Volcanoes and the Ring of Fire 3 Credits**

Volcanoes are a tangible, often breathtaking, reminder of the inner workings of our restless planet. In this course, we consider the processes leading to volcanic eruptions, the significance of volcanism for long-term Earth evolution, and the hazards volcanoes create for humans, particularly those living in the circum-Pacific (the Ring of Fire). May be combined with EES 022 or EES 004 for 4 credits.

**Attribute/Distribution:** NS

##### **EES 016 Geology of War 3 Credits**

Introduction to Earth and Environmental Sciences through a study of the geologic underpinnings of human conflict, the geologic influences over the outcomes of great battles, and the long-term environmental impacts of war. Instructional format includes lectures, discussions, student projects, and a field trip to Gettysburg National Military Park. May be combined with EES 022 or EES 004 for 4 credits.

**Attribute/Distribution:** NS

##### **EES 021 Introduction to Planet Earth 3 Credits**

Processes within the Earth and dynamic interactions between the solid earth, the atmosphere, and the oceans. Lectures.

**Attribute/Distribution:** NS

**EES 022 Exploring Earth 1 Credit**

Laboratory course in methods, data acquisition, data analyses and scientific communication relevant to Earth and Environmental Sciences. Case study of anthropogenic change in the Lehigh River watershed. Required fieldtrips. Should have a 3-credit introductory-level (000-level) course in EES (or the cross-listed EES 105/ASTR 105/PHY 105).

**Prerequisites:** (EES 021 or EES 024 or EES 025 or EES 026 or EES 027 or EES 028 or EES 031 or EES 089 or EES 002 or ES 002 or EES 011 or EES 012 or EES 014 or EES 015 or EES 016 or EES 090 or EES 095 or EES 105 or ASTR 105 or IR 016 or GCP 026 or GCP 027 or EES 028 or PHY 105 or EES 004)

**Can be taken Concurrently:** EES 021, EES 024, EES 025, EES 026, EES 027, EES 028, EES 031, EES 089, EES 002, ES 002, EES 011, EES 012, EES 014, EES 015, EES 016, EES 090, EES 095, EES 105, ASTR 105, IR 016, GCP 026, GCP 027, EES 028, PHY 105, EES 004

**Attribute/Distribution:** NS

**EES 023 Weather and Climate: Past, Present, and Future 3 Credits**

Introduction to the basic principles of meteorology, as they pertain to past, present, and future climates. Earth's energy balance; cloud formation and precipitation; winds and atmospheric circulation; regional climatologies; past warm periods and ice ages in Earth's history; the latest ideas about future climate change and global warming. Students will maintain a weather notebook to enable them to relate theory to observations from real weather data. May be combined with EES 022 or EES 004 for 4 credits.

**Attribute/Distribution:** NS

**EES 024 Climate Change 3 Credits**

Examination and discussion of Earth's climate history and the multiple interactions among components of the climate system, including ice, water, air, land, and vegetation; review of the causes of climate change at various time scales. Assessment of historical and future climate change and the role of humans in causing climate change, including global warming. May be combined with EES 022 or EES 004 for 4 credits.

**Attribute/Distribution:** NS

**EES 025 The Environment and Living Systems 3 Credits**

The course will provide an introduction to the role of the environment in regulating living systems at a variety of scales and levels of organization. The role of the environment in regulating and shaping populations, communities, and ecosystems will be explored. In addition, the role of the environment will be discussed as it relates to the origin, evolution, and diversity of life on earth. Whenever possible, the role of anthropogenic environmental change will be discussed as it relates to the above topics. May be combined with EES 022 or EES 004 for 4 credits.

**Attribute/Distribution:** NS

**EES 026 Energy – Origins, Impacts, and Options 3 Credits**

Critical assessment of current and predicted energy resources used by humans, including their origins, distribution, environmental impacts, and feasibility. Lectures, discussion, field trips. May be combined with EES 022 or EES 004 for 4 credits.

**Attribute/Distribution:** NS

**EES 027 Natural Hazards: Impacts and Consequences 3 Credits**

Earthquakes, volcanoes, tsunamis, floods, and hurricanes are a natural part of the Earth and our environment. These events have violent consequences for our lives and significant economic implications. This course examines the causes, predictability, and risk mitigation for these events. We will also consider how natural disasters are represented by popular media and whether this helps or hurts public understanding of our dynamic planet and our relationship to it. May be combined with EES 022 or EES 004 for 4 credits.

**Attribute/Distribution:** NS

**EES 028 Conservation and Biodiversity 3 Credits**

An introduction to the science of conservation biology. We examine the evolution of biodiversity on earth, spatial patterns of biodiversity, the impact of human activities on biodiversity, and assess strategies for the management and conservation of biodiversity. Students gain the scientific literacy necessary to make informed decisions about topics such as wilderness preservation, species conservation, and land use. May be combined with EES 022 or EES 004 for 4 credits.

**Attribute/Distribution:** NS

**EES 031 Introduction to Environmental and Organismal Biology 3 Credits**

Introduction to the structure, function, and evolution of living systems, with emphasis at the levels of organism, population, community, and ecosystem. May be combined with EES 022 or EES 004 for 4 credits.

**Attribute/Distribution:** NS

**EES 032 Oceanography 4 Credits**

An introduction to the structure, composition, and processes of the earth from a marine perspective. Topics include earth structure, plate tectonics, continental margins, coastal processes, seawater chemistry, ocean circulation, wave dynamics, primary productivity, plankton and plants, marine organisms and communities. May be combined with EES 022 or EES 004 for 4 credits.

**Attribute/Distribution:** NS

**EES 042 The Natural History of Costa Rica 3 Credits**

The interaction of ecology, geology, and climate shaping the natural history of Costa Rica. Population, community, and ecosystem ecology; evolution and natural selection; biodiversity and conservation biology. Offered during the winter inter-term through Lehigh Study Abroad, and involving lectures, electronic media, observations, and field experiences. Consent of instructor required. Limited enrollment. Requires payment of additional program fee and transportation to Costa Rica.

**Attribute/Distribution:** NS

**EES 089 Geographic Analysis of our Changing World 3 Credits**

This course will introduce students to maps, spatial data, and electronic tools for geographic analysis. Fundamental geographic and database concepts will include map types, spatial referencing systems, map projection systems, map scale, and database characteristics. Tools including ArcGIS Desktop software and Global Positioning System receivers will be used to acquire and analyze spatially referenced data sets drawn from diverse sources and disciplines relating to the environment. Students will use their new skills in geographic analysis to develop an electronic portfolio, including a question-based map project. This course will prepare students for more advanced geographic analysis within the arts, humanities, social sciences, natural sciences, or engineering. Lecture demonstrations. May be combined with EES 022 or EES 004 for 4 credits.

**Attribute/Distribution:** NS

**EES 093 Freshman Supervised Internship in Earth and Environmental Sciences 1-2 Credit**

Experiential learning opportunities supervised by EES faculty, including fieldwork, data collection or analysis, literature review, and information management. A maximum of two credits is allowed. Consent of supervising faculty required.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** ND

**EES 100 Earth Systems Science 4 Credits**

Examination of the Earth as an integrated system. Study of interactions and feedbacks between key components such as the atmosphere, biosphere, geosphere, and hydrosphere to permit better understanding of the behavior of the system as a whole. Response of the Earth system to human perturbations such as land use and emissions are explored in the context of predictions of future environmental conditions and their projected impacts back on human systems. Lectures, class discussions, and lab. Prerequisites as noted below.

**Prerequisites:** (EES 022) and (EES 002 or ES 002 or GCP 002 or EES 004 or EES 011 or EES 012 or EES 014 or EES 015 or EES 016 or EES 021 or EES 023 or EES 024 or EES 025 or EES 026 or GCP 026 or EES 027 or GCP 027 or EES 028 or EES 031 or EES 042 or EES 089 or GCP 089 or EES 090 or EES 093)

**Can be taken Concurrently:** EES 002, ES 002, GCP 002, EES 004, EES 011, EES 012, EES 014, EES 015, EES 016, EES 021, EES 023, EES 024, EES 025, EES 026, GCP 026, EES 027, GCP 027, EES 028, EES 031, EES 042, EES 089, GCP 089, EES 090, EES 093

**Attribute/Distribution:** NS

**EES 105 Planetary Astronomy 4 Credits**

Structure and dynamics of planetary interiors, surfaces and atmospheres. Models for the formation of the solar system and planetary evolution. Internal structure, surface topology, and composition of planets and other bodies in our solar system. Comparative study of planetary atmospheres. Organic materials in the solar system. Properties of the interplanetary medium, including dust and meteoroids. Orbital dynamics. Planets orbiting other stars.

**Prerequisites:** (EES 022) and (EES 002 or ES 002 or GCP 002 or EES 004 or EES 011 or EES 012 or EES 014 or EES 015 or EES 016 or EES 021 or EES 023 or EES 024 or EES 025 or EES 026 or GCP 026 or EES 027 or GCP 027 or EES 028 or EES 031 or EES 042 or EES 089 or GCP 089 or EES 090 or EES 093)

**Attribute/Distribution:** NS

**EES 115 Surficial Processes 4 Credits**

An introduction to process geomorphology and sedimentology that emphasizes the dynamic interactions of climate, tectonics, and watershed hydrology on the erosional, transportational, depositional, and biological processes that shape landscapes. Includes a field and computer-intensive lab. Prerequisites as noted below.

**Prerequisites:** (EES 022) and (EES 002 or ES 002 or GCP 002 or EES 004 or EES 011 or EES 012 or EES 014 or EES 015 or EES 016 or EES 021 or EES 023 or EES 024 or EES 025 or EES 026 or GCP 026 or EES 027 or GCP 027 or EES 028 or EES 031 or EES 042 or EES 089 or GCP 089 or EES 090 or EES 093)

**Can be taken Concurrently:** EES 022, EES 002, ES 002, GCP 002, EES 004, EES 011, EES 012, EES 014, EES 015, EES 016, EES 021, EES 023, EES 024, EES 025, EES 026, GCP 026, EES 027, GCP 027, EES 028, EES 031, EES 042, EES 089, GCP 089, EES 090, EES 093

**Attribute/Distribution:** NS

**EES 131 Introduction to Rocks and Minerals 4 Credits**

Hand-specimen identification of the major mineral groups and rock types. Atomic structure of minerals; relationship of mineral structure to chemical and physical properties. Placement of igneous, sedimentary, and metamorphic rocks into a plate tectonics context. Introduction to optical mineralogy and x-ray diffraction techniques. Lectures, laboratories, field trips. Prerequisites as noted below.

**Prerequisites:** EES 022

**Attribute/Distribution:** NS

**EES 152 Ecology 4 Credits**

Basic principles and applications of ecological interrelationships. Examination of ecological phenomena at the individual, population, community, and ecosystem levels. Impact of human activities on global ecosystems. Prerequisites as noted below.

**Prerequisites:** (EES 022) and (EES 002 or ES 002 or GCP 002 or EES 004 or EES 011 or EES 012 or EES 014 or EES 015 or EES 016 or EES 021 or EES 023 or EES 024 or EES 025 or EES 026 or GCP 026 or EES 027 or GCP 027 or EES 028 or EES 031 or EES 042 or EES 089 or GCP 089 or EES 090 or EES 093)

**Can be taken Concurrently:** EES 022, EES 002, ES 002, GCP 002, EES 004, EES 011, EES 012, EES 014, EES 015, EES 016, EES 021, EES 023, EES 024, EES 025, EES 026, GCP 026, EES 027, GCP 027, EES 028, EES 031, EES 042, EES 089, GCP 089, EES 090, EES 093

**Attribute/Distribution:** NS

**EES 172 Topics in Earth & Environmental Science 1-4 Credit**

Study of topics in earth and environmental science not covered in other 100-level courses. May be repeated for credit. Primarily used for transfer credit. Consent of instructor required.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** NS

**EES 200 Earth History 4 Credits**

Review of the coevolution of Earth, life, climate, and the environment, and introduction to the records used to constrain this history. The course addresses environmental changes at both geologic and human time spans. Includes laboratory exercises and field trips. Prerequisites as noted below.

**Prerequisites:** EES 100

**Can be taken Concurrently:** EES 100

**Attribute/Distribution:** NS

**EES 201 Seismology: The Earth and Environment 4 Credits**

An examination of how earthquakes and active source seismology are used to understand the Earth beneath our feet. Fundamentals of seismic wave propagation in the Earth. Study of earthquakes, and reflection and refraction techniques at a variety of scales: near-surface, crustal, lithospheric, and whole Earth. Practical applications to both earth and environmental science, experiment design, data collection, processing, analysis and interpretation. Field and laboratory projects. Prerequisites as noted below.

**Prerequisites:** (EES 022 and EES 100)

**Attribute/Distribution:** NS

**EES 223 Structural Geology and Tectonics 4 Credits**

Material behavior of rocks and the architecture of the Earth's crust. Plate tectonic processes and plate margin deformation. Introduction to geologic maps and field techniques. Lectures, laboratories, and one or two weekend fieldtrips. Prerequisites as noted below.

**Prerequisites:** EES 115 or EES 131

**Can be taken Concurrently:** EES 131

**Attribute/Distribution:** NS

**EES 250 Terrestrial Ecosystems 4 Credits**

Ecosystem ecology in the context of the Earth system; discussion of mechanisms by which terrestrial ecosystems function, including the flow of water and energy and the cycling of carbon and nutrients; characterization of temporal and spatial patterns in ecosystem processes and their sensitivity to environmental and biotic changes; integration of global scale effects of these processes. Includes lectures, field trips and laboratories. Prerequisites as noted below.

**Prerequisites:** EES 115 or EES 152

**Attribute/Distribution:** NS

**EES 293 Supervised Internship in Earth and Environmental Sciences 1-4 Credit**

Experiential learning opportunities supervised by EES faculty, including data collection or analysis, literature review, and/or information management most likely as part of a longterm, continued project. The student should submit a work plan that describes activities involved and credits requested. A maximum of four credits of EES 293 and no more than eight credits combined from EES 093, EES 293 and 393 may be applied to EES B.A. and B.S. degrees (additional credits apply to free electives). Consent of supervising faculty required.

**Repeat Status:** Course may be repeated.

**EES 300 Apprentice Teaching 3 Credits****EES 306 Geologic Records of Environmental Change 3-4 Credits**

This course provides an overview of high-resolution geologic records of environmental and global change, how they are analyzed, and how they can be used in a variety of disciplines. Time series analysis, age control, completeness of sequences, and correlation of records will be covered. A class project will use acquisition and analysis of environmental magnetic data to demonstrate how records of global and environmental change are constructed. Prerequisites as noted below.

**Prerequisites:** EES 100 and EES 115

**Attribute/Distribution:** NS

**EES 316 Hydrogeology 3-4 Credits**

Water plays a critical role in the physical, chemical, and biological processes that occur at the Earth's surface. This course is an introduction to surface and groundwater hydrology in natural systems, providing fundamental concepts and a process-level understanding using the hydrologic cycle as a framework. Geochemistry will be integrated to address natural variations and the human impact on the environment. Topics covered include: watershed hydrology, regional and local groundwater flow, water chemistry, and management of water resources. Lectures and recitation/laboratory. Prerequisites as noted below, or consent of instructor.

**Prerequisites:** EES 100 and (EES 105 or EES 115 or EES 131 or EES 152 or EES 172)

**Can be taken Concurrently:** EES 105, EES 115, EES 131, EES 152, EES 172

**Attribute/Distribution:** NS

**EES 318 Geographic Analysis in EES 3,4 Credits**

This course will introduce students to traditional and digital maps, spatial data collection and analysis, and geodesy concepts. Students will apply these skills in case studies and projects relevant to Earth science and environmental sciences. Mapping tools including ArcGIS, ENVI, and Google Earth software, Global Positioning System receivers, and portable computing devices will be used to acquire and analyze spatially referenced data sets drawn from diverse sources and disciplines relating to the environment. Includes lectures and laboratory exercises. At least two EES courses at the 100-level or above are required.

**Prerequisites:** EES 100 and EES 115

**Attribute/Distribution:** NS

**EES 320 Engineering Hydrology 3 Credits**

Rainfall-runoff analysis, overland flow, hydrograph theories, modeling. Frequency analysis of extreme events. Flood routing. Design storms. Floodplain hydraulics, floodplain delineation. Prerequisites as noted below.

**Prerequisites:** (CEE 222)

**Attribute/Distribution:** NS

**EES 323 Environmental Groundwater Hydrology 3 Credits**

The study of subsurface water, its environment, distribution, and movement. Included are flow patterns, well hydraulics, and an introduction to the movement of contaminants. Design problems are included to simulate flow with analytical and numerical models, and contaminant migration using analytical models. Prerequisites as noted below or consent of instructor.

**Prerequisites:** CE 121 or CEE 316 or EES 316

**Attribute/Distribution:** NS

**EES 325 Remote Sensing of Terrestrial and Aquatic Environments 3,4 Credits**

Techniques of observing the Earth from air- and space-borne instruments, including issues of geometry and scale associated with making measurements, electromagnetic properties of Earth surface materials, the range of instruments used to observe the Earth, image interpretation, and applications of satellite remote sensing to geological, ecological, and environmental questions. Lecture and lab. Prerequisites as noted below or consent of instructor.

**Prerequisites:** EES 100

**Attribute/Distribution:** NS

**EES 327 Surface Water Quality Modeling 3 Credits**

Fundamentals of modeling water quality parameters in receiving water bodies, including rivers, lakes, and estuaries. Modeling of dissolved oxygen, nutrients, temperature, and toxic substances. Emphasis on water quality control decisions as well as mechanics and model building. Prerequisites as noted below.

**Prerequisites:** CEE 121 and (CEE 122 or CEE 222) and (CEE 170 or CEE 270)

**EES 334 Geosphere Structure and Evolution 3,4 Credits**

Synthesis of the state of knowledge of Earth structure and long-term evolution, with emphasis on the crust and mantle, and integrating petrologic, geophysical, and geochemical perspectives. Mass and energy transfer through time among the crust, mantle, hydrosphere, biosphere, and atmosphere. Petrographic study of selected rock suites, and introduction to geophysical observations of the deep structure of the solid Earth. Lectures, discussion, laboratories, field trip. Prerequisites as noted below or consent of instructor.

**Prerequisites:** EES 131 and EES 100 and EES 115

**Can be taken Concurrently:** EES 100, EES 115

**Attribute/Distribution:** NS

**EES 341 Field Camp in Earth and Environmental Sciences 6 Credits**

Integrated, capstone, geological, hydrological, and ecological field experiences using the diverse natural settings of the Rocky Mountains as the classroom. Projects challenge students to synthesize field data in solving real geologic and environmental science problems. A cross country trip is used to build a common knowledge base and introduce the student to the western landscape. Focus is on specific skills that are difficult to convey in the traditional classroom setting, including GIS/GPS computer-based geologic mapping, section measuring, structural analysis, stream hydrology, sediment transport, and landscape ecology. Five weeks in the field; summer session. Consent of Field Camp Director required. Students must apply through the Lehigh Field Camp Program. Must have declared major in EES. Prerequisites as noted below or consent of the program director.

**Prerequisites:** EES 131 and EES 115 and EES 152 and EES 223 and EES 316

**Attribute/Distribution:** NS

**EES 342 Meteorology 3,4 Credits**

An intermediate course on the basic principles of meteorology. The course considers atmospheric structure and composition, earth's energy balance and radiation laws, cloud formation and precipitation, atmospheric motion and circulation, including jet streams and planetary waves, atmospheric stability, frontal systems and air masses, regional climatologies, weather and climate modeling, and the latest ideas about future climate change and global warming. Students will view daily atmospheric charts to enable them to relate theory to observations from real weather data. Prerequisites as noted below.

**Prerequisites:** EES 100 and EES 200 and MATH 021 and MATH 022

**Attribute/Distribution:** NS

**EES 352 Limnology 3,4 Credits**

Study of inland waters, incorporating physical, chemical, and biological aspects of the environment. The origin and morphology of lakes; light, heat, carbon, salinity, nutrients (N+P), dissolved gases, primary production, and secondary production. Emphasis is on lakes, but watersheds, streams and wetlands are also considered. Relies heavily on laboratory exercises and data analysis to underscore critical principles in limnology.

**Attribute/Distribution:** NS

**EES 357 Paleocology and Landscape History 3-4 Credits**

Principles and methodologies of paleocology, with emphasis on palynology. Applications of paleo-records in tracing flora, vegetation, climate and landscape history. Long-term ecological interactions and ecosystem responses to past environmental change. Field and laboratory experiences in collecting and characterizing sediments and in processing and interpreting fossil pollen and other proxy data. Students will explore regional vegetation, climate and landscape history by coring and analyzing sediments from lakes and wetlands. Course requires one or more weekend day-long field trips. Prerequisites as noted below or consent of instructor.

**Prerequisites:** EES 100 or EES 115 or EES 152 or EES 250

**Attribute/Distribution:** NS

**EES 358 Microbial Ecology 3-4 Credits**

The role of microorganisms in the environment. Topics include: Survey of microbial classification, structure, and metabolism; study of microbes at population, community, and ecosystem levels of organization; the role of microbes in biogeochemical cycles; application of microbes to bioremediation and resource recovery problems. Fall (alternate (even) years). Prerequisites as noted below or consent of instructor.

**Prerequisites:** EES 152

**Attribute/Distribution:** NS

**EES 363 Volcanology 3,4 Credits**

Volcanic eruptions can result in devastating effects on both a regional and a global scale. This course will examine physical dynamics that control eruptive processes at active volcanoes. Topics will include the role of volatiles, magma decompression, magma chamber and conduit dynamics, magma rheology, crystallization, fragmentation criteria, and transitions from explosive to effusive behavior. We will examine specifically how geochemical/textural analyses of volcanic rocks and minerals can provide quantifiable information on eruption processes. Prerequisites: EES 131 and one other EES course at the 100 level or above.

**Prerequisites:** EES 131 and EES 115

**Attribute/Distribution:** NS

**EES 365 Ecophysiology 3,4 Credits**

Properties and processes of organisms for effective acquisition of energy and exchange of heat, water, minerals, and gases via atmosphere, soil, and water, including response to extreme environments. Special emphasis on the role of solar radiation and factors influencing its interactions with the organisms and the abiotic environment. Lecture, demonstration, laboratory. Prerequisites as noted below.

**Prerequisites:** EES 152 and (BIOS 120 or EES 200)

**Attribute/Distribution:** NS

**EES 371 Methods in Water Quality Analysis 3-4 Credits**

Survey of methods used in water quality analysis. The course will include: (1) theory and application of standard techniques and instrumentation, (2) quantitative analysis or modeling of existing or acquired data sets, and (3) data presentation and scientific report writing. Fulfills college writing intensive course requirements. Includes both lectures and laboratories.

**Prerequisites:** CHM 025

**Attribute/Distribution:** NS

**EES 372 Topics in Earth & Environmental Science 1-4 Credit**

Study of topics in earth and environmental science not covered in other 300-level courses. May be repeated for credit. Primarily used for transfer credit. Consent of instructor required.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** NS

**EES 376 Geochemistry of Natural Waters 4 Credits**

Introduction to aqueous geochemistry. Applications of thermodynamics, mass balance, systems science, and kinetics to understanding mineral-water interactions in natural aquatic systems on a variety of spatial and temporal scales. Laboratories emphasize analytical and computer methods. Lectures, discussion, student presentations, and recitation/laboratory.

**Prerequisites:** EES 115 and EES 100

**Can be taken Concurrently:** EES 100

**Attribute/Distribution:** NS

**EES 379 Environmental Case Studies 3-4 Credits**

Case studies will be used to explore the impact of politics, economics, society, technology, and ethics on environmental projects and preferences. Environmental issues in both affluent and developing countries. Multidisciplinary student teams investigate site characterization; environmental remediation design; environmental policy; and political, financial, social, and ethical implications of environmental projects. Prerequisites as noted below or consent of instructor.

**Prerequisites:** (EES 022 or CEE 276 or CHE 276)

**Attribute/Distribution:** NS

**EES 380 The Practice of Science 1 Credit**

The knowledge, skills, and discipline of mind developed in the Earth and Environmental Sciences major present students with a number of opportunities and career paths. This senior seminar provides students with the opportunity to synthesize their knowledge and expertise in EES in the context of the broader field and the opportunities and challenges facing society. The seminar also helps students explore a variety of career paths (industry, business, education, government, non-profits, etc.) and further develops professional skills. Students will build a portfolio of existing previous work and prepare a reflective narrative integrating their educational experiences into a greater whole. The seminar explores strategies for applying to graduate school or for a job, professional ethics and responsibility, and the methods and process of effective communication. Must have senior standing and EES major.

**Prerequisites:** EES 200

**Attribute/Distribution:** NS

**EES 386 Wetland Science 3,4 Credits**

Biophysical structure of wetlands and factors controlling wetland structure and function. Responses and feedbacks of wetlands to natural and human-induced environmental variability. Wetland classification and delineation, origin and development of wetlands; biotic adaptations to the wetland environment; wetland hydrology and biogeochemistry; wetland vegetation dynamics; and wetland restoration. Integrated activities with ES 461 (Wetland Policy and Valuation) provide an interdisciplinary exploration of science and policy issues. Lectures, laboratories, applied activities, and field trips. Not available to students who have taken ES 461, Wetland Policy and Valuation. Prerequisites as noted below or consent of instructor.

**Prerequisites:** EES 152 and EES 100

**Attribute/Distribution:** NS

**EES 393 Supervised Research in Earth and Environmental Sciences 1-4 Credit**

Research opportunities supervised by EES faculty to carry out a well-defined project, including exposure to problem definition, selection of research approach, and communication of results. The student should prepare a proposal and, if taking 3 or more credits, should present the results at Undergraduate Research Symposium and write a research thesis. Both proposal and thesis are filed with EES Department. No more than eight credits may be applied to EES B.A. and B.S. degrees (additional credits apply to free electives). Consent of instructor required.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** NS

**EES 402 Scientific Foundations for Environmental Policy Design 3 Credits**

This course explores the science behind the environmental issues that bear on policy process at local, national and global scales. The course delves into the science of selected environmental issues that have either arisen from anthropogenic activities, that impact social systems, or that help policy-makers understand the consequence of different policy options. The course consists of readings and discussions of timely topics and one major project.

**Attribute/Distribution:** NS

**EES 403 Earth System Modeling 3 Credits**

The concepts behind computer modeling, including stocks and fluxes, finite differencing, initial boundary conditions, feedbacks calibration, validation, data visualization, Monte Carlo, and sensitivity. We will apply these ideas to radiative energy balance, atmosphere and ocean dynamics, hydrological cycling, terrestrial carbon and nitrogen dynamics, and vegetation biogeography. Students will learn both agent-based and systems dynamics modeling using NetLogo and Stella, simple box modeling in Excel, and research-oriented models such as the NCAR Community Climate System Model using C++, Fortran and IDL.

**EES 405 Paleo- and Environmental Magnetism 3 Credits**

Topics in paleomagnetism and environmental magnetism. Class will design and conduct a research project, read the relevant literature and write a research paper. Consent of instructor required.

**EES 407 Seismology 3 Credits**

Seminar on advanced topics in seismology, review of classic and current literature. Topics include but are not limited to: wave propagation in ideal media and earth materials, seismic imaging of complex structures, tomography, modeling, and high-resolution seismic imaging. Must have completed an introductory geophysics course.

**EES 411 Physical and Chemical Processes at the Earth's Surface 3 Credits**

An advanced treatment of physical and chemical processes and their interaction in the critical zone. Quantitative methods, modeling, and process-oriented approaches are presented in a systems context from the meter, to watershed, to continental scale. Topics include weathering and soils, chemical and physical fluxes from watersheds, and global hydrology and erosion.

**EES 412 Advanced Fluvial and Tectonic Geomorphology 3 Credits**

Lecture, seminar, lab, and field-based investigation of the classic and contemporary geomorphologic literature using the processes and evolution of a watershed and its dynamic interaction with tectonics as an integrative common theme. Topics change according to student interest but typically include active tectonics, fluvial processes, landscape response to climate, and biogeomorphology. Include ArcGIS training, field trips, flume analogue modeling, and class projects with the goal of a published paper.

**EES 414 Glacial and Quaternary Geology 3 Credits**

Study of the origin, distribution, and movement of present and past glaciers. Special emphasis on glacial land forms and deposits, Quaternary stratigraphy and dating techniques, periglacial phenomena, and Pleistocene environments. Lectures and required field trips. Consent of instructor required.

**EES 415 Paleoclimatology 3 Credits**

Overview of climate system, including energy budget, feedbacks, atmospheric and ocean circulations, and their interactions. Earth's climate history and mechanisms of past climate variations at various time scales, with emphasis on late Quaternary. Lectures, presentations and discussion of recent literature, especially on approaches to studying climate change and paleo-perspectives on ongoing climate change. Must have graduate standing in EES, or consent of course instructor.

**Repeat Status:** Course may be repeated.

**EES 426 Tectonic Processes 3 Credits**

Current models of tectonic processes in intraplate settings and at plate boundaries. Critical evaluations by the class of the geological, geochemical and geophysical data sets which gave rise to these models. Must have graduate standing in EES, or consent of department chairperson.

**EES 427 Orogenic Belts 3 Credits**

Geometry, kinematics, and mechanics of orogenic belts. Course will explore current paradigms of depositional, deformational, and metamorphic processes in the Earth's crust. Lectures, seminars, and field trips. Typically variable may be repeated for credit. Consent of instructor required.

**Repeat Status:** Course may be repeated.

**EES 429 Methods and Applications of Geochronology 3 Credits**

Examination of isotopic techniques used to measure geologic time, and their applications. Lectures, laboratories, research projects, field trips. Must have graduate standing in EES. May be repeated for credit.

**Repeat Status:** Course may be repeated.

**EES 438 Petrogenetic Processes 3 Credits**

Metamorphism, melting, and magmatism in the Earth's crust and mantle. Tectonic evolution, crust-mantle heat and mass transfer, fluid-rock interactions, and rate processes. Varying combinations of lecture and seminar formats. May be repeated for credit when topics differ. May include laboratory and field experience and computational exercises. Consent of instructor required.

**Repeat Status:** Course may be repeated.

**EES 453 Advanced Microbial Ecology 3 Credits**

Lectures and seminars will focus on topics of current interest in the microbial ecology of pelagic (freshwater and marine), sediment, and/or soil environments. Emphasis will be placed on the role of microbes in ecosystems level processes such as energy transformations and elemental cycling. May include laboratory and field exercises. Must have graduate standing or consent of course instructor.

**EES 457 Advanced Remote Sensing of the Environment 3 Credits**

Seminars and hands-on, quantitative analysis of specialized satellite and aircraft data, including microwave and hyperspectral sources, will be used to investigate significant environmental questions. Students will refine visual and technical skills for image interpretation, digital image processing, change detection of environmental systems, and presentation of spatial data. Required research project. Must have graduate standing in EES or consent of the instructor.

**EES 459 Reconstructing Environmental Change 3 Credits**

Lectures, seminars, and in-depth discussion on current issues and selected topics in Quaternary paleoecology and paleoclimatology. Survey of techniques in studying and reconstructing environmental changes and biological responses. Use of multiple proxy data from paleo-archives (e.g., ice cores, lake sediments) to address nature of past climate variability. Quantitative analyses of paleo-records to test paleoecological hypothesis (e.g., multivariate analysis) and to infer possible causes and forcing mechanisms of past climate change (e.g., time series analysis). May include field and laboratory exercises.

**EES 471 Stable Isotope Chemistry - Theory, Techniques, and Applications in Earth and Environmental Sciences 3 Credits**

Distributions of stable isotopes (primarily of O, H, C, S, and N) in the lithosphere, hydrosphere, biosphere, and atmosphere. Topics include mechanisms of fractionation and mixing, advancements in techniques for extractions and mass spectrometry, and recent applications of stable isotopes in the earth and environmental sciences. Lectures, seminars, laboratory sessions. Consent of instructor required.

**EES 473 Aqueous Geochemistry 3 Credits**

Advanced study of the equilibria and kinetics of chemical reactions occurring at the earth's surface. A review of concepts in geochemistry including activity, solubility, thermodynamics, kinetics, and oxidation-reduction reactions is followed by readings from the literature. Topics covered depend on student interest, and have included chemical weathering, chemical evolution of surface and groundwater, acid mine drainage, trace element chemistry, biogeochemical cycles, and ocean chemistry. May be repeated for credit. Must have graduate standing in EES or consent of instructor.

**Repeat Status:** Course may be repeated.

**EES 476 Environmental Engineering Microbiology 3 Credits**

Fundamentals of microbiology and biochemistry applied to environmental systems and water quality control. Systems ecology, energetics and kinetics of microbial growth, nutrition and toxicology, use of microorganisms for pollution monitoring and control. Pathogenicity and disease transmission, water quality using biological indices. Prerequisites as noted below or consent of instructor.

**Prerequisites:** CEE 375 or CHE 375

**EES 484 Ecosystem Processes 3 Credits**

Theoretical and experimental approaches to investigate ecosystem processes at local, regional, and global scales. Emphasis on interactions among physical, chemical, and biotic components of ecosystems. Must have graduate standing in EES.

**EES 485 Advanced Topics in Geophysics 1-6 Credit**

Intensive study of topics in geophysics not covered in more general courses. May be repeated for credit.

**Repeat Status:** Course may be repeated.

**EES 487 Bio-Optics 3 Credits**

Bio-optics includes the ecosystem role and fate of solar radiation and the optical properties of biotic and abiotic components of ecosystems. This course will explore advanced topics through selected readings, data analysis, and modeling. Topics will emphasize aquatic ecosystems and may include optical models, atmospheric factors, inherent and apparent optical properties, algal fluorescence, photoadaptation and photodamage, ultraviolet radiation, and optical stratification.

**Repeat Status:** Course may be repeated.

**EES 490 Thesis Research 1-6 Credit**

Masters' thesis research directed by research committee. 3-6 credits required for EES M.S. programs. May be repeated for credit. Consent of research advisor required.

**Repeat Status:** Course may be repeated.

**EES 491 Investigations in Earth and Environmental Sciences 1-3 Credit**

Research on a special problem; field, laboratory, or library study; report required. Credit above three hours granted only when a different problem is undertaken.

**EES 492 Advanced Topics in Modern and Quaternary Processes 3 Credits**

Intensive study of topics in modern and Quaternary geology not covered in more general courses. May be repeated for credit.

**Repeat Status:** Course may be repeated.

**EES 493 Advanced Topics in Tectonics 1-6 Credit**

Intensive study of tectonic processes and products not covered in more general courses. May be repeated for credit.

**Repeat Status:** Course may be repeated.

**EES 494 Advanced Topics in Ecosystem Ecology 1-6 Credit**

Intensive study of ecosystem processes not covered in more general courses. May be repeated for credit.

**Repeat Status:** Course may be repeated.

**EES 496 Advanced Topics in Geochemistry 1-4 Credit**

Intensive study of geochemical processes not covered in more general courses. May be repeated for credit.

**Repeat Status:** Course may be repeated.

**EES 497 Advanced Topics in Paleoecology and Paleoclimatology 3 Credits**

Intensive study of paleoecology and paleoclimatology not covered in more general courses. May be repeated for credit.

**Repeat Status:** Course may be repeated.

**EES 499 Dissertation Research 1-15 Credit**

Ph.D. dissertation research directed by research committee. May be repeated for credit. Consent of research advisor required.

**Repeat Status:** Course may be repeated.

**Eckardt Scholars Program**

**Program Director:** Heather Johnson, Ph. D. (Northeastern)

**Email:** [hbj2@lehigh.edu](mailto:hbj2@lehigh.edu) # **Phone:** 610-758-3816

**Website:** <http://cas.cas2.lehigh.edu/content/eckardt>

*Supported by the Office of Interdisciplinary Programs 610-758-3996; [incasip@lehigh.edu](mailto:incasip@lehigh.edu)*

The Eckardt Scholars Program is a highly selective and unique honors program in the College of Arts and Sciences. The program emphasizes deep intellectual curiosity, independent work, and close mentoring relationships between the very highest achieving students and faculty at Lehigh. Students in the program are exempt from the Arts & Sciences distribution requirements and work with their major advisor and the Eckardt Scholars Program Director to create a flexible course of study that best suits their academic interests and ambitions. Although exempt from Arts and Sciences distribution requirements, students will complete the requisite number of credits for their degrees and all correlative requirements for their departmental or interdisciplinary majors. The program includes participation in two Eckardt Scholar Seminars, and completion of a large independent project (in the form of a thesis, artistic creation, or other capstone experience) during the senior year.

For program requirements, see Eckardt Scholars Program (p. 55).

**Courses****ECK 081 Eckardt Scholars Seminar 4 Credits**

Seminar for first-year Eckardt Scholars. Consent of program director required.

**Attribute/Distribution:** HU

**ECK 181 Eckardt Scholars Seminar 4 Credits**

Seminar for Eckardt Scholars. Consent of program director required.

**Attribute/Distribution:** HU

**ECK 281 Eckardt Scholars Seminar 4 Credits**

Seminar for Eckardt Scholars. Consent of program director required.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**ECK 282 Independent Study 2-4 Credits**

Directed readings for Eckardt Scholars. Requires consent of program director.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**ECK 389 Honors Project for Eckardt Scholars 1-8 Credit**

Opportunity for Eckardt Scholars to pursue an extended project for senior honors. May be repeated for credit up to a maximum 12 credit hours. Transcript will identify department in which project was completed. Consent of department required.

**Repeat Status:** Course may be repeated.

**English**

The Department of English has developed a focus on Literature and Social Justice, the outcome of a multi-year effort to revitalize the traditional period-based approach to literary studies. Our classes foster a series of related activities: an exploration of how studying literature contributes to questions of social justice; an immersion in historical periods informed by strong theoretical commitments; an engagement with contemporary literature and culture; and an emphasis on theorized pedagogy, reflective practice, and the scholar-teacher model. Our faculty interact with Lehigh's varied interdisciplinary programs, including Africana Studies, Classics, Women's Studies, Jewish Studies, and American Studies.

**Professors.** Elizabeth Fifer, PhD (University of Michigan Ann Arbor); Edward J. Gallagher, PhD (Notre Dame College); Scott Paul Gordon, DA (Harvard University); Donald E. Hall, PhD (University of Maryland College Park); Barry M. Kroll, PhD (University of Michigan Ann Arbor); Barbara R. Pavlock, PhD (Cornell University); Barbara H. Traister, PhD (Yale University)

**Associate Professors.** Katherine Crassons, PhD (Duke University); Elizabeth A. Dolan, PhD (University of North Carolina); Dawn Keetley, PhD (University Wisconsin at Madison); David Michael Kramp, PhD (Washington State University); Edward E. Lotto, PhD (Indiana University); Seth Moglen, PhD (University of California Berkeley); James B. Peterson, PhD (University of Pennsylvania); Amardeep Singh, PhD (Duke University); Billie S Watts, PhD (University of Missouri Columbia); Edward Whitley, PhD (University of Maryland College Park)

**Assistant Professors.** Lyndon Dominique, PhD (Princeton University); Suzanne Edwards, PhD (University of Chicago); Mary C. Foltz, PhD (SUNY College Buffalo); Jenna D. Lay, PhD (Stanford University); Bobby Michael Watts, PhD (University of Missouri Columbia)

**Emeriti.** Rosemarie Arbur, PhD (University of Illinois at Chicago); Peter G. Beidler, PhD (Lehigh University); Addison C. Bross, PhD (Louisiana State University at Eunice); Jack A. DeBellis, PhD (University of California Los Angeles); Jan S. Fergus, PhD (City University New York); Robert R. Harson, PhD (Ohio State University); Rosemary J. Mundhenk, PhD (University of California Los Angeles); John F. Vickrey, PhD (Indiana University Indianapolis)

**Undergraduate Major in English**

The major in English is designed to give students experience in reading, analyzing, and formulating thoughts about people and ideas that matter; an understanding of how literary artists find the appropriate words to



express their thoughts and feelings; and a basic knowledge of the historical development of British, American and world literature.

Students who major in English go on to careers in teaching, writing, law, business, science, medicine, engineering—and many others. The analytical and communication skills acquired in the study of literature and writing will be of use in almost any profession or human activity. Depending on their interests, abilities, and career plans, students who major in English are encouraged to consider double majors or one or two minors in other fields. The major in English is flexible enough to allow cross-disciplinary study with ease.

The student majoring in English chooses from an extensive list of courses. To ensure breadth of coverage each English major is required to take the following courses:

ENGL 100	Working with Texts	4
ENGL 290	Senior Seminar	4

Select four of the following:<sup>1</sup>

<b>British to 1660</b>		
ENGL 125	British Literature I	
ENGL 327	Major Medieval Writers	
ENGL 328	Shakespeare	
ENGL 360	Middle English Literature	
ENGL 362	The Sixteenth Century	
ENGL 364	The Seventeenth Century	
<b>British 1660-1900</b>		
ENGL 125	British Literature I	
ENGL 126	British Literature II	
ENGL 331	Milton	
ENGL 366	British Eighteenth-Century Literature	
ENGL 367	Transatlantic Eighteenth-Century Literature	
ENGL 369	Romantic-Era Literature	
ENGL 371	British Victorian Literature: Prose and Poetry	
ENGL 372	Victorian Literature	
<b>American to 1900</b>		
ENGL 123	American Literature I	
ENGL 374	Literature of Contact in the Americas	
ENGL 376	Early American Literature	
ENGL 377	American Romanticism	
ENGL 378	American Realism	
<b>20th C American, British, World, Film, Popular Culture</b>		
ENGL 124	American Literature II	
ENGL 126	British Literature II	
ENGL 379	Modern American Literature	
ENGL 380	Contemporary American Literature	
ENGL 383	Modernism and Post-Modernism in Fiction	
ENGL 384	Contemporary World and Postcolonial Literature	
ENGL 385	Modern British and Irish Literature	
ENGL 386	Contemporary British Literature	
ENGL 387	Film History, Theory, and Criticism	
Select at least three more courses in literature or film. <sup>2</sup>		9
<b>Total Credits</b>		<b>17</b>

<sup>1</sup> Four 300-level courses distributed over the following periods (British or American survey may substitute for one 300 level course)

<sup>2</sup> Courses in literature or film with the following qualifications:  
 • at least one at the 300-level if a survey fulfills one of the period requirements  
 • may include one advanced writing course taken in English

These nine courses are the minimum for the major. Many of our students will elect to take more, depending on their career plans, their other majors and minors, their plans to study abroad, and so on. Each

major has a departmental advisor to assist in selecting courses and to offer counsel about career plans.

The department strongly recommends that any student contemplating the possibility of advanced study of literature at the graduate level should work toward departmental honors.

#### English Major with Concentration in Creative Writing

Minimum number of hours: 16 (4 courses)

To have entered on the transcript *Concentration in Creative Writing*, the students must take:

Select one of the following:		4
ENGL 142	Introduction to Writing Poetry	
ENGL 143	Introduction to Writing Creative Non-Fiction	
ENGL 144	Introduction to Writing Fiction	
Select one of the following:		4
ENGL 342	Advanced Poetry Writing	
ENGL 343	Advanced Creative Non-Fiction	
ENGL 344	Advanced Fiction Writing	
Select one of the following: <sup>1</sup>		4
ENGL 142	Introduction to Writing Poetry	
ENGL 143	Introduction to Writing Creative Non-Fiction	
ENGL 144	Introduction to Writing Fiction	
ENGL 170	Amaranth	
ENGL 201	Special Topics in Writing	
ENGL 342	Advanced Poetry Writing	
ENGL 343	Advanced Creative Non-Fiction	
ENGL 344	Advanced Fiction Writing	
ENGL 483	Creative Writing and Literary Studies	
ENGL 305 & ENGL 306	Creative Writing Thesis Proposal and Creative Writing Thesis	4
<b>Total Credits</b>		<b>16</b>

<sup>1</sup> Note: the same course cannot fulfill both the core requirement except in the case of courses that can be repeated for credit—ENGL 201, ENGL 342, ENGL 343 and ENGL 344—which can be taken twice, once for core credit and once as an elective.

#### Departmental Honors in English

In order to receive departmental honors the English major must attain a 3.5 grade-point average in courses presented for the major and must complete at least 44 credit hours of course work in English (beyond ENGL 001 and ENGL 002). For the additional credits beyond the 36 required of all English majors, honors students must take the following courses:

ENGL 309	Interpretation: Critical Theory and Practice	3-4
ENGL 312	Studies in Literary and Cultural Theory	3
ENGL 307	Undergraduate Thesis Proposal	1
ENGL 308	Undergraduate Thesis	3
<b>Total Credits</b>		<b>10-11</b>

Because most graduate schools require language examinations, the department also strongly recommends that students going for honors achieve at least second-year college competency in at least one foreign language. Students who complete the courses required for departmental honors but who do not achieve the necessary grade-point average will receive the bachelor of arts degree with a major in English.

#### Presidential Scholars

Students who anticipate becoming Presidential Scholars should speak to the Director of Graduate Studies in their junior year.

#### Minors in English

The Department of English offers three minors, each requiring 16 hours of course work beyond English 1 and 2. Students' major advisors

monitor the minor programs, but students should consult the minor advisor in the Department of English when setting up a minor program.

To minor in English students take 4 courses in literature or film, one at the 300 level.

To minor in creative writing, students take:

Select one of the following:	4
ENGL 142 Introduction to Writing Poetry	
ENGL 143 Introduction to Writing Creative Non-Fiction	
ENGL 144 Introduction to Writing Fiction	
A literature course at the 100- or 300-level.	3
Select one of the following:	4
ENGL 342 Advanced Poetry Writing	
ENGL 343 Advanced Creative Non-Fiction	
ENGL 344 Advanced Fiction Writing	
Select one of the following: <sup>1</sup>	4
ENGL 142 Introduction to Writing Poetry	
ENGL 143 Introduction to Writing Creative Non-Fiction	
ENGL 144 Introduction to Writing Fiction	
ENGL 170 Amaranth	
ENGL 201 Special Topics in Writing	
ENGL 342 Advanced Poetry Writing	
ENGL 343 Advanced Creative Non-Fiction	
ENGL 344 Advanced Fiction Writing	
ENGL 483 Creative Writing and Literary Studies	
<b>Total Credits</b>	<b>15</b>

<sup>1</sup> Note: the same course cannot fulfill both the core requirements except in the case of a course that can be repeated for credit—ENGL 201, ENGL 342, ENGL 343, and ENGL 344—which can be taken twice, once for core credit and once as an elective.

To minor in writing, students take:

Select one of the following:	4
ENGL 142 Introduction to Writing Poetry	
ENGL 143 Introduction to Writing Creative Non-Fiction	
ENGL 144 Introduction to Writing Fiction	
ENGL 171 Writing for Audiences	
Select one of the following:	4
ENGL 201 Special Topics in Writing	
ENGL 342 Advanced Poetry Writing	
ENGL 343 Advanced Creative Non-Fiction	
ENGL 344 Advanced Fiction Writing	
Select two of the following: <sup>1</sup>	8
ENGL 142 Introduction to Writing Poetry	
ENGL 143 Introduction to Writing Creative Non-Fiction	
ENGL 144 Introduction to Writing Fiction	
ENGL 171 Writing for Audiences	
ENGL 201 Special Topics in Writing	
ENGL 342 Advanced Poetry Writing	
ENGL 343 Advanced Creative Non-Fiction	
ENGL 344 Advanced Fiction Writing	
JOUR 111 Sportswriting	
JOUR 123 Basic Science and Technical Writing	
JOUR 212 Feature Writing	
<b>Total Credits</b>	<b>16</b>

<sup>1</sup> Note: the same course cannot fulfill both the core requirements except in the case of a course that can be repeated for credit—ENGL 201, ENGL 342, ENGL 343, and ENGL 344—which can be taken twice, once for core credit and once as an elective.

### Freshman Composition Requirement

With the two exceptions noted below, all undergraduate students take six credit hours of freshman English courses:

ENGL 001	Composition and Literature	3
ENGL 002	Composition and Literature II <sup>1</sup>	3
<b>Total Credits</b>		<b>6</b>

<sup>1</sup> Or one of the alternatives to ENGL 002 such as ENGL 004, ENGL 006, ENGL 008 or ENGL 010.

The exceptions are:

- Students who receive Advanced Placement or received 700 or higher on the writing section of the SAT or score a 5 on the IB High Level Examination.
- Students with English as a Second Language. Categories include students on non-immigrant visas, students on immigrant visas, registered aliens, and citizens either by birth or by naturalization.

Students in all these categories for whom English is not the first language may petition for special instruction through the program in English as a Second Language.

All non-native English speakers will be assessed in their English skills either through the TOEFL or by other means to determine the kind of instruction best suited to their needs. From this determination, matriculating freshmen will either roster ENGL 001, followed by ENGL 002, ENGL 004, ENGL 006, ENGL 008, or ENGL 010 or be enrolled in ENGL 003, followed by ENGL 005 (or ENGL 002, ENGL 004, ENGL 006, ENGL 008, or ENGL 010).

Students enrolled in the English as a Second Language program are expected to reach a level of competence comparable to those in the usual freshman program. The form of instruction, however, will differ in the ESL program by taking into account the special language and cultural needs of non-native speakers.

Matriculating students in all the above categories who are entering at a level above the freshman year, but who need composition credit, should consult the department for advice.

### Graduate Work in English

We prepare our students to meet contemporary demands for faculty who value excellence in teaching and scholarship.

#### The Master of Arts Program

Applicants for the M.A. program should have an undergraduate English major. Students who did not major in English may be admitted but will need to supplement their undergraduate training in English.

Candidates for the master's degree must complete at least 33 credit hours. Students take at least seven of the required courses (including Thesis) at the 400 level but may select the balance of their curricula from 300-level course offerings. Course work for the M.A. must include:

Select one course in medieval British or early American literature (origins through 1776)	3-4
Select two courses in British literature, origins through 1660, or American literature, origins through 1820 <sup>1</sup>	6-8
Select two courses in British literature, 1660 through 1900, or American literature, 1820 through 1900	6-8
Select two courses, British, American, or world literature, 1900 to present	6-8
Select one theory course, in literature, writing, or film.	3-4
ENGL 490 Master's Thesis	3
<b>Total Credits</b>	<b>27-35</b>

<sup>1</sup> In addition to the one fulfilling the previous requirement.

At least two of the courses must be in American literature, at least four in British literature. This distribution allows for some concentrated study

at the master's level. ENGL 485 and ENGL 486, the required courses for new teaching fellows, are not counted in the 33 credits toward the M.A. but will be counted later toward the Ph.D., even if rostered during the M.A. program.

M.A. candidates write a Thesis Paper, certified by a faculty advisor as ready for submission to a session organizer as a conference presentation or to a professional journal for possible publication, and present a short talk on the thesis paper in a public forum.

#### **The Doctor of Philosophy Program**

The department admits to its doctoral program only students of proven competence and scholarly promise. An average of 3.5 in M.A. course work and strong endorsements from graduate instructors are minimum requirements for acceptance.

Doctoral candidates with a Lehigh master's degree are required to take eight courses and register for 42 credit hours beyond the M.A. Those entering the doctoral program with a master's from another institution are required to take nine courses and register for 48 credit hours.

Candidates must also demonstrate a reading knowledge of one or two foreign languages after having agreed on choices with the director of graduate studies.

No later than six months after completing their course work, candidates will take written and oral examinations in one major field and two minor fields.

Candidates write their dissertations after having their dissertation proposals approved by the department and being admitted to candidacy by the appropriate college.

#### **Undergraduate Courses**

ENGL 052, ENGL 054, ENGL 056, and ENGL 058 are open to all undergraduates, including first-year students also taking freshman English. Courses numbered at the 100-level are open to students who have completed or who are exempt from the required six hours of freshman English. First-year students who have completed with a grade of A or A- may roster one of the 100-level courses as a second English course to be taken concurrently with the second-semester English composition requirement.

Prerequisites: Each course is a self-contained unit. None has any other prerequisite than two semesters of freshman English. Thus, students may roster ENGL 126 whether or not they have had, or ever plan to take, ENGL 125. For all courses above 200, it is understood that students will have completed six hours of freshman English, even though that is not specified in the course description.

**Graduate Students taking 300-level courses receive 3 credits; undergraduates receive 4 credits.**

#### **Graduate Courses in English**

The following courses are seminars, ordinarily limited to no more than twelve graduate students, but undergraduate English majors who are planning to go on to graduate school in English and who have shown proficiency in the study of literature may petition to take one of these seminars in their senior year.

#### **Courses**

##### **ENGL 001 Composition and Literature 3 Credits**

Emphasis on the writing process, especially on revising for cogency and clarity. Topics drawn mainly from everyday life and culture. Students must receive a grade of C- or higher to advance to English 2.

**Attribute/Distribution:** ND

##### **ENGL 002 Composition and Literature II 3 Credits**

Continuation of ENGL 1. Emphasis on making informed, thoughtful, and well-supported claims about issues of broad public concern. Topics vary by section. Texts include both expository and literary selections, as well as films and other media. Must have a grade of C- or higher in ENGL 1.

**Prerequisites:** (ENGL 001)

**Attribute/Distribution:** ND

##### **ENGL 003 Composition and Literature I for International Writers 3 Credits**

Students improve both their advanced academic written English and academic writing style through a process of reading fiction and non-fiction and by writing well-organized, coherent essays for academics. Author citation, style, and written fluency and accuracy are addressed within students' writing. Enrollment is limited to nonnative speakers; prior academic writing history, English placement testing, and/or ESL director's recommendation determines placement.

**Attribute/Distribution:** ND

##### **ENGL 004 Composition and Literature II: Special Topic A 3 Credits**

Continuation of ENGL I. Similar to ENGL 2, except that the topic will be announced in advance. Topics vary from year to year. Students must register through the English department. Consent of department required. Prerequisites as noted below.

**Repeat Status:** Course may be repeated.

**Prerequisites:** (ENGL 001)

**Attribute/Distribution:** ND

##### **ENGL 005 Composition and Literature II for International Writers 3 Credits**

Continuation of English 3. Students practice more advanced methods and modes of writing for academics, including writing and reading for their specific field of study. Students continue to work on advanced written fluency and accuracy of idiomatic language and expression and are taught advanced methods of author citation and source integration. Pre-requisite: ENGL 003.

**Prerequisites:** (ENGL 003)

**Attribute/Distribution:** ND

##### **ENGL 006 Composition and Literature: Special Topic B 3 Credits**

Continuation of ENGL I. Similar to ENGL 2, except that the topic will be announced in advance. Topics vary from year to year. Students must register through the English department. Consent of department required. Prerequisites as noted below.

**Repeat Status:** Course may be repeated.

**Prerequisites:** (ENGL 001)

##### **ENGL 007 Global Literature 3 Credits**

This multidisciplinary seminar asks students to explore the notion of "global citizenship" by using the lens of literature, i.e., by applying rhetorical and persuasive techniques to address various issues. Literature from the country or region targeted by the intercession trip will be the object of the students' explorations. English 002 equivalent.

**Attribute/Distribution:** HU

##### **ENGL 008 Composition and Literature: Special Topic C 3 Credits**

Continuation of ENGL I. Similar to ENGL 2, except that the topic will be announced in advance. Topics vary from year to year. Students must register through the English department. Consent of department required. Prerequisites as noted below.

**Repeat Status:** Course may be repeated.

**Prerequisites:** (ENGL 001)

##### **ENGL 010 Composition and Literature: Special Topic D 3 Credits**

Continuation of ENGL I. Similar to ENGL 2, except that the topic will be announced in advance. Topics vary from year to year. Students must register through the English department. Consent of department required. Prerequisites as noted below.

**Repeat Status:** Course may be repeated.

**Prerequisites:** (ENGL 001)

##### **ENGL 011 Literature Seminar for Freshmen 3 Credits**

Alternative to Composition and Literature for freshmen who have earned exemption from English 1 and qualify for a seminar in literature. Recommended especially for qualified students who are considering a major in the humanities. Topics vary by section. Must have a score of 4 on Advanced Placement Test in English or 700-749 or higher on the writing section of the SAT.

**Prerequisites:** APEN 4 or APES 4 or ATWR 700 or S07 700

**Attribute/Distribution:** ND

**ENGL 015 Speech Communication for International Speakers of English 1 Credit**

Spoken English improvement through the practice of American English in "real contexts." This course is for first or second year undergrads who have advanced English skills, but who need to improve their advanced communication and idiomatic language skills for the advanced speaking contexts of the American university classroom and campus. Advanced Spoken English accent improvement and academic presentations skills are also practiced as needed.

**Attribute/Distribution:** ND

**ENGL 038 Introduction to African Literature 3 Credits**

Sub-Saharan African literary themes and styles; historical and social contexts, African folktales, oral poetry, colonial protest literature, postcolonial writing, and films on contemporary Africa.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**ENGL 052 Classical Epic 4 Credits**

Study of major epic poems from Greece and Rome. Works include Homer's Iliad and Odyssey, Apollonius' Argonautica, Vergil's Aeneid, and Ovid's Metamorphoses.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**ENGL 054 Greek Tragedy 4 Credits**

Aspects of Greek theater and plays of Aeschylus, Sophocles, and Euripides in their social and intellectual contexts.

**Attribute/Distribution:** HU

**ENGL 056 Topics in Greek and Roman Literature 4 Credits**

Classical literature in translation, including themes or specific periods in Greek or Roman literature. May be repeated for credit, as topics vary.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**ENGL 058 Greek and Roman Comedy 4 Credits**

Study of comedy as a social form through plays of Aristophanes, Menander, Plautus, and Terence.

**Attribute/Distribution:** HU

**ENGL 060 Dramatic Action 4 Credits**

How plays are put together; how they work and what they accomplish. Examination of how plot, character, aural and visual elements of production combine to form a unified work across genre, styles and periods. Recommended as a foundation for further studies in design, literature of performance.

**Attribute/Distribution:** HU

**ENGL 091 Special Topics 1-4 Credit**

A topic, genre, or approach in literature or writing not covered in other courses.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**ENGL 100 Working with Texts 4 Credits**

A course to help students to become, through intense practice, independent readers of literary and other kinds of texts; to discern and describe the devices and process by which texts establish meaning; to gain an awareness of the various methods and strategies for reading and interpreting texts; to construct and argue original interpretations; to examine and judge the interpretations of other readers; to write the interpretive essay that supports a distinct position on some literary topic of importance; and to learn to find and assimilate into their own writing appropriate information from university library resources. To be rostered as early as possible in the English major's program.

**Attribute/Distribution:** HU

**ENGL 115 Topics in Literature, Medicine, and Health 4 Credits**

Largely focused on narratives about health, illness and disability, this course will examine individual experiences with attention to social context. Topics may include the physician/patient relationship, illness and deviance, plague literature, gender and medicine, autism, AIDS, mental illness, aging.

**Attribute/Distribution:** HU

**ENGL 120 Literature from Developing Nations 4 Credits**

Contemporary literature from Africa, Central and South America, and Asia. Must have completed six hours of freshman English. Cannot be taken pass/fail.

**Attribute/Distribution:** HU

**ENGL 121 Topics in African-American Literature 4 Credits**

Selected works of African American literature and/or the literatures of the African diaspora. May be repeated for credit as title varies. Must have completed six hours of first-year English. Cannot be taken pass/fail.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**ENGL 123 American Literature I 4 Credits**

American literary works through the mid-19th century. Must have completed six hours of freshman English. Cannot be taken pass/fail.

**Attribute/Distribution:** HU

**ENGL 124 American Literature II 4 Credits**

American literature from the middle of the 19th century to the present. Must have completed six hours of freshman English. Cannot be taken pass/fail.

**Attribute/Distribution:** HU

**ENGL 125 British Literature I 4 Credits**

British literature and literary history from Beowulf through the Pre-Romantics. Must have completed six hours of freshman English. Cannot be taken pass/fail.

**Attribute/Distribution:** HU

**ENGL 126 British Literature II 4 Credits**

British literature and literary history from the Romantic period into the 20th century. Must have completed six hours of freshman English. Cannot be taken pass/fail.

**Attribute/Distribution:** HU

**ENGL 127 The Development of Theatre and Drama I 4 Credits**

Historical survey of western theatre and dramatic literature from their origins to the Renaissance.

**Attribute/Distribution:** HU

**ENGL 128 The Development of Theatre and Drama II 4 Credits**

Historical survey of western theatre and dramatic literature from the Renaissance to the modern era.

**Attribute/Distribution:** HU

**ENGL 138 Introduction to African American Literature 4 Credits**

Survey of African American prose narrative and poetry from the 18th century to the present. Features writers from the Harlem Renaissance, the Black Arts Movement, and the post-Black Power era.

**Attribute/Distribution:** HU

**ENGL 142 Introduction to Writing Poetry 4 Credits**

Instruction in the craft of writing poetry, with a focus on prosody. Practice in and classroom criticism of poems written by students taking the course. May be repeated for credit. Must have completed six hours of freshman English.

**Attribute/Distribution:** ND

**ENGL 143 Introduction to Writing Creative Non-Fiction 4 Credits**

Practice in writing non-fiction from immediate experience, with emphasis on accurate, persuasive description writing. May be repeated for credit. Must have completed six hours of freshman English.

**Attribute/Distribution:** ND

**ENGL 144 Introduction to Writing Fiction 4 Credits**

Instruction in the craft of writing fiction. Practice in and classroom criticism of stories written by students taking the course. May be repeated for credit. Must have completed six hours of freshman English.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** ND

**ENGL 155 The Novel 4 Credits**

Selected novels, with attention to such matters as narrative, characterization, and cultural context. Must have completed six hours of freshman English. Cannot be taken pass/fail.

**Attribute/Distribution:** HU

**ENGL 157 Poetry 4 Credits**

Selected traditional and modern poetry, with attention to voice, form, and cultural context. Must have completed six hours of freshman English. Cannot be taken pass/fail.

**Attribute/Distribution:** HU

**ENGL 163 Topics in Film Studies 4 Credits**

History and aesthetics of narrative film. May be repeated for credit as subject varies. Must have completed six hours of freshman English. Cannot be taken pass/fail.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**ENGL 170 Amaranth 1 Credit**

Amaranth editorial staff. Students can earn one credit by serving as editors (literary, production, or art) of Lehigh's literary magazine. Work includes soliciting and reviewing manuscripts, planning a winter supplement and spring issue, and guiding the magazine through all phases of production. Editors attend weekly meetings with the faculty advisor. Consent of department chair required. May be repeated for credit.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** ND

**ENGL 171 Writing for Audiences 4 Credits**

Practice in writing in a variety of discourse modes for different audiences. Consideration of the role of style, clarity, and careful observation in writing. Must have completed six hours of freshman English.

**Attribute/Distribution:** ND

**ENGL 175 Individual Authors 4 Credits**

Intensive study of the works of one or more literary artists, such as Austen, Hemingway, and Kerouac. May be repeated for credit as artists and works vary. Must have completed six hours of freshman English. Cannot be taken pass/fail.

**Attribute/Distribution:** HU

**ENGL 177 Individual Works 4 Credits**

Intensive study of one or more literary works, such as Moby Dick, and study of other major texts such as the Bible with attention to literary form. May be repeated for credit as works vary. Must have completed six hours of freshman English. Cannot be taken pass/fail.

**Attribute/Distribution:** HU

**ENGL 183 Independent Study 1-4 Credit**

Individually supervised study of a topic in literature, film, or writing not covered in regularly listed courses. Consent of department chair required.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**ENGL 187 Themes in Literature 4 Credits**

Study of a theme as it appears in several works of literature, such as Love in the Middle Ages. May be repeated for credit as titles and themes vary. Must have completed six hours of freshman English. Cannot be taken pass/fail.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**ENGL 189 Popular Literature 4 Credits**

The form of literature that has been designated in one way or another as "popular," such as folklore and detective fiction. May be repeated for credit as titles vary. Must have completed six hours of freshman English. Cannot be taken pass/fail.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**ENGL 191 Special Topics 1-4 Credit**

A topic, genre, or approach in literature or writing not covered in other courses. Must have completed six hours of freshman English.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**ENGL 201 Special Topics in Writing 1-4 Credit**

Approaches not covered in other writing courses. Individual projects. May be repeated for credit.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** ND

**ENGL 282 Professional Internship 1-4 Credit**

Individualized work experience, on- or off-campus, in a field that a student of English wishes to explore as a career. Before registering, a student must meet with the internship adviser and obtain departmental approval. Internship credits do not count toward major in English. Sophomore standing and departmental approval required.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** ND

**ENGL 290 Senior Seminar 4 Credits**

In-depth study of a problem, issue, question, or controversy. Enrollment limited to 15 students. Required writing intensive course for English majors. May be repeated for credit, space permitting, as title varies. Consent of department required. Must have senior English major standing.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**ENGL 291 Special Topics 1-4 Credit**

A topic, genre, or approach in literature or writing not covered in other courses.

**ENGL 300 Apprentice Teaching 1-4 Credit**

**Repeat Status:** Course may be repeated.

**ENGL 301 Topics in Literature 3-4 Credits**

A theme, topic, or genre in literature, such as autobiography as literature and the gothic novel. May be repeated for credit as titles vary.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**ENGL 303 Grimms' Fairy Tales: Folklore, Feminism, Film 3-4 Credits**

This intercultural history of the Grimms' fairy tales investigates how folktale types and gender stereotypes developed and became models for children and adults. The course covers the literary fairy tale in Germany as well as Europe and America. Versions of "Little Red Riding Hood", "Cinderella", or "Sleeping Beauty" exist not only in the Grimms' collection but in films and many forms of world literature. Modern authors have rewritten fairy tales in feminist ways, promoting social change. Taught in English. German language students may receive a German component.

**Attribute/Distribution:** HU

**ENGL 305 Creative Writing Thesis Proposal 1 Credit**

Preparation to write creative thesis. Requirements include writing a proposal and bibliography.

**Attribute/Distribution:** ND

**ENGL 306 Creative Writing Thesis 3 Credits**

Portfolio of original creative work in poetry, fiction, or creative non-fiction, plus introductory researched essay. Required for concentration in creative writing.

**Attribute/Distribution:** ND

**ENGL 307 Undergraduate Thesis Proposal 1 Credit**

Course to be enrolled by senior honors students preparing to write honors thesis. Course requirements include conducting preliminary research for the thesis and writing a detailed thesis proposal and bibliography. May not be rostered concurrently with English 308.

**Attribute/Distribution:** HU

**ENGL 308 Undergraduate Thesis 3 Credits**

Open to advanced undergraduates who wish to submit theses in English. Consent of department chair required.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**ENGL 309 Interpretation: Critical Theory and Practice 3-4 Credits**

Introduction to recent literary and cultural theory, such as New Criticism, Structuralism, Marxism, Psychoanalytic approaches, Reader-response Criticism, Deconstruction, Feminist Theory, New Historicism, and Cultural Criticism.

**Attribute/Distribution:** HU

**ENGL 310 Introduction to Methods of English as a Second Language Instruction 3,4 Credits**

An introduction to teaching English as a second language including the theory and principles of second language acquisition, ESL methods, materials, and current trends such as computer assisted language instruction. With sufficient effort, students will learn to plan and teach an ESL/EFL class in the four areas of Writing, Reading, Speaking and Listening, choose appropriate materials for varying age and proficiency levels, and most importantly, have a concrete approach to teaching ESL/EFL. Required classroom observing and tutoring hours that can be completed in Lehigh's ESL classes, in Lehigh's ELLC language lab, or in the local public school ESL classes. Course restricted to upperclass and graduate students.

**Attribute/Distribution:** HU

**ENGL 311 Gender and Literature 3-4 Credits**

This course explores constructions of gender and sexuality in literature from different historical periods, traditions, and nationalities. How do female and male writers envision what it means to be a "woman" or to be a "man" at various moments in history and from various places around the world? How have gendered (and sexed) identities been shaped in various constraining and empowering ways in the literary imagination? What specifically gendered issues (such as love and violence) have been represented in literature? Content changes each semester. May be repeated for credit as title changes.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**ENGL 312 Studies in Literary and Cultural Theory 3 Credits**

Study of a particular contemporary theoretical approach to literature, film, or other cultural texts. May be repeated for credit as the topic changes.

**Attribute/Distribution:** HU

**ENGL 314 Teaching English as a Second Language: A Practicum 1-4 Credit**

Companion course to English 310 (Intro to Methods of English as a Second Language). This course will include class meetings that focus on guided discussions of the practical application of principles and practices of ESL pedagogy in a real-world environment. Supervised ESL classroom student teaching required. Prerequisites as noted below.

**Prerequisites:** ENGL 310

**Attribute/Distribution:** ND

**ENGL 315 Topics in Literature, Medicine, and Health 3-4 Credits**

Analyzing the stories people tell about health, illness and disability, this course engages cultural studies approaches in order to explore the way those stories are told. Topics may include: illness and the graphic novel, the changing image of the healer in literature, collaborative storytelling with Alzheimer's patients, end of life narratives, tales from the ER, narrative ethics. May be repeated for credit as title varies.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**ENGL 316 Native American Literature 3-4 Credits**

This course is a survey of the literary texts written by the indigenous inhabitants of what is now the United States, beginning with the myths and legends of the era before European contact and ending with the novels, poems, and films produced by Native Americans in the twentieth- and twenty-first centuries. May be repeated for credit as title varies.

**Attribute/Distribution:** HU

**ENGL 317 Topics in Jewish Literature 3-4 Credits**

Selected topics in Jewish literature, which may include: Contemporary Jewish Literature, Philip Roth's Complaint, and Jewish Women Writers. May be repeated for credit as title varies.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**ENGL 318 African-American Literature and Culture 3,4 Credits**

Topics in African-American culture and/or the cultures of the African diaspora. Topics may be focused by period, genre, thematic interest or interdisciplinary method including, for example, Nineteenth-century African-American Literature and Politics; African-American Folklore; Black Atlantic Literature; The Harlem Renaissance; and African-American Women Writers. May be repeated for credit as title varies.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**ENGL 321 History of the English Language 3-4 Credits**

The phonology, grammar, and lexicon of English from its Anglo-Saxon beginnings to current World dialects, with a focus on the expressive literary effects of linguistic change.

**Attribute/Distribution:** HU

**ENGL 323 Anglo-Saxon Language and Literature 3-4 Credits**

An introduction to Anglo-Saxon language and culture, through Anglo-Saxon prose and short poetry, with special attention to the range of Anglo-Saxon genres and the problems of translation and interpretation. May be repeated for credit as title varies.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**ENGL 324 Anglo-Saxon Poetry 4 Credits**

A study of Anglo-Saxon poetry, including discussion of the critical tradition and manuscript production. Special attention to the epic poem Beowulf. Open only to students who have completed ENGL 323 or who show proficiency in Anglo-Saxon. May be repeated for credit as title varies.

**Repeat Status:** Course may be repeated.

**Prerequisites:** ENGL 323

**Attribute/Distribution:** HU

**ENGL 327 Major Medieval Writers 3-4 Credits**

Study of major medieval writers. Titles include The Canterbury Tales; Early Chaucer and the Continental Tradition, and Langland's Piers Plowman. May be repeated for credit as title varies.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**ENGL 328 Shakespeare 3-4 Credits**

An introduction to Shakespearean drama including comedies, histories, tragedies, and romances. Emphasis on textual study, cultural contexts, and performance strategies. May be repeated for credit as title varies.

**Attribute/Distribution:** HU

**ENGL 331 Milton 3-4 Credits**

An introduction to John Milton's poetry and prose emphasizing close reading and cultural contexts. Half of the course will be devoted to Paradise Lost, and particular attention will be paid to politics, religion, and gender. May be repeated for credit as title varies.

**Attribute/Distribution:** HU

**ENGL 342 Advanced Poetry Writing 3-4 Credits**

An intensive writing workshop in which student poems and related literary texts receive close reading and analysis. May be repeated for credit. Prerequisites as noted below or consent of writing minor advisor.

**Repeat Status:** Course may be repeated.

**Prerequisites:** ENGL 142

**Attribute/Distribution:** ND

**ENGL 343 Advanced Creative Non-Fiction 4 Credits**

Practice of the essay, including such forms as the personal, academic, or argumentative essay. Emphasis on developing a strong personal voice and learning to use other voices. Intensive revision. May be repeated for credit. Prerequisites as noted below or permission of writing minor advisor.

**Repeat Status:** Course may be repeated.

**Prerequisites:** ENGL 143

**Attribute/Distribution:** ND

**ENGL 344 Advanced Fiction Writing 3-4 Credits**

An intensive writing workshop in which student stories and related literary texts receive close reading and analysis. May be repeated for credit. Prerequisites as noted below or consent of writing minor advisor.

**Repeat Status:** Course may be repeated.

**Prerequisites:** ENGL 144

**Attribute/Distribution:** ND

**ENGL 360 Middle English Literature 3-4 Credits**

Major literary works of the Middle English period by authors other than Chaucer. Emphasis on *Piers Plowman*, the *Gawain/ Pearl Poet*, and the metrical romances. May be repeated for credit as title varies.

**Attribute/Distribution:** HU

**ENGL 362 The Sixteenth Century 3-4 Credits**

Humanist, Petrarchan and dramatic traditions in the literature of renaissance England. Readings from such authors as Erasmus, More, Wyatt, Sidney, Spenser, and Marlowe. May be repeated for credit as title varies.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**ENGL 364 The Seventeenth Century 3-4 Credits**

Poetry, prose, and drama chronicling the literary, political, and social innovations of the century of revolutions. Readings may include Bacon, Cary, Cavendish, Donne, Herbert, Jonson, Middleton, Milton and Shakespeare. May be repeated for credit as title varies.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**ENGL 366 British Eighteenth-Century Literature 3-4 Credits**

The poetry, drama, fiction, and non-fictional prose of the long eighteenth century (1660-1800), with particular attention to how writers are shaped by and engage with the cultural issues of their time. May be repeated for credit as title varies.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**ENGL 367 Transatlantic Eighteenth-Century Literature 3-4 Credits**

The poetry, drama, fiction, and non-fictional prose written in Britain and the Americas during the long eighteenth century (1660-1800), with particular attention to the transatlantic circulation of texts and ideas. May be repeated for credit as title varies.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**ENGL 369 Romantic-Era Literature 3-4 Credits**

This study of British Literature and Culture of the Romantic Era (1780-1830) will address specific questions of genre, theme or historical developments. Readings may cover issues such as slavery and abolition, the effect of the French Revolution on British Literature, the rights of women, scientific innovation, ethics, landscape aesthetics, and the gothic. May be repeated for credit as title varies.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**ENGL 371 British Victorian Literature: Prose and Poetry 3-4 Credits**

Poetry and prose of Tennyson, Browning, Arnold, Swinburne, Carlyle, Mill, Newman, and Ruskin within the contemporary political, religious, and social contexts. May be repeated for credit as title varies.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**ENGL 372 Victorian Literature 3-4 Credits**

This study of British Literature and Culture of the Victorian Age (1830-1901), including the Empire, will address specific questions of genre, theme, or historical developments. Readings may cover issues such as industry, imperialism, the cult of domesticity, aesthetics, the Woman Question, the Reform Acts, the place of the art and the artist, and modern nationalism. May be repeated for credit as title varies.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**ENGL 374 Literature of Contact in the Americas 4 Credits**

The literature of exploration, discovery, and the early years of first settlement in contact zones from the Caribbean to Newfoundland. May be repeated for credit as titles varies.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**ENGL 375 Major Authors 1-4 Credit**

The works of one or more major literary figures studied in depth. May be repeated for credit as titles and authors vary.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**ENGL 376 Early American Literature 3-4 Credits**

American literature from settlement until the 1820s, emphasizing fiction, poetry, and non-fiction that helped form and contest American identities and national consciousness. May be repeated for credit as title varies.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**ENGL 377 American Romanticism 3-4 Credits**

Literature from the antebellum United States viewed through the literary practices of sentimentalism (an ethos that values sympathy, empathy, and human contact) and the sublime (an aesthetic that attempts to create within readers a sense of the awe-inspiring, otherworldly, and terrifying aspects of life), as well as social conflicts over race, class, and gender. May be repeated for credit as title varies.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**ENGL 378 American Realism 3-4 Credits**

Topics in American literature from the Civil War to the early twentieth century. Topics may include the evolution of literary genres and movements, including realism and naturalism. Authors may include Twain, Davis, Howells, Harper, James, Chesnutt, Jewett, Chopin, Norris, Crane, Du Bois, Gilman, Wharton, Cahan, Olsen and Wright. May be repeated for credit as title varies.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**ENGL 379 Modern American Literature 3-4 Credits**

Topics in American literature before World War II. Topics may be focused by genre, thematic interest, mode of theoretical inquiry or interdisciplinary method, including, for example, Modernism and Mourning; The Harlem Renaissance; Modernism and Social Justice. May be repeated for credit as title varies.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**ENGL 380 Contemporary American Literature 3-4 Credits**

Topics in American literature since World War II. Lectures and class discussions of new writers and of recent works of established writers organized around various themes of import for the contemporary period. May be repeated for credit as title varies.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**ENGL 382 Themes in American Literature 3,4 Credits**

Intensive study of one topic in American literature. Readings from the colonial period to the present. May be repeated for credit as title varies.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**ENGL 383 Modernism and Post-Modernism in Fiction 3,4 Credits**

Topics in 20th and 21st century literature with a focus on the defining features of modernism and/or postmodernism. May be repeated for credit as title varies.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**ENGL 384 Contemporary World and Postcolonial Literature 3,4 Credits**

Topics in contemporary world literature after 1960, engaging the history and legacy of European colonialism. Topics might include: African Literature; South Asian Literature; Caribbean Literature; and Literature of Globalization. May be repeated for credit as title varies.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**ENGL 385 Modern British and Irish Literature 3-4 Credits**

Topics in British and Irish literature before World War II. Topics might include: British Modernism; James Joyce; Virginia Woolf and Bloomsbury; Modern Irish literature; East Meets West: British and Colonial Travel Writing; and Gender and Sexuality. May be repeated for credit as title varies.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**ENGL 386 Contemporary British Literature 3-4 Credits**

Topics in post-1945 British literature, including postmodernism and multicultural writing. Topics may include Black British Writing; Immigrant Literature; Gender and Sexuality; Travel Writing; and British Postmodernism. May be repeated for credit as title varies.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**ENGL 387 Film History, Theory, and Criticism 3-4 Credits**

Study of film with the focus on particular genres, directors, theories, periods, or topics. Weekly film screenings. May be repeated for credit as title varies. May be repeated for credit as title varies. Cannot be taken pass/fail.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**ENGL 388 Independent Study 1-4 Credit**

Individually supervised study of a topic in literature, film, or writing not covered in regularly listed courses. Consent of department chair required.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**ENGL 389 Honors Project 1-8 Credit**

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**ENGL 391 Special Topics 1-4 Credit**

A topic, genre, or approach in literature or writing not covered in other courses.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**ENGL 400 Supervised Teaching 1 Credit**

Practical experience in teaching through assisting a faculty teacher in conduct of a regularly scheduled undergraduate course. Open only to graduate students with at least one semester of graduate course work at Lehigh University and a GPA of at least 3.5 Usually rostered in conjunction with 485. Consent of department required.

**ENGL 411 Gender and Literature 3 Credits**

This seminar explores constructions of gender and sexuality in literature from different historical periods, traditions, and nationalities. Content changes each semester. Course may be repeated for credit as title varies.

**Repeat Status:** Course may be repeated.

**ENGL 433 Medieval Genres and Authors 3 Credits**

This course examines major Middle English authors (Chaucer, Langland, the Pearl-poet) or genres of Middle English writing (romance, dream vision, drama) in their historical and literary contexts. Individual titles include: Medieval Drama, Chaucer's Literary Circles, Langland: Tradition and Afterlife, and Dream Visions and Revelations. Course may be repeated as title varies.

**Repeat Status:** Course may be repeated.

**ENGL 435 Topics in Medieval Literature 3 Credits**

This course explores a thematic topic in medieval literature. Typically, this course challenges traditional conceptions of literary historical periods by spanning Anglo-Saxon and late-medieval texts or late-medieval and early modern texts. Individual titles include: Writing, Rebellion, and Reform: Medieval Literature of Dissent; Poverty and Property, 1350-1650; Sex, Gender, and Sexuality in the Middle Ages; Imagining this Island: Nation and Identity, 800-1400. Course may be repeated as title varies.

**Repeat Status:** Course may be repeated.

**ENGL 439 Early Modern Genres and Authors 3 Credits**

Examination of major sixteenth- and seventeenth-century authors or distinctive Renaissance genres in their historical and cultural contexts. Individual courses may focus on authors such as Shakespeare, Milton, Spenser, or Jonson, or genres such as utopian fiction, psalms and sonnets, or city comedy. Course may be repeated as title varies.

**Repeat Status:** Course may be repeated.

**ENGL 441 Early Modern Literature 3 Credits**

This course explores a thematic topic in sixteenth- and seventeenth-century English literature. Individual titles may include: Dealing with Difference in Early Modern England; Gender and Catholicism in Early Modern England; Literature of City and Court; Poetry, Politics, and Prophecy: Writing of the English Civil War. Course may be repeated as title varies.

**Repeat Status:** Course may be repeated.

**ENGL 442 British Eighteenth-Century Literature 3 Credits**

This course explores British poetry, drama, fiction, and non-fictional prose written during the long eighteenth century (1660-1800). Topics may be organized by period, genre, thematic interest or interdisciplinary method. Individual titles may include: Money, Sex, and Selves; The Rise of the Novel; Witchcraft and History; Conspiracy Theory and Eighteenth-Century Literature. Course may be repeated as title varies.

**Repeat Status:** Course may be repeated.

**ENGL 443 Transatlantic Eighteenth-Century Literature 3 Credits**

This course explores the transatlantic circulation of texts and ideas during the long eighteenth century (1660-1800). Topics may be organized by period, genre, thematic interest or interdisciplinary method. Individual titles may include: The Colonial Rise of the Novel; Writing for a Cause; Transatlantic Eighteenth-Century Paranoia. Course may be repeated as title varies.

**Repeat Status:** Course may be repeated.

**ENGL 445 British Romantic-Era Literature 3 Credits**

The seminar will explore a focused topic in British Literature and Culture of the Romantic Era (1780-1830) taking into account larger historical, aesthetic, and theoretical concerns. Topics may include slavery and abolition, the cult of childhood, women's writing, imperialism, the gothic, the Jacobin novel, poetic innovation, the Shelley circle, and travel literature. Course may be repeated for credit as title varies.

**Repeat Status:** Course may be repeated.

**ENGL 447 British Victorian Literature 3 Credits**

The seminar will explore a focused topic in British Literature and Culture of the Victorian Age (1830-1901), including the Empire, taking into account larger historical, aesthetic, and theoretical concerns. Topics may include industry, imperialism, the cult of domesticity, aesthetics, the Woman Question, new sexual cultures, the Reform Acts, the emergence of photography and mass visual culture, the place of art and the artist, and modern nationalism. Course may be repeated for credit as title varies.

**Repeat Status:** Course may be repeated.

**ENGL 449 Modern British and Irish Literature 3 Credits**

Topics in British and Irish literature before World War II. Topics may be organized by genre, theoretical mode of inquiry, or author. Topics might include: British Modernism; James Joyce and Modern Ireland; Virginia Woolf and Bloomsbury; East Meets West: British and Colonial Travel Writing; and Gender and Sexuality. Course may be repeated as title varies.

**Repeat Status:** Course may be repeated.



**ENGL 451 Contemporary British Literature 3 Credits**

Topics in post-1945 British literature, including postmodernism and multicultural writing. Topics may be organized by genre, theoretical mode of inquiry, or interdisciplinary method. Topics might include Black British Writing; Immigrant Literature; Gender and Sexuality; Travel Writing; and British Postmodernism." Course may be repeated as title varies.

**Repeat Status:** Course may be repeated.

**ENGL 471 Early American Literature 3 Credits**

This course explores topics in the literature of New England, the Middle Colonies, the South, the Southwest, and the Caribbean from Columbus to the close of the eighteenth century, emphasizing our cultural and artistic diversity. Titles may include *The Literature of Justification*, *First Contact: Then and Now*, *America's Many Beginnings*; and *Literature of Revolution and the Early Republic*. Course may be repeated for credit as title varies.

**Repeat Status:** Course may be repeated.

**ENGL 473 Antebellum American Literature 3 Credits**

This course explores thematic topics in antebellum U.S. literature through readings in the expanded canon of American literature from approximately 1820-1865. Individual titles include: *Class in Antebellum American Literature*; *Antebellum Literature and Transatlantic Reform*; *The Global Nineteenth Century*; *Print Culture and the Economics of Antebellum American Literature*. Course may be repeated for credit as title varies.

**Repeat Status:** Course may be repeated.

**ENGL 475 Late Nineteenth-Century American Literature 3 Credits**

This seminar will explore topics in American literature between the Civil War and the early twentieth century. Topics may be organized by genre, theoretical mode of inquiry, historical problematic, or interdisciplinary method. Topics might include, for example, *Realism and Naturalism*; *Nineteenth-Century African American Literature and Politics*. Course may be repeated for credit as title varies.

**Repeat Status:** Course may be repeated.

**ENGL 477 Modernism 3 Credits**

This seminar will explore topics in literary modernism, including the formal innovations, political implications, historical configurations, and critical and theoretical approaches to the literatures of the early twentieth century. Topics may be organized around national literatures or transnational formations. Topics might include *Modernism and Mourning*; *Transatlantic Modernism*; *The Harlem Renaissance*; *Modernism and Social Justice*. Course may be repeated for credit as title varies.

**Repeat Status:** Course may be repeated.

**ENGL 478 Contemporary American Literature 3 Credits**

Topics in American literature since World War II. Lectures and class discussions of new writers and of recent works of established writers organized around various themes of import for the contemporary period. Course may be repeated for credit as title varies.

**Repeat Status:** Course may be repeated.

**ENGL 479 Contemporary World and Postcolonial Literature 3 Credits**

Topics in contemporary world literature after 1960, engaging the history and legacy of European colonialism. Topics may be organized by genre, theoretical mode of inquiry, or interdisciplinary method. Topics might include: *African Literature*; *South Asian Literature*; *Caribbean Literature*; and *Literature of Globalization*. Course may be repeated for credit as title varies.

**Repeat Status:** Course may be repeated.

**ENGL 480 Composition and Rhetoric 3 Credits**

This course explores a topic in composition studies or rhetoric. Topics may be historical, pedagogical, theoretical, or thematic. Course may be repeated for credit as title varies.

**Repeat Status:** Course may be repeated.

**ENGL 481 Theory and Criticism 3 Credits**

Topics might include: *Theories of Gender and Feminism*; *Theories of Transnationalism and Globalization*; and *Historicism*. Course may be repeated for credit as title varies.

**Repeat Status:** Course may be repeated.

**ENGL 483 Creative Writing and Literary Studies 3 Credits**

*From the Inside: Creative Writing and Reading*. A combination of seminar and workshop, this course uses instruction and practice in the techniques and genres of creative writing (prosody, narratology, characterization, etc.) to develop tools for studying literary texts. Consent of instructor required. Course may be repeated for credit as title varies.

**Repeat Status:** Course may be repeated.

**ENGL 485 Introduction to Writing Theory 2 Credits**

Survey of major approaches and theoretical issues in the field of composition and rhetoric. Required of all new teaching assistants in the department. Usually rostered in conjunction with 400 or 486.

**ENGL 486 Teaching Composition: A Practicum 1 Credit**

Introduction to teaching writing at Lehigh. Bi-weekly discussions of practical issues and problems in the teaching of freshman composition. Required of all new teaching assistants in the department. Usually rostered in conjunction with English 485.

**ENGL 487 Teaching with Technology: A Practicum 1 Credit**

Hands-on introduction to the tools and skills necessary to teach with the computer, along with some attention to appropriate pedagogy. Consent of the graduate program coordinator required.

**ENGL 490 Master's Thesis 3 Credits**

Writing master's thesis papers.

**ENGL 491 Special Topics 1-3 Credit**

A topic, genre, or approach in literature or writing not covered in other courses. May be repeated for credit as title varies. Consent of graduate program coordinator required.

**Repeat Status:** Course may be repeated.

**ENGL 493 Graduate Seminar 3 Credits**

Intensive study of the works of one or more authors, or of a type of literature. May be repeated for credit as title varies.

**Repeat Status:** Course may be repeated.

**ENGL 495 Independent Study 3 Credits**

Individually supervised course in an area of literature, film or writing not covered in regularly listed courses. Consent of graduate program coordinator required.

**ENGL 499 Dissertation 1-9 Credit**

Research and study for comprehension exams.

**Environmental Initiative****Program Directors:**

**Donald Morris, Ph.D. (Colorado)**

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*Supported by the Office of Interdisciplinary Programs 610-758-3996; [incasip@lehigh.edu](mailto:incasip@lehigh.edu)*

**Program Faculty:**

**Professors:** Sharon M. Friedman, M.A. (Penn State), Journalism and Communication and Director of Science and Environmental Writing Program; John Martin Gillroy, Ph.D. (Chicago), Environmental Studies and International Relations.

**Associate Professors:** David Casagrande (Georgia), Sociology and Anthropology; Breena Holland, Ph.D. (Chicago), Environmental Studies and Political Science.

The Environmental Initiative is a broadly interdisciplinary program of education, research, and outreach. The curricula include courses in four colleges and 10 departments in social sciences, humanities, education, science, mathematics and engineering. Earth and Environmental Sciences (<http://www.ees.lehigh.edu>) and Civil and Environmental Engineering (<http://www.lehigh.edu/~incee>) are core Departments in the program.

#### Undergraduate Studies

The Environmental Studies BA program examines the cultural, economic, historical, communication, political and social factors that influence local, national, international and global environmental issues and policies. Investigating a wide range of perspectives, it includes a broad exposure to many factors confronting humans as they struggle with complex problems and possible solutions to environmental questions.

The program has been designed so students will develop a broad understanding of social science environmental concerns, along with a basic familiarity with environmental science, statistics and research methods. Of benefit to all students interested in environmental issues, this B.A. degree complements existing B.A. and B.S. programs in Earth and Environmental Sciences and the B.S. program in Environmental Engineering. The B.A. program is intended for students who are interested in environmental affairs from the perspective of the social sciences and humanities. This degree will prepare students for a variety of career options including positions in policy agencies at the federal, state and local government levels, corporate management, nonprofit organizations, environmental journalism, environmental education or environmental law. It also will prepare students for graduate studies in a number of environmental policy and social science fields. The B.A. is specifically designed to be broadly inclusive yet flexible enough to allow for double majors and minors in other fields. Double majors or minors in social science fields such as anthropology, communication, history, international relations, journalism, political science, psychology, science and environmental writing or sociology could easily be accomplished. Minors in the sciences, such as Earth and Environmental Sciences, also can be completed. If students are not pursuing a double major, a minor in another field to complement the Environmental Studies major is highly recommended but not required.

The major consists of five required and a choice of three core courses, plus three elective courses chosen from a list that follows. The B.A. is considered a social science major and most of its courses fulfill college social science distribution requirements. Its collateral requirements, which include a social science research methods course, one course in statistics and two science courses, can be used to fulfill college math and science distribution requirements.

#### Program Honors

To graduate with honors, a major in Environmental Studies must maintain a 3.2 overall average, attain a 3.5 average in the courses constituting the major program, and complete an honors thesis in the senior year.

#### Environmental Studies Major

##### Required Courses

ES 001	Introduction to Environmental Studies	4
ES/EES/GCP 002	Introduction to Environmental Science	3
ES/EES 004	The Science of Environmental Issues	1
ES/POLS 105	Environmental Policy and Planning	4
ES 381	Senior Seminar: Issues in Environmental Studies	4

##### Core Courses

Select at least three of the following:		10-12
ES/POLS 106	Environmental Values and Ethics	

ES/ECO 111	Introduction to Environmental Economics	
ES/ANTH 121	Environment and Culture	
ES/JOUR 125	Environment, the Public and the Mass Media	
CEE 272	Environmental Risk Assessment	
ES/HIST 315	American Environmental History	
<b>Major Electives</b>		
Select 12 credits of the following: <sup>1,2</sup>		12
ANTH 145	Human Evolution	
ANTH 305	Anthropology Of Fishing	
CEE/EES 379	Environmental Case Studies	
ECO 311	Environmental Economics	
ENGL 380	Contemporary American Literature	
EES 089	Geographic Analysis of our Changing World	
EES 386	Wetland Science	
ES 010	Environment and the Consumer Society	
ES/GCP/EES 100	Earth Systems Science	
ES/POLS 107	The Politics of the Environment	
ES/JOUR/HMS 117	Environmental Health Risks and the Media	
ES/CEE 171	Fundamentals of Environmental Technology	
ES/REL/ASIA 254	Buddhism and Ecology	
ES/HMS/JOUR/STS 323	Health and Environmental Controversies	
ES/POLS 328	U.S. Politics and the Environment	
ES 331	Environmental Law I: Pollution & Risk Abatement	
ES/IR 333	International Environmental Law & Policy	
ES 338	Environmental Risk	
ES/IR 339	Global Security and the Environment	
ES/IR 343	Comparative Environmental Law & Policy	
ES/ANTH 352	Environmental Archaeology	
ES/POLS 355	Environmental Justice and the Law	
ES/TLT 367	Environmental Education	
ES/TLT 368	Teaching and Learning with Geospatial Tools	
ES/POLS 375	Seminar: Green Polity	
ES 391	Honors Thesis	
IR 344	International Politics of Oil	
JOUR 123	Basic Science and Technical Writing	
POLS 338	Markets, Justice, And Law	
POLS 348	Land Use, Growth Management, and the Politics of Sprawl	
REL 006	Religion and Ecological Crisis	
SDEV 010	Challenges of Sustainable Development	
<b>Additional electives that may be used to fulfill the major elective requirement:</b>		
ES 093	Lehigh Earth Observatory Field/Laboratory Internship	
ES 123	Sustainability in Action I	
ES 124	Sustainability in Action II	
ES 131	Internship	
ES 181	Independent Study	
ES 223	Advanced Sustainability in Action I	
ES 224	Advanced Sustainability in Action II	

ES 293	Advanced Lehigh Earth Observatory Field/Laboratory Internship	
ES 371	Special Topics	
SDEV 122	Sustainable Dev:CR Experience	
SDEV 201	Sustainable Development Solutions, I	
SDEV 202	Sustainable Development Solutions, II	
SDEV 203	Research in Sustainable Development	
SDEV 372	Independent Study in Sustainable Development	

**Collateral Requirements**

MATH 012	Basic Statistics <sup>3</sup>	4
SOAN 111	Research Methods and Data Analysis	4
Select at least one EES and one other science course (6-8) credits OR a minor in EES (see EES program descriptions)		6-8
<b>Total Credits</b>		<b>52-56</b>

1 12 credits including 1 course at the 200 level or above. Additional core courses can be used to fulfill this requirement.

2 At least 2 courses from the major electives courses must be applied towards the major electives requirement. In addition, new courses may be offered annually. Students should check with the program director for an updated list.

3 A calculus course may be substituted with permission of the program director.

**Minor in Environmental Studies**

A minor in Environmental Studies consists of four 4-credit courses, for a total of 16 credits. At least one course must be at the 300-level. To declare a minor in Environmental Studies, students must complete a minor declaration form ([http://catalog.lehigh.edu/coursesprogramsandcurricula/artsandsciences/environmentalinitiative/Environmental\\_Studies\\_Minor\\_Declaration\\_Form.pdf](http://catalog.lehigh.edu/coursesprogramsandcurricula/artsandsciences/environmentalinitiative/Environmental_Studies_Minor_Declaration_Form.pdf)).

ES 001	Introduction to Environmental Studies	4
One course from the required or core set of courses for the major		4
Two courses from either the core or elective courses for the major		8
<b>Total Credits</b>		<b>16</b>

**Minor in Sustainable development**

The minor in Sustainable Development (p. 235) consists of a minimum of at least 15 hours of study that includes a combination of core courses and approved electives. Minors are required to complete a total of 8 core credits (SDEV 010 Challenges of Sustainable Development, and SDEV 202 Sustainable Development Solutions, II) or (SDEV 010 Challenges of Sustainable Development and SDEV 203 Research in Sustainable Development). The remaining 7 credits may be selected from the Additional Course Electives listed below or in consultation with the Program Director.

Completion of ECO 001 Principles of Economics is a prerequisite for enrollment in the Sustainable Development minor, except for those for whom the program director waives the prerequisite.

To declare a minor in Sustainable Development, students must complete a minor declaration form. ([http://catalog.lehigh.edu/coursesprogramsandcurricula/artsandsciences/environmentalinitiative/Sustainable\\_Development\\_Minor\\_Declaration\\_Form.pdf](http://catalog.lehigh.edu/coursesprogramsandcurricula/artsandsciences/environmentalinitiative/Sustainable_Development_Minor_Declaration_Form.pdf))

**Core Courses** 8

SDEV 010 & SDEV 201 & SDEV 202	Challenges of Sustainable Development and Sustainable Development Solutions, I and Sustainable Development Solutions, II	
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or

SDEV 010 & SDEV 203	Challenges of Sustainable Development and Research in Sustainable Development	
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**Additional Core Electives** 7

ECO 203	Microfinance: Financial Inclusion for the Poor	
ENTP 307	International Social Entrepreneurship	
SDEV 122	Sustainable Dev:CR Experience	
SDEV 372	Independent Study in Sustainable Development	
ANTH 305	Anthropology Of Fishing	
ANTH 324	Globalization and Development in Africa	
SSP 328	Global Food Systems	

**Graduate Studies****M.A. Environmental Policy Design**

The M.A. in Environmental Policy Design trains scholars and practitioners alike for the demanding task of designing environmental policy that can protect or restore an increasingly degraded natural environment while sustaining the benefits of economic growth and providing for the needs of an ever more vulnerable (and growing) human population. Achieving this goal will require policy professionals to understand and analyze environmental problems amidst multiple systems and levels of law and in the context of rapidly globalizing governance structures, institutions, and regimes that cut across geographical and political boundaries. Specifically, the M.A. program in Policy Design assumes that traditional economic analysis of environmental policy is a point of departure rather than the sole and adequate approach to environmental questions. We seek to prepare policy professionals who can more fully address environmental dilemmas as philosophical questions that have technical, social, political and economic dimensions dependent on the logic and persuasive power of the underlying argument as to both the inadequacy of current law and the requirements of future policy. With this background an Environmental Policy Designer can better entertain two questions. First, how are legal institutions, regulations, and public management responding to the political, social, moral and economic dynamics affecting the natural environment at the local, regional, national, and international level? Second, how should legal institutions, regulations, and public management respond to the impact of these various dynamics in order to ensure the integrity of ecosystems and a sustainable natural environment for humanity Overall, we seek to create a generation of policy practitioners that can (1) critically assess and analyze the multiple conditions and inherent conceptual logics that create environmental problems, (2) arrive at novel investigational logics as solutions to those problems, and (3) justify those solutions as persuasive public policy or codified law.

Applicants for the MAEPD program may also choose to apply to the Community Fellows Program, a one year Master's Program in which students work for 15 hours a week in a non-profit organization as part of their academic experience. Please see the program website at [www.lehigh.edu/communityfellows](http://www.lehigh.edu/communityfellows).

**Required Courses**

ES 401	Philosophical-Policy and Environmental Legal Design	3
ES/EES 402	Scientific Foundations for Environmental Policy Design	3

**Core Courses**

Select at least 4 of the following: 12

ES 431	U.S. Environmental Law I: Pollution and Risk Abatement	
ES 433	International Environmental Law & Policy	
ES 435	Environmental Valuation for Policy Design & Legal Analysis	
ES 443	Comparative Environmental Law & Policy	
ES/POLS 455	Environmental Justice & The Law	
ES 465	International Law and Policy Design	

**Electives**

Select 3 courses of the following, including at least 1 Foundation Course, except that one or more Core Courses may be substituted for Foundation or Context Courses

**Foundation**

EES 325	Remote Sensing of Terrestrial and Aquatic Environments
EES 358	Microbial Ecology
EES 365	Ecophysiology
EES 318	Geographic Analysis in EES
EES/CEE 379	Environmental Case Studies
POLS 402	Methods Of Policy Analysis
POLS 421	Research Methods
CEE 471	Environmental Risk Assessment

**Context**

HIST 315	American Environmental History
POLS 416	American Environmental Policy
POLS 438	Markets, Justice, And Law
POLS 448	Land Use, Growth Management, and the Politics of Sprawl
ES 461	Wetland Policy and Valuation
ES 475	Seminar: Green Polity

Thesis: A six credit thesis ( ) can be taken in lieu of two Foundation/Context Courses with the approval of the EI Graduate Curriculum Committee. The student must find a thesis supervisor and a second reader and produce a five page thesis proposal to the specifications of the program format. This proposal, signed by the student and the primary and second readers, must then be submitted to the committee six weeks before the beginning of the term in which the first thesis credit is to be taken. If the proposal fails to be approved, the student will be required to fill out his/her program with courses.

**Graduate Certificate in Environmental Law and Policy**

This graduate certificate offers a credential in environmental law and policy for individuals with a background in various science, engineering, social science and humanities fields who wish to understand the theory and practice of environmental and natural resource law at the national, comparative or international level. It is especially valuable for those in various environmental fields who come in contact with the law in the course of their work, to policy makers at all levels of government who routinely handle legal affairs, to lawyers without specific training in environmental law, and to business people who want to know what the law says about the legality of their business' impact on the natural environment. The certificate also can be preparation for further studies in law, policy, or politics or for professional positions in the private or public sector. Certificate courses can be counted toward MA in Environmental Policy Design, as appropriate.

**Requirements**

The certificate program requires 4 courses with 1 course from each of the 2 core groups and 2 other courses from either the core groups or electives selected in consultation with the program advisor. No more than 6 credits can be taken at the 300 level and the certificate must be completed in a maximum of 3 years.

**Core Groups**

Select 1 course from each of the 2 core groups 6

**Core Courses in Environmental Law**

ES 431	U.S. Environmental Law I: Pollution and Risk Abatement
ES 433/333	International Environmental Law & Policy
ES 443	Comparative Environmental Law & Policy

**Core Courses in Policy Analysis, Valuation & The Law**

ES 401	Philosophical-Policy and Environmental Legal Design
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ES 435 Environmental Valuation for Policy Design & Legal Analysis

ES 455 Environmental Justice & The Law

**Elective Courses**<sup>1</sup>

Select 2 courses from either the core groups or electives selected in consultation with the program advisor 6

Total Credits 12

<sup>1</sup> Elective courses will be chosen from existing Environmental Studies, Environmental Science or Environmental Engineering courses (ES, EES or CEE) at the 300/400 level in consultation with the program advisor. Students are encouraged to choose their elective courses from ES core offerings; however, they can select a specific elective pertinent to their studies or background in consultation with their advisor.

**Courses****ES 001 Introduction to Environmental Studies 4 Credits**

Gateway to the field of Environmental Studies, the course surveys central issues and themes confronting humanity in the natural world on a national and global basis. Topics include humankind's role in environmental change; society's response to the dynamism of nature; cultural evaluations of nature; population dynamics; resource availability and pollution sinks; land use patterns; sustainability and consumerism; environmental justice and ethics; policy and planning. This course fulfills a social science credit requirement. Please select ES 002 to fulfill the natural science requirement.

**Attribute/Distribution:** SS

**ES 002 Introduction to Environmental Science 3 Credits**

Focuses on natural and human-induced drivers and consequences of environmental change. Exploring options for mitigating and adapting to environmental change in ecosystems, physical and social systems, we will examine such topics as biogeochemical cycles, population pressure, ecosystem diversity, productivity and food security, energy, water resources, climate change, pollution, ozone, urban issues and sustainability. Stresses interactions and interrelationships, using a series of case studies.

**Attribute/Distribution:** NS

**ES 004 The Science of Environmental Issues 1 Credit**

Analysis of current environmental issues from a scientific perspective. The focus on the course will be weekly discussions based on assigned readings. Prerequisites as noted below.

**Prerequisites:** EES 002 or ES 002 or EES 028 or GCP 002 or EES 011 or EES 012 or EES 014 or EES 015 or EES 016 or IR 016 or EES 021 or EES 024 or EES 025 or EES 026 or GCP 026 or EES 027 or GCP 027 or GCP 028 or EES 031 or EES 089 or EES 090 or EES 095 or EES 105 or ASTR 105 or PHY 105 or EES 022

**Can be taken Concurrently:** EES 002, ES 002, EES 028, GCP 002, EES 011, EES 012, EES 014, EES 015, EES 016, IR 016, EES 021, EES 024, EES 025, EES 026, GCP 026, EES 027, GCP 027, GCP 028, EES 031, EES 089, EES 090, EES 095, EES 105, ASTR 105, PHY 105, EES 022

**Attribute/Distribution:** NS

**ES 010 Environment and the Consumer Society 4 Credits**

Is there such a thing as sustainable consumption, or will life on Earth become increasingly imbalanced? Will our grandchildren accuse us of "devouring" their future? This multidisciplinary course investigates these issues, both locally and globally from the perspectives of anthropology, history, communication and politics. Topics include cultural causes of and responses to past environmental disasters; biological and cultural limits to growth; overfishing the commons; resources and land use issues; communication in a consumer culture; and politics and governmental regulations. Team projects researching the environmental impacts of campus consumption will be included.

**Attribute/Distribution:** SS

**ES 093 Lehigh Earth Observatory Field/Laboratory Internship 1-4 Credit**

The Lehigh Earth Observatory (LEO) is a distributed, multidisciplinary program that focuses study on the environment with a particular emphasis on understanding the science of environmental systems and the relationship between these systems and society. LEO has a focus on environmental systems, drawing students from a variety of disciplines including policy, management, economics, journalism, business, art, and philosophy in addition to science and engineering. Field projects contribute to an overall theme of postindustrial land use and development as it impacts the natural environment of the Lehigh Valley, and may include long-term monitoring programs, or individually designed projects that contribute to the overall mission that includes science, engineering, policy, communications, ethics, social dynamics, and other environmentally pertinent aspects of the region. Students work with a faculty advisor on individually designed projects. Projects may involve technical, social, educational, or other outreach activities, and NS, SS, or HU credits are designated as appropriate. This course is intended for first time participants and is not repeatable for credit. Past projects and more details about LEO are available at <http://www.leo.lehigh.edu>. Students should contact the Environmental Initiative for departmental permission to register.

**ES 100 Earth Systems Science 4 Credits**

Examination of the Earth as an integrated system. Study of interactions and feedbacks between key components such as the atmosphere, geo-sphere, and hydrosphere to permit better understanding of the behavior of the system as a whole. Response of the Earth system to human perturbations such as land use and emissions are explored in the context of predictions of future environmental conditions and their projected impacts back on human systems. Lectures, class discussions, and recitation. Prerequisites as noted below.

**Prerequisites:** (EES 022)

**Attribute/Distribution:** NS

**ES 104 Political and Environmental Geography 4 Credits**

Geographical foundations of political phenomena and human impacts on the environment. Global focus on geographic influences on growth and development of states and empires, the nature and impact of borders, how people have altered pattern of climate, hydrology, land forms soils, and biota.

**Attribute/Distribution:** SS

**ES 105 Environmental Policy and Planning 4 Credits**

Analysis of the framework that has been established to protect the environment and promote sustainable growth. Focus on the roles of the different branches of the U.S. government and the relative responsibilities of state and local governments within this framework. Consideration of the political nature of environmental issues and the social forces influencing environmental protection in different areas of domestic environmental policy, such as climate change, toxic waste disposal and natural resources conservation.

**Attribute/Distribution:** SS

**ES 106 Environmental Values and Ethics 4 Credits**

An introduction to the ethical perspectives and values that shape human relationships to the natural environment in contemporary society. What are the moral implications of these relationships for justice and human collective action? Given these implications, what policy responses to environmental problems are morally or politically justifiable? In answering these questions, the course explores ethical ideas developed in different schools of environmental thought, such as deep ecology and eco-feminism, in addition to ideas that emerge from social movements, such as environmental justice and bioregionalism.

**Attribute/Distribution:** SS

**ES 107 The Politics of the Environment 4 Credits**

A survey of the major environmental, resource, energy and population problems of modern society, focusing on the United States. The politics of people's relationship with nature, the political problems of ecological scarcity and public goods, and the response of the American political system to environmental issues.

**Attribute/Distribution:** SS

**ES 111 Introduction to Environmental Economics 4 Credits**

An examination of the interactions between our economic systems and the environment. Pollution as a consequence of human activity within a framework for analyzing the relationships between environmental quality, scarcity of resources and economic growth. How to develop appropriate public policies to deal with these issues.

**Attribute/Distribution:** SS

**ES 115 Communicating about the Environment 4 Credits**

Introduction to the need for and ways to communicate about environmental issues to laypersons, government officials, journalists, members of the judiciary and technical experts. Explores case studies of good and bad communication about environmental issues. Internet communication, including the efficacy of placing governmental reports and databases on the Web for public consumption, will be evaluated.

**Attribute/Distribution:** SS

**ES 117 Environmental Health Risks and the Media 4 Credits**

This course explores the risks and effects of environmental contamination on human health and behavior as well as the role of the mass media in alerting citizens to potential environmental health risks. Environmental topics vary but usually include air and water pollution, endocrine disrupters and radioactive waste.

**Attribute/Distribution:** SS

**ES 121 Environment and Culture 4 Credits**

Impact of environment upon cultural variability and change. Comparative study of modern and past cultures and their environments as well as current theories of human/environmental interaction.

**Attribute/Distribution:** SS

**ES 123 Sustainability in Action I 1-4 Credit**

First half of a year-long experiential learning program for students to engage with sustainability in both general theory and applied practices. Students will learn the political, economic and social effects of changing earth systems through a global, national and local lens. Students will explore the multitude of challenges posed by increasing natural resource consumption, inequitable distribution of wealth and rapid uneven globalization. Most importantly, students will engage the Lehigh community and broader community in developing and implementing practical solutions to creating a more sustainable and just world. Offered in coordination with the Campus Eco-Reps program. Instructor permission required. May be repeated for credit.

**Repeat Status:** Course may be repeated.

**ES 124 Sustainability in Action II 1-4 Credit**

Continuation of ES 123 Sustainability in Action I; second half of a year-long experiential learning program for students to engage with sustainability in both general theory and applied practices. Students will learn the political, economic and social effects of changing earth systems through a global, national and local lens. Students will explore the multitude of challenges posed by increasing natural resource consumption, inequitable distribution of wealth and rapid uneven globalization. Most importantly, students will engage the Lehigh community and broader community in developing and implementing practical solutions to creating a more sustainable and just world. Students in ES 124 expand the scope and scale of sustainability projects and activities piloted in ES 123. Offered in coordination with the Campus Eco-Reps program. Instructor permission required. May be repeated for credit.

**Repeat Status:** Course may be repeated.

**ES 125 Environment, the Public and the Mass Media 4 Credits**

Extensive exploration of local, national and international environmental problems and their social, political and economic impacts. Analysis of mass media coverage of complex environmental issues and the media's effects on public opinion and government environmental policies. Examination of environmental journalism principles and practices in the United States and around the world.

**Attribute/Distribution:** SS

**ES 131 Internship 1-2 Credit**

Practical experience in the application of environmental studies for both on- and off-campus organizations. Course is designed to provide credit for supervised experiential learning experiences. May be repeated for credit up to four credits. Consent of program director required.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** ND

**ES 171 Fundamentals of Environmental Technology 4 Credits**

Pollution control technologies and how they work for water, air and solid wastes. Assessment and management of risk as applied to remediation of contaminated wastes. Role of life cycle analysis of products in risk reduction. Emphasis on technologies leading to sustainable environment. Government policies and regulations, including litigation and Best Engineering Practices. Must have completed a course designated as NS. Not available to students in RCEAS.

**ES 181 Independent Study 1-4 Credit**

Directed readings or research on an Environmental Studies topic. May be repeated for credit up to four credits. Consent of program director required.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU, SS

**ES 223 Advanced Sustainability in Action I 1-4 Credit**

Leadership and coordination of Sustainability in Action projects and activities for students in ES 123. Experienced students who have completed the year-long Sustainability in Action sequence (ES 123 and ES 124) continue in course coordination role. Offered in coordination with the Campus Eco-Reps Program. Consent of instructor required. May be repeated for credit. Prerequisites as noted below.

**Repeat Status:** Course may be repeated.

**Prerequisites:** ES 123 and ES 124

**ES 224 Advanced Sustainability in Action II 1-4 Credit**

Continuation of ES 223. Leadership and coordination of Sustainability in Action projects and activities for students in ES 124. Experienced students who have completed the year-long Sustainability in Action sequence (ES 123 and ES 124) continue in course coordination role. Offered in coordination with the Campus Eco-Reps Program. Consent of instructor required. May be repeated for credit. Prerequisites as noted below.

**Repeat Status:** Course may be repeated.

**Prerequisites:** ES 123 and ES 124 and ES 223

**ES 254 Buddhism and Ecology 4 Credits**

Buddhism's intellectual, ethical, and spiritual resources and reexamined in light of contemporary environmental problems. Is Buddhism the most green of the major world religions? What are the moral implications of actions that affect the environment?

**Attribute/Distribution:** HU

**ES 293 Advanced Lehigh Earth Observatory Field/Laboratory Internship 1-4 Credit**

A continuation of LEO Internship 93, this course will entail further development of supervised projects and leadership opportunities. Past projects and more details about LEO are available at <http://www.leo.lehigh.edu>. Students should contact the Environmental Initiative for departmental permission to register. Prerequisites as noted below.

**Prerequisites:** ES 093

**Attribute/Distribution:** HU, NS, SS

**ES 315 American Environmental History 3,4 Credits**

Relationship between Americans and their natural environment from the colonial period to the present: impact of European settlement, attitudes toward wilderness, role of technological development, rise of preservation and conservation movements, establishment of national parks, recent environmental protection legislation.

**Attribute/Distribution:** SS

**ES 323 Health and Environmental Controversies 4 Credits**

Exploration of health and environmental controversies from the perspectives of scientific uncertainty and mass media coverage. Examines genetic engineering, biotechnology, environmental health risks, and nanotechnology. Includes discussion of ethical and social responsibilities and interactions with the public.

**Attribute/Distribution:** SS

**ES 328 U.S. Politics and the Environment 4 Credits**

An examination of contemporary American politics and policy dealing with environmental issues. Current controversies in the legislative and regulatory areas will be covered to examine environmental issues and the political process. Significant portions of the course readings will be taken from government publications.

**Attribute/Distribution:** SS

**ES 331 Environmental Law I: Pollution & Risk Abatement 4 Credits**

This course studies the practical reality of environmental regulation as codified law. It also aims at understanding the law's foundation in argument and justification as both existing law and proposed policy through the use of cases, statutes, and regulations on air, water, risk, waste and environmental impact. Utilizing two legal paradigms for charting the relationship between humanity and nature, it examines a wide range of environmental law as well as ethical, political, economic, scientific, and policy dimensions.

**Attribute/Distribution:** SS

**ES 333 International Environmental Law & Policy 4 Credits**

This course examines the basic international legal setting for the protection and management of the global environment. It examines how international law concerning nature is made and applied, the role of international environmental regimes or institutions, enforcement strategies, and compliance mechanisms. Emphasis will be placed on a review of various regulatory regimes for the protection of the global commons, including the history and legal sources of the Global Climate Change Convention.

**Attribute/Distribution:** SS

**ES 338 Environmental Risk 4 Credits**

Starting with the distinction between traditional pollution problems and environmental risk, this course examines the policy and legal implications of its unique characteristics.

**Attribute/Distribution:** SS

**ES 339 Global Security and the Environment 4 Credits**

This course examines the links between international security and the environment. Topics include the effects of military actions on the environment; the environment contributing to international conflict; environmental conditions as security issues; the relationship between public health and security; bioterrorism, eco-terrorism, and biological threats; environmental remediation and conflict resolution.

**Attribute/Distribution:** SS

**ES 340 International Environmental and Science Policy 4 Credits**

The politics of science behind global climate change, trans-boundary environmental pollution, international regulatory standards, and environmental risk assessment. How international/global science communities operate, how to communicate scientific research across cultures, and how to translate scientific data into international policy. Case studies include climate change, the ozone hole, avian influenza, and HIV/AIDS. Consent of department required. Prerequisites as noted below.

**Prerequisites:** IR 010

**Attribute/Distribution:** SS

**ES 343 Comparative Environmental Law & Policy 3,4 Credits**

This course studies the different ways in which domestic legal systems handle the regulation of humanity's relationship to the natural world. The first part of the course concentrates on comparative law that examines the evolution of distinct types of legal systems from their origins in the ancient world. The second part of the course specifically and comparatively examines environmental law as it has developed in Canada, China, the European Union and the United States. Ranges of alternatives for environmental law and policy as practiced in various parts of the world will be explored.

**Attribute/Distribution:** SS

**ES 352 Environmental Archaeology 4 Credits**

This course reviews the various categories of archaeological data used to examine the nature of past human-environmental relationships. We will explore how archaeologists use data to recognize anthropogenic and natural environmental changes, as well as cultural adaptations to local environments.

**Attribute/Distribution:** SS

**ES 355 Environmental Justice and the Law 4 Credits**

This course explores the various ways in which environmental law and policy can have discriminatory effects. It examines the rise and evolution of the environmental justice movement, and the impact of environmental justice claims on administrative rulemaking at both the state and federal level. Reviewing the history of case law concerning environmental justice suits filed under the 1964 Civil Rights Act, it also examines the future of environmental justice in environmental law and policy. Prerequisites as noted below.

**Prerequisites:** POLS 105 or ES 105

**Attribute/Distribution:** SS

**ES 367 Environmental Education 3 Credits**

Introductory environmental education course designed to prepare students to implement environmental education opportunities in formal and non-formal education settings. Topics include history and philosophy of environmental education, environmental laws and regulations, GIS, environmental issues and decision making, curriculum integration and environmental education teaching methodologies. This is a Web enhanced course containing both online and fieldwork components.

**ES 368 Teaching and Learning with Geospatial Tools 3 Credits**

Exploration of geospatial tools, including but not limited to global positioning systems (GPS), geographic information systems (GIS), and related visualization tools (e.g., Google Earth). Application of these tools and techniques to instructional settings, including appropriate pedagogy and assessment.

**ES 371 Special Topics 1-4 Credit**

Intensive, research-oriented study of a subject or issue in Environmental Studies not covered in other courses. For students of demonstrated ability and adequate preparation. May be repeated for credit up to four credits. Consent of program director required.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU, SS

**ES 375 Seminar: Green Polity 4 Credits**

Development of guidelines and applications for public policy and political action directed toward environmental sustainability and political feasibility. Focus on problem-solving and policy design, connecting sustainable environmental goals with workable and responsive institutional designs.

**Attribute/Distribution:** SS

**ES 381 Senior Seminar: Issues in Environmental Studies 4 Credits**

Advanced seminar focusing on discussion and research on specialized subjects in Environmental Studies. Subject matter varies from semester to semester. Intended for Environmental Studies majors and minors but open to others. Prerequisites as noted below or consent of program director.

**Prerequisites:** ES 001 or ES 002

**Attribute/Distribution:** SS

**ES 391 Honors Thesis 1-4 Credit**

Directed undergraduate research thesis required of students who apply and qualify for graduation with program honors. Consent of program director required.

**Attribute/Distribution:** HU, SS

**ES 401 Philosophical-Policy and Environmental Legal Design 3 Credits**

A basic class for graduate students on the idea of policy design, as opposed to standard economic analysis of public policy and its application to various domestic and international environmental dilemmas. The course will also introduce the idea of Philosophical-Policy, or the use of integrated philosophical systems to justify specific policy design arguments, through the use of two distinct theoretical paradigms that focus on, specifically, the integrity of the natural environment and the capabilities of humans in relation to ecosystems.

**ES 402 Scientific Foundations for Environmental Policy Design 3 Credits**

This course explores the science behind the environmental issues that bear on the policy process at local, national and global scales. It delves into the science of selected environmental issues that have either arisen from anthropogenic activities, or that impact social systems, or that help policy makers understand the consequences of different policy options. The course will consist of readings and discussions of timely topics and one major project.

**Attribute/Distribution:** NS

**ES 431 U.S. Environmental Law I: Pollution and Risk Abatement 3 Credits**

The study of bureaucracy and problems of public and nonprofit organization and management; executive leadership; personnel management systems and regulatory administration.

**ES 433 International Environmental Law & Policy 3 Credits**

This course examines the basic international legal setting for the protection and management of the global environment. It examines how international law concerning nature is made and applied, the role of international environmental regimes or institutions, enforcement strategies, and compliance mechanisms. Emphasis will be placed on a review of various regulatory regimes for the protection of the global commons, including the history and legal sources of the Global Climate Change Convention.

**Attribute/Distribution:** SS

**ES 435 Environmental Valuation for Policy Design & Legal Analysis 3 Credits**

Reviewing the history and legal context that gave rise to the current use of the "contingent valuation method" for pricing environmental resources, this course assesses empirical and normative strengths of this method, as well as the weaknesses that challenge its effectiveness and political legitimacy. Students will evaluate the recent turn to "deliberative" methods of resource valuation and consider empirical and normative problems that deliberative methods address.

**ES 443 Comparative Environmental Law & Policy 3 Credits**

This course studies the different ways in which domestic legal systems handle the regulation of humanity's relationship to the natural world. The first part of the course concentrates on comparative law that examines the evolution of distinct types of legal systems from their origins in the ancient world. The second part of the course specifically and comparatively examines environmental law as it has developed in Canada, China, the European Union and the United States. Ranges of alternatives for environmental law and policy as practiced in various parts of the world will be explored.

**Attribute/Distribution:** SS

**ES 455 Environmental Justice & The Law 3 Credits**

This course is an in-depth exploration of the various ways in which environmental law and policy can have discriminatory effects. It examines the rise and evolution of the environmental justice movement, and the impact of environmental justice claims on administrative rulemaking at both the state and federal level. Reviewing the history of case law concerning environmental justice suits filed under the 1964 Civil Rights Act, it also examines the future of environmental justice in environmental law and policy.

**Attribute/Distribution:** SS

**ES 461 Wetland Policy and Valuation 3 Credits**

An interdisciplinary exploration of the laws, political context, and administrative issues shaping wetlands policy. Legal component will review the statutory and case law relevant to legislative and judicial decisions about wetlands. Valuation component will consider instrumental and non-instrumental approaches to valuation of wetland ecosystems, and how these approaches bear on the prospects for wetland restoration in light of global climate change. Managerial component will explore the science of wetland structure and function, and how science-based decisions about wetland protection are complicated by conflicting levels – local, state, and federal – of regulatory authority. Integrated activities with EES 386, Wetland Science. Not available for students who have taken EES 386.

**ES 465 International Law and Policy Design 3 Credits**

Beginning in the 13th Century, this course traces the various philosophical, historical, and policy design arguments that have been used to explain, justify, and influence the evolution of the rule of law between states (*ius gentium*).

**Attribute/Distribution:** SS

**ES 475 Seminar: Green Polity 3 Credits**

Development of guidelines and applications for public policy and political action directed toward environmental sustainability and political feasibility. Focus on problem-solving and policy design, connecting sustainable environmental goals with workable and responsive institutional designs.

**ES 483 Independent Study 1-3 Credit**

**Repeat Status:** Course may be repeated.

**ES 490 Thesis 1-6 Credit**

Thesis.

**ES 499 Dissertation 1-15 Credit****Global Studies**

**Program Director:** Jack Lule, Ph.D. (Georgia)

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**Associate professor.** Vera Fennel, Ph.D. (Chicago) Political Science and Global Studies.

**Assistant professor.** John Jirik, Ph.D. (Texas), Journalism and Communication and Global Studies.

Terrorism. Poverty. The dollar. Global warming. The World Cup. Immigration. MTV International. The United Nations. Ethnic cleansing. McDonald's.

Almost every aspect of human existence has been touched by the dynamic of globalization, which may be the defining characteristic of the 21st Century.

Yet, the origins, history, evolution, and impact of globalization – even its very definition – are subject to intense debate. We can surely say, however, that every student leaving college and entering the workforce – the world – should have a fundamental understanding of globalization.

Such understanding will give students crucial knowledge and skills that will set them apart in this new world and help them succeed in an increasingly globalized context. It will help them anticipate the social, cultural, economic and political changes brought about by globalization – and the resistance to globalization. It will better prepare students to draw connections in an interdependent and interconnected world.

Global Studies is a relatively new and increasingly popular major at universities worldwide, including Yale, UCLA, the London School of Economics and others. **Different from study in an individual department, Global Studies is emphatically interdisciplinary**, with professors from anthropology, journalism, sociology, modern languages and literature, religion studies, political science, history, international relations, and others. Increasingly, the most important questions cannot be answered by one discipline but by the combined efforts of multiple disciplines.

Although study of globalization has gone on at Lehigh for years, the University formally created the Globalization and Social Change Initiative in Fall 2006, and the major in Global Studies followed soon after.

The Initiative's three main areas of focus are Global Communication, Culture and Identity, and Politics and Social Structures. Rooted in these areas of interest, the major examines how the forces of globalization shape and are shaped by history, culture, economics, politics, communication, and other fundamental aspects of the human condition.

In many Global Studies programs, students choose from a sprawling array of courses tied together loosely by virtue only of international

content. Global Studies at Lehigh directs students in a more focused manner to core courses that confront, from the perspectives of multiple disciplines, perhaps the single, central force shaping the world today – globalization.

The program requires a total of 40 credits, intermediate language proficiency, a semester of study abroad, and a global studies research project undertaken as part of a capstone seminar.

The program also takes advantage of Lehigh's NGO (non-government organization) status at the United Nations. Students have the opportunity to meet and work with UN officials. A number of Global students become delegates to the UN for international NGOs while they are still at Lehigh.

**Careers in Global Studies**

Career opportunities are numerous for graduates of Global Studies.

Professions in the 21<sup>st</sup> century increasingly are demanding global understanding and expertise as well as the ability to take on interdisciplinary work across boundaries. People trained in the interdisciplinary field of **Global Studies** have increasing advantages over those trained in a single discipline.

Through the Global Studies major, students acquire a strong grounding in global affairs and an understanding of the complex phenomenon of globalization. They engage in problem-solving across boundaries and cultures. They are able to critically and analytically evaluate information from a comparative perspective. They learn to be effective communicators and learn to argue and defend complex views in writing, such as policy papers, and public speaking, such as individual and group presentations, to a variety of global audiences. Careers paths include work with:

Global culture industries music, film, sports	MTV, Disney, the NBA, Coca Cola
Global environment	World Wildlife Fund, Greenpeace, Sierra International
Global health	World Health Org (WHO), Ctr for Disease Control (CDC)
Global marketing agencies	BBDO, DDB, J. Walter Thompson, Leo Burnett
Human justice organizations	Amnesty International, Human Rights Watch
Global governing agencies	UN, World Bank, International Monetary Fund (IMF)
Global service agencies	Red Cross, CARE, UNICEF, Peace Corps
Global development agencies	U.S. Agency for International Development, relief funds
International businesses	Sony, Microsoft, Apple, medicine and pharmaceuticals
Mass communication	CNN, ESPN, Rodale International, foreign correspondence
Travel and tourism	Travel agencies, global tours, cruise lines
U.S. gov't offices and agencies	Foreign Service, State Department, political staffs

**Global Studies Major**

<b>Introductory Course</b>	<b>4</b>
GS 001 Introduction to Global Studies	
<b>Core Courses</b>	<b>16</b>
Select one course from each core area that explores how globalization shapes and is shaped by.	

**History Core**

GS/HIST 101	Histories of Globalization
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**Culture Core**

GS/MLL 006	Globalization and Cultures
GS/ANTH 106	Cultural Studies and Globalization
GCP/ENGL 007	Global Literature

**Political Economy Core**



IR/POLS 125	International Political Economy	
GS/SSP 126	The Political Economy of Globalization	
<b>Politics Core</b>		
IR 010	Introduction to World Politics	
GS/POLS 003	Comparative Politics	
GS/POLS/PHIL 100	Introduction to Political Thought	
<b>Advanced Coursework</b>		<b>8</b>
Select two of the following: <sup>1,2</sup>		
JOUR 101	Media, Sports and Society	
GS/HIST 107	Technology and World History	
GS/POLS/ASIA 201	Democracy and Dictatorship in South Asia	
GS/REL/GCP 244	Globalization and Religion	
IR 245	International Organization	
GS/JOUR 246	International Communication	
GS/COMM 248	Global Communication	
GS 315	Seminar in Globalization and Culture	
GS 318	Seminar in Globalization and Communication	
GS/ANTH/GCP 320	Global Capitalism	
GS/MLL 321	Intercultural Communication	
GS/GCP/HMS/SSP 322	Global Health Issues	
GS/ANTH/AAS 324	Globalization and Development in Africa	
GS/POLS 325	Nationalism in Comparative Perspective	
GS/SSP 329	Global Migration	
GS/POLS/WGSS 342	Gender and Third World Development	
IR 347	Non-State Actors in a Globalized World	
PSYC 364	Children and Narratives	
GS/PSYC 365	Human Development in Cross-Cultural Perspective	
<b>Area Studies</b>		<b>6-8</b>
Select two courses from one Area Studies program, including area studies coursework from study abroad approved by adviser:		
Africana Studies		
Asian Studies		
Latin American Studies		
European Studies		
<b>Senior Seminar</b>		<b>4</b>
GS 375	Senior Seminar in Global Studies	
<b>Collateral Requirements</b>		<b>4-8</b>
Intermediate language proficiency <sup>3</sup>		
<b>Study abroad</b>		<b>12</b>
Study abroad <sup>4</sup>		
<b>Total Credits</b>		<b>54-60</b>

- Students can choose from a wide variety of Global Studies courses each semester, including but not limited to the courses listed.
- One advanced course can be replaced by an approved, overseas internship or relevant, supervised experiential learning in the United States. The program will work to develop a network of global internships.
- Intermediate II or equivalent in a language taught at Lehigh, other than the student's native language
- 12 credits of study abroad, taken in one semester, or one 6-credit summer session with approval of adviser, for financial or academic reasons. In all cases, coursework can be substituted, with the guidance of an adviser, if student is financially or academically unable to study abroad)

**Global Studies Minor**

A minor in Global Studies consists of four courses with one class at the 200 level or above. Visits to the UN as well as study abroad or Lehigh Abroad are strongly recommended. To declare a minor in Global Studies, students must complete a minor declaration form. (<http://>

[catalog.lehigh.edu/coursesprogramsandcurricula/artsandsocieties/globalstudies/Global\\_Studies\\_Minor\\_Declaration\\_Form.pdf](http://catalog.lehigh.edu/coursesprogramsandcurricula/artsandsocieties/globalstudies/Global_Studies_Minor_Declaration_Form.pdf))

GS 001	Introduction to Global Studies	4
Select three courses from the list of core and advanced classes. <sup>1, 2</sup>		12
<b>Total Credits</b>		<b>16</b>

- One class must be 200 level or above.
- Visits to the UN as well as study abroad or Lehigh abroad are strongly recommended.

**Courses**

**GS 001 Introduction to Global Studies 4 Credits**

MTV/International. Islam. Yao. The UN. Global warming. Terrorism. McDonald's. Almost every aspect of human existence has been touched in some way by the dynamic of globalization. The historical and continuing integration of peoples, cultures, markets and nations, globalization may become the defining characteristic of the 21st Century. It has been a Janus-like force of two faces, with advantages and disadvantages, surfeit and suffering. In this emphatically interdisciplinary course, the foundation class for the Global Studies major and intended for freshmen and sophomores, students will be introduced to a variety of historical, critical and analytical perspectives, methods and vocabularies for continued study of globalization and social change.

**Attribute/Distribution:** SS

**GS 003 Comparative Politics 4 Credits**

The political systems of foreign countries; approaches to the study of comparative politics.

**Attribute/Distribution:** SS

**GS 006 Globalization and Cultures 4 Credits**

This course is a reflection on the processes of globalization and their consequences, both good and bad, on the world's societies and on our concepts of culture and identity. It provides a multidisciplinary examination of what cultures gain and lose from their interaction with the rest of the world and what it means to be a citizen of a globalized yet diverse world.

**Attribute/Distribution:** HU

**GS 100 Introduction to Political Thought 4 Credits**

A critical examination of political ideologies: Liberalism, Marxism, Fascism, and Islamism.

**Attribute/Distribution:** ND

**GS 101 Histories of Globalization 4 Credits**

Critical historical perspectives on current debates around "globalization" and the varied paths and responses to modernity, using recent scholarship associated with the New Global History. The "Rise of the West" paradigm, Industrial Revolution and modernization theory; creation of global financial markets, nation-building and New Imperialism; Great Depression and World Wars as global historical events; postwar decolonization, Cold War and emergence of North-South relations; impact of consumerism, movements for women's rights, ethnic nationalism and religious fundamentalist movements in tradition-bound societies.

**Attribute/Distribution:** HU

**GS 106 Cultural Studies and Globalization 4 Credits**

This course closely examines the complex relationship between culture and globalization. The impact of globalization on local culture is an essential topic. But the interaction of globalization and culture is not a oneway process. People around the world adapt globalization to their own uses, merging global cultural flows with local practices in transformative ways. The course will study the interaction of local culture with globalizing forces; immigration and culture; the localizing of mass culture; cultures of diasporic and migratory groups, and globalization, gender and identity.

**Attribute/Distribution:** SS

**GS 107 Technology and World History 4 Credits**

Development of technology and its relationship to political, economic, military, and cultural aspects of world civilization from pyramids to the present period.

**Attribute/Distribution:** SS

**GS 126 The Political Economy of Globalization 4 Credits**

This course studies the relationship among economic, political and cultural forces in an era of globalization. Focus is on how global capitalism, the world market and local economics shape and are shaped by social, cultural and historical forces. Topics include political and cultural determinants of trade and investment; culture and the global economy; global capitalism, especially studied through the lens of culture; globalization and patterns of economic growth; cross-cultural study of consumerism; poverty and inequality; the interplay of foreign and domestic economic policy; international economic organizations, such as the World Trade Organization, the International Monetary Fund, and the World Bank, and globalization and national development.

**Attribute/Distribution:** SS

**GS 201 Democracy and Dictatorship in South Asia 4 Credits**

Theories of democracy and democratization explored in the South Asian context. Relationship of democracy to economic development and identity considered. How do historical legacies of colonialism and conflict shape contemporary outcomes.

**Attribute/Distribution:** SS

**GS 244 Globalization and Religion 4 Credits**

This course examines the complexity of globalization and its multi-layered impact on religious identity and piety. Though comparative in methodology and historical framework, the class will give special attention to Islam and Hinduism in South Asia. Topics include: European colonialism; Orientalism and its legacy; religious nationalism; Islamophobia; and the Internet and mass media.

**Attribute/Distribution:** HU

**GS 246 International Communication 4 Credits**

The subject matter is crucial to understanding modern life: the role of international news media in world affairs. The class studies the social, political and economic contexts that frame the reporting of international events by U.S. news media, such as politics, war, disasters, and other crises, as well as U.S. reporting on international issues, such as poverty, disease, and environmental change. The course also surveys reporting practices in nations around the world, including the varying systems of journalism and mass media and the brutal censorship and repression facing many foreign journalists.

**Attribute/Distribution:** SS

**GS 248 Global Communication 4 Credits**

This class studies, from an historical and cultural perspective, how globalization shapes and is shaped by communication and media structures and processes, with special emphasis on transnational media corporations and their interaction with cultures around the globe. Topics include: globalization, media and culture; mass media and development; the flow of entertainment programs and debates on cultural imperialism; media and migration; the imbalanced flow of information in the world; the debate on the New World Information Order; and forms of resistance to transnational media from world governance institutions, such as UNESCO, state regulatory responses, and alternative media, such as citizen blogs and pirate radio.

**Attribute/Distribution:** SS

**GS 300 Apprentice Teaching 1-4 Credit**

**Repeat Status:** Course may be repeated.

**GS 315 Seminar in Globalization and Culture 4 Credits**

Advanced seminar that focuses on research and discussion of specialized topics in globalization and culture. Subjects vary by semester. Junior or senior standing and departmental Permission required.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** SS

**GS 318 Seminar in Globalization and Communication 4 Credits**

Advanced seminar that focuses on research and discussion of specialized topics in globalization and communication. Subjects vary by semester. Junior or senior standing and departmental Permission required.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** SS

**GS 320 Global Capitalism 4 Credits**

Anthropological approach to the forms and effects of global capitalism. Topics include the structure of contemporary global capitalism, including the growth of multinational corporations, flexible corporate strategies, overseas manufacturing, and global branding and marketing; the impact of global capitalism on the environment and on the lives of people in "Third World" countries; consumer culture and the diversity of non-Western consumption practices; alternative capitalist systems, especially Asian capitalisms.

**Attribute/Distribution:** SS

**GS 321 Intercultural Communication 4 Credits**

Language is ambiguous by nature and discourse is interpreted in cultural and linguistic contexts. This course covers different cultural and linguistic strategies individuals use to communicate with each other, essential concepts for interacting with individuals from other cultural and linguistic backgrounds, and different strategies of communication as defined by specific cultures. Covering the theory and practice of intercultural interaction, this course examines assumptions about language and culture, and includes practical advice to help students develop the cultural sensitivity essential for communication today.

**Attribute/Distribution:** HU

**GS 322 Global Health Issues 4 Credits**

Sociological dimensions of health, illness, and healing as they appear in different parts of the world. Focus on patterns of disease and mortality around the world, with special emphasis on major epidemics such as HIV/AIDS, and malaria; the relative importance of 'traditional' and 'modern' beliefs and practices with regard to disease and treatment in different societies; the organization of national health care systems in different countries; and the role of international organizations and social movements in promoting health.

**Attribute/Distribution:** SS

**GS 324 Globalization and Development in Africa 4 Credits**

Course examines the challenges Africa presents to expectations of modernization and development. It poses these questions: Have African societies been left behind by globalization, shut out from it, or do they reflect an unexpected side of globalization processes? What is Africa's place in the neo-liberal world order? What role does "African culture" play in generating or blocking social change? How can anthropology illuminate prospects for change on what has long been regarded as the "dark continent"?

**Attribute/Distribution:** SS

**GS 325 Nationalism in Comparative Perspective 4 Credits**

Examination of major theoretical and policy debates in contemporary studies of nationalism. Focus on the emergence and endurance of nationalist movements in the modern era. Discussion of efforts to evaluate the legitimacy of nationalist claims and to resolve nationalist conflict.

**GS 328 Global Food Systems 4 Credits**

Where does our food come from? How does it get to our tables? Why are there famines in some parts of the world and obesity epidemics in other parts of the world? This course will investigate these questions by focusing on food systems – the chains of social action that link food producers to food consumers. We will also explore a range of alternatives to global food systems that emphasize food democracy, security, and sustainability.

**Attribute/Distribution:** SS

**GS 329 Global Migration 4 Credits**

International migration is transforming societies at both the global and national levels, and in both origin and destination areas. Why do people move? What are the consequences of these movements? We will investigate the political and economic explanations for international migration and explore how each act of migration contributes to the transnationalization of social relations, alters existing livelihoods, transforms economic production and social support arrangements, and recreates racial, ethnic, and national identities.

**Attribute/Distribution:** SS

**GS 339 The Rise of the State in Modern East Asia 4 Credits**

An examination of the role of Asian nationalism in the construction of the modern state form in Asia.

**Attribute/Distribution:** SS

**GS 342 Gender and Third World Development 3-4 Credits**

Focus on gender implications of contemporary strategies for Third World economic growth, neo-liberalism. How do economic theories affect 'real people?' How do economic theories affect men vs. women? What is the role of people who want to 'help?' Some background in economic theories and/or Third World politics desired, but not required. Prerequisites as noted below.

**Prerequisites:** POLS 001 or WGSS 001

**Attribute/Distribution:** SS

**GS 343 Global Politics of Race: Asia and Africa 4 Credits**

An examination of the concept of "race" and its impact on domestic and international politics.

**Attribute/Distribution:** SS

**GS 348 The British Empire and the Modern World 4 Credits**

Examines the empire from its humble beginnings in the sixteenth century to its sudden collapse after World War II. Topics include exploration, ideology, state-building, war, capitalism, globalization, racism, social transformation, independence movements, and post-colonial legacies.

**Attribute/Distribution:** HU

**GS 351 "The Gangs of New York" 4 Credits**

The course will use the Martin Scorsese film "The Gangs of New York" as a window to examine the social economic transformations of New York City in the middle of the nineteenth century. Emphasis will be on immigration, slum gangs and street violence, politics, the Draft Riot of 1863, and the Tweed Ring. A recurrent theme will be to compare the historical record with the film's depiction of those events. There will be a required evening showing of the film. Not available for pass/fail.

**Attribute/Distribution:** HU

**GS 355 Destruction and Reconstruction of Europe, 1879-1950 3 Credits**

An analysis of the decline and disintegration of European civilization through two world wars and Europe's reintegration in the era of the European Union. Emphasis on the development of the European state system, international conflict, and political thought.

**Attribute/Distribution:** SS

**GS 365 Human Development in Cross-Cultural Perspective 4 Credits**

The formation of mind and personality is shaped in profound ways by the sociocultural contexts within which individuals develop. This course introduces students to basic theoretical and methodological issues and explores important examples of cross-cultural variation and diversity, using comparisons between different societies and between different subcultures within American society. Topics include cognition, language, personality, moral development, socio-emotional development, identity, attachment, and socialization. Materials drawn from anthropology, sociology and education in addition to psychology. Consent of department required. Prerequisites as noted below or consent of instructor.

**Prerequisites:** PSYC 107 or PSYC 109 or PSYC 121 or SSP 121 or ANTH 001

**Attribute/Distribution:** SS

**GS 375 Senior Seminar in Global Studies 4 Credits**

Advanced seminar with readings, in-depth discussion, and independent research. The goal of the seminar is for each student to produce a research project that might prepare him or her for the first steps after graduation. For example, students interested in global culture industries might do research on issues or organizations in that area. Students interested in human justice might do research on issues or organizations on that area.

**Attribute/Distribution:** ND, SS

**GS 390 Directed Readings 1-4 Credit**

Directed course of readings for students with interests in Global Studies not fully explored in regular course offerings. Junior or senior standing required. May be repeated for credit. Departmental permission required.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**GS 391 Directed Research 1-4 Credit**

Research and study for students with interests in Global Studies not fully explored in regular course offerings. Junior or senior standing required. May be repeated for credit. Departmental permission required.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** SS

**GS 392 Internship in Global Studies 1-4 Credit**

Supervised work relevant to global studies, including internships at the United Nations, nongovernment organizations (NGOs), government organizations, and other public and private agencies. May be repeated for credit. Department permission required.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** SS

**GS 394 Honors Thesis 1-4 Credit**

To graduate with honors in Global Studies, students need to attain a 3.5 grade point average in Global Studies classes; a 3.5 grade point average overall, and complete 4 credits of GS 399 Honors Thesis at the time of graduation. The four credits may be taken in one semester or split over two semesters. The honors thesis is an intensive project of original research, undertaken under the direct supervision of a faculty adviser. Senior standing required. May be repeated for credit. Departmental permission required.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** SS

**Health, Medicine, and Society**

**Program Director:** Elizabeth Dolan, Ph.D (North Carolina)

**Email:** bdolan@lehigh.edu # **Phone:** 610-758-3317

**Website:** <http://cas.lehigh.edu/casweb/default.aspx?id=1019>

*Supported by the Office of Interdisciplinary Programs 610-758-3996; incasip@lehigh.edu*

An interdisciplinary Health, Medicine, and Society minor is offered in the College of Arts and Sciences. A committee composed of faculty from several departments across the college developed and participate in the program. Students interested in declaring a minor in Health, Medicine, and Society should contact the Office of Interdisciplinary Programs.

The challenge of meeting the increasingly complex health needs of growing and aging populations is moving to the forefront of national and international concerns in the 21<sup>st</sup> century. The Health, Medicine, and Society field focuses on the social scientific and humanistic dimensions of health and medical care to develop an understanding of the impact of health, illness, and medical care on individuals, families, and societies. This minor is intended to serve students who wish to be involved in some aspect of the health care industry or health policy and also students who are interested in communications, the pharmaceutical industry, law, business, agency work, and other careers where understanding health care is essential.

**Minor in Health, Medicine, and Society**

The minor in HMS consists of one core course and three elective courses for a total of 16 credits. To declare a minor in HMSs, students must complete a minor declaration form ([http://catalog.lehigh.edu/courses/programsandcurricula/artsandsciences/healthmedicineandsociety/hms\\_minor\\_declaration\\_form.pdf](http://catalog.lehigh.edu/courses/programsandcurricula/artsandsciences/healthmedicineandsociety/hms_minor_declaration_form.pdf)).

**Required Core Course (select one)**<sup>1</sup>

HMS/SSP 160	Medicine and Society (fall)
HMS 170	Medical Humanities (summer)
HMS 180	Introduction to Public Health (spring)

**Electives (select three)**<sup>2</sup>

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HMS/ENGL 115	Topics in Literature, Medicine, and Health
HMS/PHIL/REL 116	Bioethics
HMS/JOUR/ES 117	Environmental Health Risks and the Media
HMS/STS/HIST 118	History of Modern Medicine
HMS/PSYC 138	Abnormal Psychology
HMS/SSP 152	Alcohol, Science, and Society
HMS/ANTH 155	Health, Illness & Healing
HMS/SSP 162	AIDS and Society
HMS/REL 226	From Black Death to AIDS:Plague,Pandemic,Ethics and Religion
HMS 291	Independent Study
HMS/ENGL 315	Topics in Literature, Medicine, and Health
HMS/SSP/GS 322	Global Health Issues
HMS/JOUR/STS 323	Health and Environmental Controversies
HMS/PSYC 327	Health Psychology
HMS/PSYC/WGSS 334	The Psychology of Body Image and Eating Disorders
HMS/SSP/WGSS 341	Women and Health
HMS/PSYC 344	Health Care Reasoning and Decision-Making
HMS/POLS 354	U.S. Health Care Politics
HMS/PSYC 386	Child Health Psychology
BIOS 010	Bioscience in the 21st Century
ECO 368	Health Economics
POLS 307	The Politics of Mental Health Policy

Total Credits 16

1 If more than one core course is taken, core courses may substitute for electives.

2 Additional HMS designated courses may be offered each semester, consult with the Office of Interdisciplinary Programs for a complete listing of HMS courses.

#### Courses

##### **HMS 115 Topics in Literature, Medicine, and Health 4 Credits**

Largely focused on narratives about health, illness and disability, this course will examine individual experiences with attention to social context. Topics may include the physician/patient relationship, illness and deviance, plague literature, gender and medicine, autism, AIDS, mental illness, aging.

**Attribute/Distribution:** HU

##### **HMS 116 Bioethics 4 Credits**

Moral issues that arise in the context of health care and related biomedical fields in the United States today, examined in the light of the nature and foundation of moral rights and obligations. Topics include: confidentiality, informed consent, euthanasia, medical research and experimentation, genetics, and the distribution of health care.

**Attribute/Distribution:** HU

##### **HMS 117 Environmental Health Risks and the Media 4 Credits**

This course explores the risks and effects of environmental contamination on human health and behavior as well as the role of the mass media in alerting citizens to potential environmental health risks. Environmental topics vary but usually include air and water pollution, endocrine disrupters and radioactive waste.

**Attribute/Distribution:** SS

##### **HMS 118 History of Modern Medicine 4 Credits**

Introduction to Western medical history from the 18th century to the present day. Students will explore patient/practitioner relationships; examine changing ideas concerning health, sickness, and disease; chart changes in hospital care and medical education; and tackle topics such as eugenics, medical experimentation and health insurance.

**Attribute/Distribution:** HU

##### **HMS 138 Abnormal Psychology 4 Credits**

Examines research and theory on the patterns, causes, and treatment of various forms of abnormal behavior. Prerequisites as noted below.

**Prerequisites:** PSYC 001

**Attribute/Distribution:** SS

##### **HMS 152 Alcohol, Science, and Society 4 Credits**

Alcohol use and abuse, its historical function in society, moral entrepreneurship, status struggles and conflict over alcohol. Current problems with attention to special population groups and strategies for prevention of alcohol abuse.

**Attribute/Distribution:** SS

##### **HMS 155 Health, Illness & Healing 4 Credits**

Introduction to medical anthropology, a field of study that examines how conceptions of illness and health and methods of healing vary over time and across cultures. Introduces a number of culturally specific approaches to health and illness, including Western biomedicine, and aims to provide a broad understanding of the relationship between culture, illness, and healing.

**Attribute/Distribution:** SS

##### **HMS 160 Medicine and Society 4 Credits**

Health, illness, and the health professions from the sociological perspective. Social epidemiology, social psychology of illness, socialization of health professionals, organization of health care, patient-professional relationships and ethical issues in medical care.

**Attribute/Distribution:** SS

##### **HMS 162 AIDS and Society 4 Credits**

Impact of the AIDS epidemic on individuals and on social institutions (medicine, religion, education, politics, etc.); social and health policy responses; international experience; effect on public attitudes and policy on people affected directly by AIDS.

**Attribute/Distribution:** SS

##### **HMS 170 Medical Humanities 4 Credits**

The focus on individual voices and particular historical moments in the humanities disciplines has much to add to our understanding of health and illness. This course will take up ethical, historical, and literary approaches to health. The course can count as the core course for the minor (instead of HMS/SSP160), or it can be taken as one of the three electives.

**Attribute/Distribution:** HU

##### **HMS 180 Introduction to Public Health 4 Credits**

This course provides historical perspective on the contributions and roles of public health; introduces health status indicators of morbidity and mortality, concepts of rate, causation, and public health surveillance and vital statistics; and addresses determinants of health from an environmental, social, behavioral perspective. Aspects of health care delivery will be addressed from a population perspective and organizational structure. Course can count as the core course for the minor (instead of HMS/SSP160), or taken as an elective.

**Attribute/Distribution:** SS

##### **HMS 226 From Black Death to AIDS:Plague,Pandemic,Ethics and Religion 4 Credits**

An investigation of the role of religion and ethical analysis in constructing meaning around the idea of plague and pandemic. The role of religion in the European bubonic plague epidemic, the influenza pandemic of 1918, and the AIDS crisis will be examined, with attention given to ethical analysis of the institutional response to pandemic disease as distortions have occurred for political, social, and religious reasons.

**Attribute/Distribution:** HU

##### **HMS 291 Independent Study 1-4 Credit**

Independent research and reading with a faculty member. After receiving initial approval from the HMS director, the student must prepare an independent study proposal, with readings and assignments, in consultation with a professor who agrees to direct the independent study. Open only to declared HMS minors who have completed HMS/SSP 160 in a previous term.

**Attribute/Distribution:** HU, SS

**HMS 315 Topics in Literature, Medicine, and Health 3,4 Credits**

Analyzing the stories people tell about health, illness and disability, this course engages cultural studies approaches in order to explore the way those stories are told. Topics may include: illness and the graphic novel, the changing image of the healer in literature, collaborative storytelling with Alzheimer's patients, end of life narratives, tales from the ER, narrative ethics.

**Attribute/Distribution:** HU

**HMS 322 Global Health Issues 4 Credits**

Examines the sociological dimensions of health, illness, and healing as they appear in different parts of the world. Focuses on patterns of disease and mortality around the world, with special emphasis on major epidemics such as HIV/AIDS, and malaria; the relative importance of 'traditional' and 'modern' beliefs and practices with regard to disease and treatment in different societies; the organization of national health care systems in different countries; and the role of international organizations and social movements in promoting health.

**Attribute/Distribution:** SS

**HMS 323 Health and Environmental Controversies 4 Credits**

Exploration of health and environmental controversies from the perspectives of scientific uncertainty and mass media coverage. Examines genetic engineering, biotechnology, environmental health risks, and nanotechnology. Includes discussion of ethical and social responsibilities and interactions with the public.

**Attribute/Distribution:** SS

**HMS 327 Health Psychology 4 Credits**

An overview of the topic of health psychology. The course presupposes a preventative intervention approach to the problem of assisting healthy individuals to understand the relationship between behavior and health, and to engage those behaviors that promote health. This course will be underpinned with basic science and research on health psychology, but will include an application focus. Consent of department required. Prerequisites as noted below.

**Prerequisites:** PSYC 001

**Attribute/Distribution:** SS

**HMS 334 The Psychology of Body Image and Eating Disorders 4 Credits**

The course addresses the psychosocial aspects of the development of healthy and unhealthy body image and eating disorders. The roles of personality traits/individual factors, family and interpersonal functioning, and cultural factors will be examined, as will the impact of representations of body image in mass media. Public health and psychological interventions for prevention and treatment will be explored. Personal accounts/memoirs, clinical case presentations, and documentary and dramatic films will be incorporated in the presentation of topics.

**Attribute/Distribution:** SS

**HMS 341 Women and Health 4 Credits**

Relationships of women to the medical system. Influence of medicine on women's lives and the impact of the women's movement on health care.

**Attribute/Distribution:** SS

**HMS 344 Health Care Reasoning and Decision-Making 4 Credits**

Health care professionals diagnose physical and mental illnesses and create treatment plans to improve their patients' health. How do these professionals make decisions related to these important issues? We will explore the literature on how medical and mental health professionals reason and make decisions about health care issues. Topics to be covered include diagnosis, treatment decisions, access to care, and how these reasoning processes are swayed. Consideration will be given to patient decision-making as well. Consent of department required. Prerequisites as noted below or consent of instructor.

**Prerequisites:** PSYC 117 or PSYC 176 or COGS 007

**Attribute/Distribution:** SS

**HMS 354 U.S. Health Care Politics 4 Credits**

Explores a range of health care programs and policies and their impacts on American society. Topics include the development of the U.S. approach to health care; public sector plans (Medicare and Medicaid); the role of managed care; the employer-sponsored system; the situation of the medically uninsured; the health care vested interests and lobbyists; movements for national health care; and options for change.

**Attribute/Distribution:** SS

**HMS 386 Child Health Psychology 4 Credits**

Focuses on developmental research and theory related to health and wellness issues in children and adolescents. Topics include children's understanding of biology and disease, disease management, medical consent, education and policy efforts to promote children's health. Consent of department required. Prerequisites as noted below or consent of instructor.

**Prerequisites:** PSYC 107

**Attribute/Distribution:** SS

**Hebrew**

Modern Hebrew is taught in the Department of Modern Languages and Literature. Biblical Hebrew is taught in the Department of Religion Studies.

**History**

History home page (<http://history.cas2.lehigh.edu/node/8>)

The history major introduces students to the study of the causes and consequences of change through an examination of political, economic, social, cultural, and intellectual developments and institutions over time. The department's goal is to train its majors to think critically about the events and forces that have shaped the modern world, to analyze and interpret sources and evidence, and to view issues from a variety of perspectives. Those skills have served students well in a wide range of careers. Lehigh history majors have frequently gone on to law school or to work in various areas of education, journalism, public affairs, and business. The major also provides an excellent basis for graduate training in a wide range of public policy fields. The department offers a program of independent honors research under the direction of an individual faculty member (HIST 391, HIST 392). A maximum of six credits may be used toward this project. Normally students pursue their research in the second semester of the junior year and the first semester of their senior year; the project may also be undertaken during the senior year. Students who do well on their research project will graduate with department honors. The writing intensive requirement must be filled by a course in the history department. For advanced placement, please see Section I.

The department recommends that students intending to major in history take MATH 012, Basic Statistics, to fulfill their college math requirement.

**Professors.** Stephen H. Cutcliffe, PhD (Lehigh University); Charles Robert Phillips, II, MA (Oxford University); William R. Scott, PhD (Princeton University); Roger D. Simon, PhD (University Wisconsin at Madison); Jean R. Soderlund, PhD (Temple University)

**Associate Professors.** Gail A. Cooper, PhD (University of California Santa Barbara); Michelle LeMaster, PhD (Johns Hopkins University); Monica Najar, PhD (University Wisconsin at Madison); John Pettegrew, PhD (University Wisconsin at Madison); John Savage, PhD (New York University); John Kenly Smith, Jr., PhD (University of Delaware)

**Assistant Professors.** William Bulman, PhD (Princeton University); Kwame Essien, PhD (University Texas Austin); Nitzan Lebovic, PhD (University of California Los Angeles); Maria Barbara Zepeda Cortes, PhD (University of California San Diego)

**Professor Of Practice.** Kimberley Carrell-Smith, PhD (University of Delaware)

**Emeriti.** Michael G. Baylor, PhD (Stanford University); Ian P. Duffy, PhD (Oxford University); G. Mark Ellis, PhD (Harvard University); James S. Saeger, PhD (Ohio State University)

**Department Major Requirements**

A history major consists of 35 hours, normally nine courses, as follows:

HIST 011	Survey of Europe to 1648	4
HIST 012	Survey of Europe Since 1648	4
HIST 201	Historical Perspectives	4
or HIST 202	Historical Research	

Select one of the following in the history of Asia, Africa, or Latin America:

HIST 005	African Civilization	
HIST 049	History of Latin America	
HIST 050	History of Latin America	
HIST 075	Chinese Civilization	
HIST 076	Understanding Contemporary China	
HIST 340	Japanese Industrialization	
HIST 342	Argentina, Brazil and Chile	
HIST 368	Seminar in Latin American History	

These provisional courses may be used to fulfill this requirement in accordance with their contents and emphases:

HIST 104	Themes in History	
HIST 303	Topics in History	
HIST 331	United States and Africa	
HIST 371	Independent Study	
HIST 391	Honors Thesis in History	
HIST 392	Honors Thesis in History	

Select a minimum of 12 hours of courses numbered 303 or higher (except HIST 306)

Total Credits 31

To graduate with a history major, a minimum 24 hours must be graded course work taken at Lehigh.

**Requirements for Honors**

Students wishing to graduate with honors must have a minimum GPA of 3.40 in history, 39 credits and must have completed HIST 391.

**History Minor Requirements**

Each student's minor program is prepared in consultation with the advisor of minors in the history department. Advanced placement credit may not be used for the minor program.

- 15 credits
- at least 4 credits at 200 or 300 level
- maximum of one course (4 credits) of transfer or cross-listed courses may count toward minor.

**Concentration in Public History**

History majors may earn a concentration in Public History by completing a total of 16 hours in the following courses:

HIST 305	Public History (required)	4
HIST 306	Internship in Public History (required)	4

Select at least two of the following:

ART 175	Introduction to Museum Work	
ART 275	Museums: Research, Collections Management and Exhibition Planning	
ART 370	Special Topics in Museum and Curatorial Studies	
ART 375	Museum Internship	
HIST 336	Bethlehem and the Lehigh Valley	
HIST 338	Techniques in Public History (2-4 credits, may be repeated for up to 8 credits)	
HIST 339/370/ANTH 370	Managing Nonprofit Organizations	

Total Credits 16

**Graduate Work in History**

Lehigh University has been granting advanced degrees in history for more than seventy years. Its graduates have become university and college professors, secondary school teachers and administrators, museum directors, and public servants. The graduate program focuses primarily on the areas in which the department is particularly strong in faculty and resources, notably 1) Atlantic World and Colonial America and 2) Modern America, including industry and technology. The department works closely with the Lawrence Henry Gipson Institute for Eighteenth Century Studies which sponsors yearly symposia and provides research support for both faculty and students. The history of technology program is closely tied to Lehigh's Science, Technology, and Society program.

Lehigh's libraries are especially rich in materials for graduate research in history, particularly in the fields listed above. They have an extensive collection of scholarly periodicals and monographs. Graduate programs provide intensive and specialized study, and the policy of limited enrollment permits close relations between faculty and students.

Admission to graduate study in history is competitive and dependent upon the applicant's undergraduate preparation and record, recommendations, and Graduate Record Examination scores. Besides general requirements for College of Arts and Sciences graduate programs, the following special requirements apply to graduate study in history.

**Master of Arts**

There are two masters programs. Under Plan I, a candidate may earn the degree by successfully completing 27 hours of approved course work and submitting a thesis of the length and quality that would make it suitable for publication as a scholarly article. The paper may build on work presented in a graduate research seminar in the program. Candidates continuing toward a doctorate should select Plan I. Candidates declaring Plan II take 30 hours of approved course work and pass examinations in two fields chosen from American, British, European, and Latin American history, and History of Technology. Candidates in either plan are required to maintain a 3.3 average in all graduate work.

**M.A. in History with Concentration in Public History**

Students may earn through either Plan I or Plan II (see above), an M.A. in History with a concentration in Public History by completing a total of 36 hours of approved course work, including a minimum of 10 credits and maximum of 12 credits in approved Public History courses.

HIST 305	Public History (required)	3
HIST 306	Internship in Public History (required but may be waived for equivalent experience)	3
ART 370	Special Topics in Museum and Curatorial Studies	1-4
HIST 339	Managing Nonprofit Organizations	3-4
HIST/ANTH 370	Historical Archeology	3-4
HIST 438	Techniques in Public History (2 or 3 credits; may be repeated for up to 8 credits)	2-3

Total Credits 15-21

**Doctor of Philosophy**

Students in the Ph.D. program in history must maintain a 3.50 average after two semesters of study. During the second semester, doctoral students select one major and three minor fields in which to take comprehensive written and oral examinations. The dissertation will be in the major field. The dissertation advisor will chair a special committee that will oversee the student's graduate program. The other members of the special committee will be those faculty who are examiners in the selected fields and one professor from another department relevant to the candidate's major field. No professor may direct more than one field, but the direction of a field may involve two professors. An original dissertation is required, and it must be successfully defended to the examining committee.

All Ph.D. students must meet the University Concentrated Learning Requirement. They must take Historical Research (401). Students who

enter the Ph.D. program with an M.A. from another university must also take either Readings in the History of the Atlantic World (HIST 404) or Readings in the History of Industrial America (HIST 405). Students are encouraged to take both seminars if appropriate to their course of study. All Ph.D. students must take at least 18 hours of directed readings courses (400 series) beyond the M.A.

#### Major Fields

Major fields are Technology, Modern Britain, Colonial America, Nineteenth Century United States, Twentieth Century United States. (The Nineteenth and Twentieth century fields may be divided topically rather than chronologically; for example, a Student may be examined in labor/social history 1800-present, and in political history 1800-present.)

#### Minor Fields

Any of the major fields listed above may also be minor fields. Examples of other minor fields are American Studies; Ancient History; Early Modern Europe; Modern Europe; Latin America; Environmental History; Japan; Public History; Science, Technology and Society studies.

#### Language Requirements

The student's special committee determines whether proficiency in a foreign language or proficiency in statistical methods will be required for the doctoral degree.

#### Undergraduate Courses in History

Petitions are required for first-year students to take 100-level or higher courses, and for sophomores to take 200-level or higher courses. HU fills humanities distribution requirements; SS fills social science requirements; ND not designated.

#### For Advanced Undergraduates and Graduate Students

Graduate students may take 300 level courses, for which they receive 3 credits. Undergraduates must take them for 4 credits.

#### Courses

##### HIST 005 African Civilization 4 Credits

SubSaharan Africa through the millennia of the ancient world to the present. Human origins, state and nonstate systems, the external slave trade, colonialism, resistance to European rule, independence movements, and neocolonialism.

**Attribute/Distribution:** SS

##### HIST 007 Technology in America's Industrial Age 4 Credits

Traces the development of American technology from the preindustrial colonial era until America's emergence as the world's leading industrial power. The interactions between technology and culture, society, politics, and the economy will also be addressed.

**Attribute/Distribution:** SS

##### HIST 008 Technology in Modern America 4 Credits

Traces the evolution of modern American technology, including automobiles, aircraft, computers, nuclear weapons, television, space, pharmaceuticals, and biotechnology. Includes critiques of technology such as environmentalism. The interactions of technology and culture, society, politics, and the economy will also be addressed.

**Attribute/Distribution:** SS

##### HIST 011 Survey of Europe to 1648 4 Credits

Development of European history from Rome to the 17th century. End of the ancient world, origins and growth of medieval civilization, the Renaissance and Reformation.

**Attribute/Distribution:** HU

##### HIST 012 Survey of Europe Since 1648 4 Credits

The rise of modern nation states; the scientific and industrial revolutions; social movements and the French and Russian revolutions; impact of Enlightenment philosophy, nationalism, liberalism, imperialism and fascism; the development of modern class structure and transformations in gender relations, art, popular culture and society.

**Attribute/Distribution:** HU

##### HIST 015 English History 4 Credits

The history of England to 1688. The origins of representative government, the development of English social institutions, the unification of England, and the Renaissance and Reformation in England.

**Attribute/Distribution:** HU

##### HIST 016 English History 4 Credits

English political and social institutions from 1688 to the present. The evolution of parliamentary government, the rise of modern parties, the industrial revolution, and recent social philosophies.

**Attribute/Distribution:** HU

##### HIST 021 Greek History 4 Credits

The development of civilization from paleolithic times to the world empire of Alexander the Great. The social, economic, religious, philosophic, artistic, and literary development of the ancient world; the origin of political institutions.

**Attribute/Distribution:** SS

##### HIST 022 Roman History 4 Credits

Rome from its origins to A.D. 476. Political, social and religious developments. Transformation of the late Roman Empire to the early medieval period.

**Attribute/Distribution:** SS

##### HIST 041 United States to 1865 3,4 Credits

Native American cultures; European settlement; development of slavery and free labor systems; the Revolution; founding of the new nation; 19th century social, economic, cultural, and political development; Civil War.

**Attribute/Distribution:** SS

##### HIST 042 United States, 1865-1941 4 Credits

America's transformation into an industrial and global power from Reconstruction after the Civil War to the Great Depression; includes social, political, and cultural developments.

**Attribute/Distribution:** SS

##### HIST 043 United States Since 1939 4 Credits

World War II; Cold War at home and abroad; Civil Rights movement; the 1960s: Vietnam, the welfare state and social upheavals; new forms of cultural expression; feminism; rise of neoconservatism.

**Attribute/Distribution:** HU

##### HIST 049 History of Latin America 4 Credits

Spanish and Portuguese colonization of America and the struggles for independence, preceded by a brief view of the ancient American civilizations and Iberian backgrounds.

**Attribute/Distribution:** SS

##### HIST 050 History of Latin America 4 Credits

Continuation of HIST 049. The development of the Latin American nations in the 19th and 20th centuries.

**Attribute/Distribution:** SS

##### HIST 075 Chinese Civilization 4 Credits

The development of traditional Chinese thought, beliefs, technology, and institutions from a historical perspective.

**Attribute/Distribution:** HU, SS

##### HIST 076 Understanding Contemporary China 4 Credits

An overview of recent history, politics, economy, religion, problems of modernization, popular culture, and attitudes. Contemporary Chinese society viewed against the backdrop of tradition and the tumultuous history of 20th century China.

**Attribute/Distribution:** SS

##### HIST 101 Histories of Globalization 4 Credits

Critical historical perspectives on current debates around "globalization" and the varied paths and responses to modernity, using recent scholarship associated with the New Global History. The "Rise of the West" paradigm, Industrial Revolution and modernization theory; creation of global financial markets, nationbuilding and New Imperialism; Great Depression and World Wars as global historical events; postwar decolonization, Cold War and emergence of North-South relations; impact of consumerism, movements for women's rights, ethnic nationalism and religious fundamentalist movements in traditionbound societies.

**Attribute/Distribution:** HU

**HIST 104 Themes in History 2-4 Credits**

Seminar on a particular theme or topic not covered by a currently listed offering.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU, SS

**HIST 105 Sports in Modern America 4 Credits**

Surveys the social, cultural, and political role of sports in America since the Civil War. By addressing the development of sports and its relationship with race, class, ethnicity, gender, the media, popular culture, and government, this class will examine the impact of sports in making the America and Americans of the 20th century.

**Attribute/Distribution:** HU

**HIST 107 Technology and World History 4 Credits**

Development of technology and its relationship to political, economic, military and cultural aspects of world civilization from pyramids to the present.

**Attribute/Distribution:** SS

**HIST 108 Bethlehem and the Lehigh Valley 3-4 Credits**

Local history focusing on Native American communities, Moravian settlement, natural resources, industrial firms, immigration and ethnic communities, organized labor, housing patterns and urban sprawl, hightech industry, and tourism. Includes an analysis of techniques used in presenting these topics to the public.

**Attribute/Distribution:** SS

**HIST 109 The Built Environment of New York: 1624-2001 4 Credits**

How the physical environment of New York City, particularly Manhattan, came to be. Course themes include the evolution of land use, housing, changing economic functions of the city, immigration, cultural life, social communities, and changing technology. Topics include: settlement of lower Manhattan, the street system, immigrant neighborhoods and the Lower East Side, Greenwich Village, Central Village, Central Park, the elevated trains and the subways, the Brooklyn Bridge, apartment living, specialized shopping and entertainment districts, skyscrapers, Harlem, Rockefeller Center, the automobile and highway system, public housing, the World Trade Center. Usually taught in the summer in New York with walking tours to many of the locations listed above.

**Attribute/Distribution:** HU

**HIST 110 American Military History 4 Credits**

The American military tradition from colonial times to the present. America's wars and the development and operation of military institutions within the political, economic, ideological, and technological milieu of American society.

**Attribute/Distribution:** SS

**HIST 111 Engineering in the Modern World 4 Credits**

Roles played by engineers and engineering in the modern world, focusing on major achievements and failures, prominent engineers, and evolution of the profession.

**Attribute/Distribution:** SS

**HIST 117 Women, Science, and Technology 4 Credits**

Explores the impact of technology and science on women's social roles and the contribution of women engineers and scientists to their disciplines. Will focus on the American experience. Among the topics discussed are invention, design, laboratory research, education, engineering, professionalism, labor force participation, office mechanization, household appliances, virtual spaces, childcare and reproduction.

**Attribute/Distribution:** SS

**HIST 118 History of Modern Medicine 4 Credits**

Introduction to Western medical history from the 18th century to the present day. Students will explore patient/practitioner relationships, examine changing ideas concerning health, sickness, and disease, chart changes in hospital care and medical education, and tackle topics such as eugenics, medical experimentation, and health insurance.

**Attribute/Distribution:** HU

**HIST 119 History of North American Indians 4 Credits**

The history of American Indians from before European contact to the present. Emphasis will be placed on the diversity of native peoples of eastern North America and how patterns of interaction between native Americans and Euro-Americans have changed over time. Discussion format, research paper.

**Attribute/Distribution:** SS

**HIST 120 Revolutionary America 4 Credits**

Origins and development of the American republic from 1750 through the adoption of the Federal Constitution.

**Attribute/Distribution:** SS

**HIST 124 Women in America 4 Credits**

Roles of women in American society from colonial to present times: attitudes toward women, female sexuality, women's work, and feminism.

**Attribute/Distribution:** SS

**HIST 130 African American History 4 Credits**

Blacks in America from the first importation of Africans to the implementation of civil rights laws. West African origins, slave trade, slavery, free blacks and emancipation and study of Reconstruction, segregation, urbanization, and the struggle for racial equality.

**Attribute/Distribution:** SS

**HIST 133 Lehigh in Martinique: Globalization and Local Identity 3,4 Credits**

History, culture and politics of the French Caribbean island of Martinique, from its position as a key site of the 18th century Atlantic World economy to becoming an official French department and outpost of the European Union. Interdisciplinary perspectives on the complex nature of social identity, historical memory and impact of globalization. No French is required. Offered during winter inter-term through Lehigh Study Abroad.

**Attribute/Distribution:** HU

**HIST 135 Era of Jefferson and Jackson 4 Credits**

Colonial beginnings; the Articles of Confederation and the Constitution; the creation of a new nation; the development of American political parties; the antebellum American state.

**Attribute/Distribution:** SS

**HIST 136 Era of the Civil War and Reconstruction 4 Credits**

American abolitionism and the origins of the Civil War; the Second American Revolution; Reconstruction and its sequel.

**Attribute/Distribution:** SS

**HIST 145 Introduction to the History of Science 4 Credits**

The history of modern science, primarily physical and biological, with emphasis on the development of major theoretical models since the 17th century.

**Attribute/Distribution:** SS

**HIST 150 Medieval Civilization 4 Credits**

Formation and development of western culture to about 1400. Rise of universities and towns, legal development and origins of representative government, origins of nationstates, scholasticism and decline of the medieval church.

**Attribute/Distribution:** HU

**HIST 153 Women in European History, 1500-Present 4 Credits**

Examines the position of women in Europe since the Renaissance. Particular attention is given to changing conceptions of women and their roles in society, the evolution of women's work, the origins, growth and impact of feminism, and gender distinctions as reflected in law, politics, popular culture and leisure.

**Attribute/Distribution:** SS

**HIST 154 The Holocaust: History and Meaning 4 Credits**

The Nazi Holocaust in its historical, political and religious setting. Emphasis upon the moral, cultural and theological issues raised by the Holocaust.

**Attribute/Distribution:** HU



**HIST 157 Europe in the Age of the Reformation 4 Credits**

The breakup of the religious culture of medieval Christian Europe in the reformation movements of the sixteenth century. The origins and varieties of Protestantism; the intersection of religious ideas and politics in Germany, Switzerland, Britain, France, and the Netherlands; the "wars of religion" and the emergence of the European state system.

**Attribute/Distribution:** HU

**HIST 158 Europe in the 17th and 18th Centuries 4 Credits**

Transformation of European civilization from the 30 Years War to the outbreak of the French Revolution. Origins and development of the European state system; absolutism; commercial expansion and competition for empire; science; the Enlightenment and its impact on European culture and politics.

**Attribute/Distribution:** HU

**HIST 159 Revolutionary Europe, 1789-1870 4 Credits**

Revolutions and reactions; the rise and spread of liberalism, nationalism, and socialism.

**Attribute/Distribution:** HU

**HIST 160 Europe in the Age of Total War, 1870-1945 4 Credits**

Origins of two world wars; revolutionary governments in Germany, Italy, and Russia.

**Attribute/Distribution:** HU

**HIST 161 Roman Law 4 Credits**

Examination of Roman legal systems from the Twelve Tables to the Digest of Justinian. Emphasis on development of legal concepts and their historical context. Readings in primary sources; lectures; discussion.

**Attribute/Distribution:** SS

**HIST 162 Contemporary Europe 4 Credits**

Development of European States since 1945; European Community; Soviet influence and collapse.

**Attribute/Distribution:** HU

**HIST 163 France since 1789 4 Credits**

France's tumultuous transformation from an absolutist monarchy to a modern democratic republic. Explores major cultural, social and economic changes, with particular attention given to industrialization and urbanization, gender and class, church and state relations, the French Left and France's unique contribution to modern philosophy, art and culture.

**Attribute/Distribution:** SS

**HIST 170 The Last Samurai 4 Credits**

Explores the revolutionary character of the political upheaval in 1868 that led to the fall of the ruling shogun and the dissolution of the elite samurai class. Examines both the causes of these major political and social changes, and their continuing impact upon Japanese culture and society.

**Attribute/Distribution:** HU

**HIST 179 Black Political Thought in America 4 Credits**

Black leadership, organizations, and philosophy in America from Reconstruction to the Civil Rights Era; ideas and programs of Booker T. Washington, W.E.B. DuBois, Marcus Garvey, Malcolm X and Martin Luther King, Jr.

**Attribute/Distribution:** SS

**HIST 180 Religion and the American Experience 4 Credits**

The historical development of major religious groups in this country from colonial times to the present. Their place in social and political life, and the impact of the national experience upon them. Emphasis on religious freedom and pluralism, and the church-state relationship.

**Attribute/Distribution:** HU

**HIST 183 France from Medieval to Modern: Soc., Pol. & Art 3 Credits**

France's artistic, cultural, social and political development from early kingship and the dominance of the Church in the Middle Ages to the grandeur of the court at Versailles in the Age of Absolutism; the radical transformation of culture and society during the French Revolution and advent of the Modern Nation-State; to twentieth century developments including the two World Wars, imperialism and impact of post-war globalization. Course pays particular attention to the history of artistic and architectural movements as indexes of social and cultural change. Offered in summer only through Lehigh Study Abroad Office as part of Lehigh in Paris program.

**Attribute/Distribution:** HU

**HIST 201 Historical Perspectives 4 Credits**

Methodologies and interpretations of Western historians from ancient times to the present.

**Attribute/Distribution:** HU

**HIST 202 Historical Research 4 Credits**

An introduction to historical interpretation, research design, and methodology. Students will research and write a paper on a historical topic using secondary and primary sources.

**Attribute/Distribution:** SS

**HIST 213 Ancient Roman Religion 4 Credits**

Religious experience of the Roman people from prehistory to end of the empire. Nature of polytheism and its interactions with monotheism (Christianity, Judaism). Theories of religion. Emphasis on primary source materials.

**Attribute/Distribution:** SS

**HIST 253 Paris: Plan of Metropolis 3 Credits**

The splendor of modern Paris is due in large part to bold, large scale modernization and changes in the city's patterns during the 19th century. This course, which is part of the Lehigh in Paris summer program, will cover a century of change and focus on the major accomplishments of its visionary planners.

**Attribute/Distribution:** HU

**HIST 300 Apprentice Teaching 3 Credits**

**Attribute/Distribution:** ND

**HIST 303 Topics in History 3-4 Credits**

Intensive study in a particular area of history for advanced students. Topics may vary; may be repeated for credit with consent of advisor.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU, SS

**HIST 305 Public History 3-4 Credits**

An examination of the public role of history in modern society, with focus on issues facing historians in museums, historical societies, archives, historic preservation, the federal government, and other organizations in the public sphere.

**Attribute/Distribution:** SS

**HIST 306 Internship in Public History 2-4 Credits**

Professionally supervised work in a museum, historical society, archive, or other historical agency. Written journal or report evaluating the experience is required. Permission of department chair required. May be repeated for a maximum of six credits. May not be counted toward the major requirement of 12 hours of courses numbered 303 or higher.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** ND

**HIST 308 Industrial America since 1945 3-4 Credits**

Explores efforts to achieve both prosperity and security in the postwar era. Among the topics discussed: new technologies, consumer culture, disposable products, advertising, defense spending, technical assistance, and multinational corporations.

**Attribute/Distribution:** SS

**HIST 311 Twins and Sins: The Rise of Rome 3,4 Credits**

Rome from its origins to the mid-third century B.C. Emphasis on foundation legends, the power of the monarchy, and development of Roman political and religious institutions. Papers, quizzes, discussions.

**Attribute/Distribution:** SS

**HIST 312 Decline and Fall of the Roman Empire 3-4 Credits**

Political, social, and economic history of the Roman Empire, A.D. 117- A.D. 565. Romanization of the provinces, diffusion of Christianity, and special attention to transformation to medieval period. Includes readings in translation of primary sources.

**Attribute/Distribution:** SS

**HIST 314 Age of Caesar and Christ 3,4 Credits**

Roman history of the 1st century A.D. Political, cultural, and socioeconomic changes; special attention to the evolution of absolute power. Lectures, discussions, papers.

**Attribute/Distribution:** SS

**HIST 315 American Environmental History 3-4 Credits**

Relationship between Americans and their natural environment from the colonial period to the present: impact of European settlement, attitudes toward wilderness, role of technological development, rise of preservation and conservation movements, establishment of national parks, recent environmental protection legislation.

**Attribute/Distribution:** SS

**HIST 323 American Cultural History since 1900 3-4 Credits**

Development of American popular culture and media: popular press, Hollywood, radio, television, sports, and advertising, and the meanings these institutions have created in 20th-century United States.

**Attribute/Distribution:** HU

**HIST 325 History of Sexuality and the Family in the U.S. 3-4 Credits**

Changing conceptions of sexuality and the role of women, men, and children in the family and society from the colonial to the postWorld War II era. Emphasis on the significance of socioeconomic class and cultural background. Topics include family structure, birth control, legal constraints, marriage, divorce, and prostitution.

**Attribute/Distribution:** SS

**HIST 326 Social Class in American History 3,4 Credits**

Emphasis on the 19th and 20th century, focusing on: emergence of a white-collar middle class; condition and treatment of the poor and growth of the welfare state; conditions of industrial workers, struggle to organize unions and their later decline; indicators of social status and exclusion among the rich; changing distribution of income and wealth over time and extent of social mobility.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** SS

**HIST 328 American Intellectual History since 1900 3,4 Credits**

Social, literary, and political thought in the 20th century with emphasis on pragmatism and progressivism, maturation of American literary culture, ideas of American exceptionalism at midcentury, civil rights movement and feminism, neoconservatism and recent trends.

**Attribute/Distribution:** HU

**HIST 331 United States and Africa 3,4 Credits**

Reciprocal relationships between North America and the African continent from the slave trade in the 17th century to the 20th century-Afrocentric movement; impact of Americans on the shaping of modern Africa, Pan-African relations; influence of African Americans on US policies toward Africa.

**Attribute/Distribution:** SS

**HIST 332 Slavery and the American South 3-4 Credits**

The emergence and demise of the "peculiar institution" of African American slavery in British North America and the Old South. African background; colonial beginnings; 19th century-slave community; the ruling race and proslavery ideology; the death of slavery and its aftermath; slavery and freedom in a comparative context.

**Attribute/Distribution:** SS

**HIST 333 American City to 1900 3-4 Credits**

Settlement and planning of colonial towns; role of towns in the revolutionary era; industrialization and relationship of economic and technological change to urbanization; establishment of urban institutions; Irish and German immigration; beginnings of suburbanization; downtowns and the creation of a civic culture. Required field trip.

**Attribute/Distribution:** SS

**HIST 334 American City in the Twentieth Century 3,4 Credits**

Immigration; Progressive "reforms;" urban planning and zoning; impact of automobile and suburbanization; Depression and New Deal; public housing and racial ghettos; urban decline and "renewal." Required field trip.

**Attribute/Distribution:** SS

**HIST 336 Bethlehem and the Lehigh Valley 3-4 Credits**

Local history focusing on Native American communities, Moravian settlement, natural resources, industrial firms, immigration and ethnic communities, organized labor, housing patterns and urban sprawl, high-tech industry, and tourism. Includes an analysis of techniques used in presenting these topics to the public.

**Attribute/Distribution:** SS

**HIST 337 History and Community Memory 3,4 Credits**

This public history course provides students with the opportunity to research the history of a community. The community focus of the course will change each year. We will explore what constitutes community, what historical memory means, and how history functions to build or divide a community. Students will use both documents and oral history methods, and practice will be a major component of this course.

**Attribute/Distribution:** SS

**HIST 338 Techniques in Public History 2,4 Credits**

Designed to introduce students to a variety of public history techniques. Instructor will focus on one of the following topics each term: archives, documentary film, exhibit design, historical editing, material culture, oral history. May be repeated to a maximum of 8 credits.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**HIST 339 Managing Nonprofit Organizations 3-4 Credits**

Addresses the effective management of nonprofit organizations, focusing on operations, administration, legal, marketing, finance and accounting issues in the nonprofit environment and emphasizing organizations such as museums and preservation organizations.

**Attribute/Distribution:** SS

**HIST 340 Japanese Industrialization 3-4 Credits**

Explores economic growth in the traditional economy, the rise of an entrepreneurial class, the importation of western technology, and the social, political and economic institutions which support industrial society since the early 19th century.

**Attribute/Distribution:** SS

**HIST 342 Argentina, Brazil and Chile 3,4 Credits**

Eighteenth-century Spanish imperial readjustments, independence, the emergence of new societies, 20th-century extremist movements, and the problems of developing nations.

**Attribute/Distribution:** SS

**HIST 348 The British Empire and the Modern World 3,4 Credits**

Examines the empire from its humble beginnings in the sixteenth century to its sudden collapse after World War II. Topics include exploration, ideology, state-building, war, capitalism, globalization, racism, social transformation, independence movements, and post-colonial legacies.

**Attribute/Distribution:** HU

**HIST 349 Revolutions in Modern European History 3,4 Credits**

Explores the origins, meanings, and impact of European revolutions from a theoretical and comparative perspective. Focuses on the English (1642-1660), the French (1789-1799), and the Russian Revolution (1917-1929), and how they reflected and shaped new ideologies and policies related to human rights, economic development, popular sovereignty, nationalism, class and gender politics, and State and society relations.

**Attribute/Distribution:** SS

**HIST 350 19th Century Paris and the Invention of Modernity 3 Credits**

This course considers the dramatic destruction and rebuilding of the city of Paris in the decades after 1850 and how changes in the built environment shaped social relations, political authority and cultural expression. Topics include the politics of city planning and architectural design; the history of the engineering profession, technology and the building trades; reactions to crime, disease and prostitution in the modern city; the 1848 Revolution, Paris Commune and political theory; the origins of photography, Impressionist painting and cinema; and the creation of mass consumer society.

**Attribute/Distribution:** HU

**HIST 351 "The Gangs of New York" 3,4 Credits**

The course will use the Martin Scorsese film "The Gangs of New York" as a window to examine the social economic transformations of New York City in the middle of the nineteenth century. Emphasis will be on immigration, slum gangs and street violence, politics, the Draft Riot of 1863, and the Tweed Ring. A recurrent theme will be to compare the historical record with the film's depiction of those events. There will be a required evening showing of the film. Not available for pass/fail.

**Attribute/Distribution:** HU

**HIST 355 Destruction and Reconstruction of Europe, 1879-1950 3,4 Credits**

An analysis of the decline and disintegration of European civilization through two world wars and Europe's reintegration in the era of the European Union. Emphasis on the development of the European state system, international conflict, and political thought.

**Attribute/Distribution:** SS

**HIST 356 European Cultural History 3,4 Credits**

Transformation of European culture from the 18th century to the present. The Enlightenment, cultural impact of the French and industrial revolutions, romanticism and ideologies of the 19th century, contemporary European thought.

**Attribute/Distribution:** HU

**HIST 357 Early Modern Germany, 1500-1850 3-4 Credits**

The emphasis will be on one or more of the following topics: the Reformation, the Thirty Years' War and its impact, absolutism, the rise of Prussia, the failure of German liberalism.

**Attribute/Distribution:** HU

**HIST 358 Modern Germany, 1850 to Present 3,4 Credits**

Focus on one or more of the following topics: nationalism and unification, the Second Empire, World War I, the Weimar republic, the Nazi movement, the Third Reich, and postwar Germany.

**Attribute/Distribution:** HU

**HIST 360 American Legal History 3,4 Credits**

The interrelationship between law and social development with emphasis on modern period. Founding of constitutional government and balance of power within the federal system, the problem of slavery, legal support and regulation of business, and the use of law in various reform and civil rights movements.

**Attribute/Distribution:** SS

**HIST 367 Rise and Fall of the Old South 3,4 Credits**

Explores the American South as a region from the era before European contact to the end of the Civil War. Emphasis will be placed on exploration and settlement, Native American-European relations, the pre-Revolutionary contest for empire, and the rise and development of the plantation complex and slavery.

**Attribute/Distribution:** SS

**HIST 368 Seminar in Latin American History 3,4 Credits**

Readings and individual investigation of selected topics.

**Attribute/Distribution:** SS

**HIST 370 Historical Archeology 3-4 Credits**

This course examines the unique nature of historical archaeology of postcontact America. Topics include reconstructing the past through the archaeological and historical record, exhibiting past culture, and capturing the real or imagined past. Course includes fieldwork and visits to famous archaeological sites.

**Attribute/Distribution:** SS

**HIST 371 Independent Study 1-4 Credit**

Directed readings in a topic or area of history not covered by current course offerings. For students of demonstrated ability and adequate preparation. Consent of department chair required. May be repeated for credit with permission up to a maximum of six credits.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** ND

**HIST 372 Special Topics In History 1-3 Credit**

**Attribute/Distribution:** ND

**HIST 373 The French Revolution and Napoleon 3,4 Credits**

Breakdown of Absolute Monarchy; rise of Enlightenment culture and decadence of the court; storming of the Bastille and creation of republican government; daily life and "Great Fear" in rural areas; invention of modern nationalism and Napoleonic military culture; role of women in political life; uses of mass propaganda, public festivals and transformation of the arts; political violence in the "Terror," Napoleon's imperial system and warfare with Europe; impact on revolutionary movements abroad and geopolitical realignment of the Atlantic World.

**Attribute/Distribution:** HU

**HIST 389 Honors Project 1-6 Credit**

**Attribute/Distribution:** ND

**HIST 391 Honors Thesis in History 4 Credits**

Opportunity for undergraduate majors in history to pursue an extended project for senior honors. By invitation and department permission only.

**Attribute/Distribution:** ND

**HIST 392 Honors Thesis in History 2 Credits**

Continuation of History 391 available under exceptional circumstances where additional credit for honors project is warranted. Department permission only.

**Prerequisites:** HIST 391

**Attribute/Distribution:** ND

**HIST 401 Historical Research 3 Credits**

Techniques of research in history: training in the critical handling of documentary materials, in measuring the value of evidence, and in formal presentation of the results of research. Students will write an original research paper using primary materials. Required of all graduate students in history.

**HIST 404 Readings in the History of the Atlantic World, 1500-1900 3 Credits**

Core readings offering a comparative and integrative approach to studying the development of nations, economic systems and trade, colonization, and cultural encounters among the people of Europe, Africa, and the Americas.

**HIST 405 Readings in the History of Industrial America 3 Credits**

Core readings in the history of technology and the larger framework of intellectual, social, economic, and political history. Includes comparative studies in the history of industrializing Europe and Japan.

**HIST 407 Seminar in the History of American Industrial Technology 3 Credits**

Origin and evolution of American technology and industry from the 19th century to the present. Investigates dynamics of major industries in national and international context. Not open to students who have taken HIST 307.

**HIST 421 Readings in Topics in the Atlantic World 3 Credits**

Study in small groups under the guidance of a faculty member on a particular topic in the history of the Atlantic World. May be repeated for credit with the permission of the instructor.

**Repeat Status:** Course may be repeated.

**HIST 426 Readings in Topics in American History 3 Credits**

Study in small groups under the guidance of a faculty member on a particular topic in U.S. history across several centuries. May be repeated for credit with permission of the instructor.

**Repeat Status:** Course may be repeated.

**HIST 438 Techniques in Public History 2,3 Credits**

Designed to introduce students to a variety of public history techniques. Instructor will focus on one of the following topics each term: archives, documentary film, exhibit design, historical editing, material culture, oral history. May be repeated to a maximum of 8 credits.

**Repeat Status:** Course may be repeated.

**HIST 440 Readings in Colonial American History 3 Credits**

Study in small groups under the guidance of a faculty member of the literature of the 17th and 18th centuries. May be repeated for credit with the permission of the faculty advisor.

**Repeat Status:** Course may be repeated.

**HIST 441 Readings in Nineteenth Century American History 3 Credits**

Study in small groups under the guidance of a faculty member of the literature of the 19th century. May be repeated for credit with the permission of the faculty advisor.

**Repeat Status:** Course may be repeated.

**HIST 442 Readings in Twentieth Century American History 3 Credits**

Study in small groups under the guidance of a faculty member of the literature of the 20th century. May be repeated for credit with permission of the faculty advisor.

**Repeat Status:** Course may be repeated.

**HIST 443 Readings in English History 3 Credits**

Study in small groups, under the guidance of a faculty member, of the literature of a particular period, problem, or area of English history. May be repeated for credit with permission of the faculty advisor.

**Repeat Status:** Course may be repeated.

**HIST 444 Readings in Latin American History 3 Credits**

Study in small groups, under the guidance of a faculty member, of the literature of a particular period, problem, or area of Latin American history. May be repeated for credit with permission of the faculty advisor.

**Repeat Status:** Course may be repeated.

**HIST 445 Readings in the History of Science 3 Credits**

Study in small groups under the guidance of a faculty member on the history of science. May be repeated for credit with permission of the faculty advisor.

**Repeat Status:** Course may be repeated.

**HIST 446 Readings in the History of Technology 3 Credits**

Study in small groups under the guidance of a faculty member of the history of technology. May be repeated for credit with the permission of the faculty advisor.

**Repeat Status:** Course may be repeated.

**HIST 447 Readings in European History 3 Credits**

Study in small groups, under the guidance of a faculty member, of the literature of a particular period, problem or aspect of European history. May be repeated for credit with permission of the faculty advisor.

**Repeat Status:** Course may be repeated.

**HIST 448 Land Use, Growth Management, and the Politics of Sprawl 3 Credits**

Introduction to issues of Land Use Planning, Community, Growth Management, and Sprawl. Examination of history of urban development in America from earliest settlements to the auto suburbs; also such planning and development factors as comprehensive plans, zoning, and the influence of infrastructure on development. Concludes with an assessment of the revival of city centers, alternatives to sprawl, and comparisons to development patterns in other countries.

**HIST 451 Readings in Topics in American History 3 Credits**

Study in small groups under the guidance of a faculty member on a particular topic in U.S. history across several centuries. May be repeated for credit with permission of the instructor.

**Repeat Status:** Course may be repeated.

**HIST 452 Research in American History 3 Credits**

An intensive research seminar on a phase of American history. May be repeated for credit with permission of the department chair.

**Repeat Status:** Course may be repeated.

**HIST 453 Research in English History 3 Credits**

An intensive research seminar on a phase of English history. May be repeated for credit with permission of the department chair.

**Repeat Status:** Course may be repeated.

**HIST 454 Research in Latin American History 3 Credits**

An intensive research seminar on a phase of Latin American history. May be repeated for credit with permission of the department chair.

**Repeat Status:** Course may be repeated.

**HIST 455 Research in History of Science and Technology 3 Credits**

An intensive research seminar on a phase or aspect of the history of science and technology. May be repeated for credit with permission of the department chair.

**Repeat Status:** Course may be repeated.

**HIST 457 Research in European History 3 Credits**

An intensive research seminar on a phase of European history. May be repeated for credit with permission of the department chair.

**Repeat Status:** Course may be repeated.

**HIST 458 Readings in Gender History 3 Credits**

Study in small groups under the guidance of a faculty member on the literature of an issue, period, country or culture within gender history. May be repeated for credit with permission of the faculty advisor.

**Repeat Status:** Course may be repeated.

**HIST 471 Special Topics in History 1-3 Credit**

Individual study under the direction of a faculty member of a topic in history. May be repeated for credit.

**Repeat Status:** Course may be repeated.

**HIST 472 Special Topics in History 1-3 Credit**

Individual study under the direction of a faculty member of a topic in history. May be repeated for credit.

**Repeat Status:** Course may be repeated.

**HIST 473 Special Topics in History 1-3 Credit**

Individual study under the direction of a faculty member of a topic in history. May be repeated for credit.

**Repeat Status:** Course may be repeated.

**HIST 482 Special Topics 3 Credits****HIST 490 Thesis 1-6 Credit****HIST 499 Dissertation 1-15 Credit**

**Repeat Status:** Course may be repeated.

**Humanities**

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**Website:** <http://www.lehigh.edu/~inhum/>

*General contact information for the Humanities Center: 610-758-4649; [humanities@lehigh.edu](mailto:humanities@lehigh.edu)*

The Humanities Center provides a physical home as well as intellectual, financial, and organizational support for students, faculty, and staff who wish to come together to participate in humanistic inquiry, understood in the broadest possible terms. We seek to enrich the work of existing academic departments and programs in the humanities, by stimulating a wide range of activities that move beyond and across disciplines, urging members of the community to consider in the freest and fullest ways what humans are or have been, what humans have produced and are producing. We seek to break down the division between work and play, between the classroom and the rest of life. We aim to foster vibrant intellectual inquiry, and to diffuse the energies of such inquiry into the broader culture of the Lehigh campus. We choose a theme for each year (The Public Intellectual, Waste, Just Globalization, New Bethlehem, Speaking Bodies, Excess are examples) and bring a series of scholars, intellectuals, artists, writers, activists, and visionaries to address related issues. We host conferences, cosponsor visiting speakers, support reading groups, and organize a works-in-progress series. The Humanities Center also hosts a wide range of informal activities to create lively, unstructured humanistic community.

### Course Offerings

The Humanities Center hosts and sponsors the production of the Lehigh Review, an undergraduate research journal founded in 1992 by the Lehigh humanities faculty. Original articles range in topic and subject across the spectrum of undergraduate study, from English to Economics and Physics. Published annually, the entire publication process—from reviewing submissions to editing to design and illustration—is handled almost exclusively by undergraduate students and supervised by a graduate student instructor.

Any scholarly articles, academic essays or book reviews written for a Lehigh course may be submitted. The Review does not ordinarily accept fiction or poetry.

All submissions should reflect sustained intellectual engagement in any of Lehigh's many fields of study. We are especially interested in essays that draw from the content or methodology of more than one discipline. The Review expects students to submit well-researched and well-written works that exceed a mere synthesis of existing sources. The Review publishes submissions which demonstrate imagination, original insight and a mastery of the subject.

HUM 224	Lehigh Review (Students will produce the annual edition of the Lehigh Review, the journal of undergraduate academic (nonfiction) writing. The production tasks are divided into one 4 credit editorial board and three 1 credit pass-fail modules (reviewing, distribution, images). Students may enroll in either the 4 credit editorial board or in one or more of the 1 credit modules. Admission is by application at the Humanities Center. HU)	1-4
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### International Relations

Today's world is more interconnected than ever before: what happens "here" affects what happens "there," and vice versa. The economic fortunes of countries, firms, and individuals have become so sensitive to trade, monetary, and investment decisions made elsewhere that economic policy that is purely national has become all but impossible. Nuclear weapons, which can kill thousands in minutes, do not respect international boundaries; neither do the consequences of ethnic and communal conflicts. Non-state actors, from terrorists to human rights activists, also act across boundaries. The Internet has made it easier than ever to form networks and political movements that span borders. Climate everywhere is affected by environmental decisions anywhere.

In the 21<sup>st</sup> century, no state – not even the United States, though it has become the first sole superpower in the history of the modern international system— and no citizen can make important choices in a sound manner without understanding how their decisions are shaped by what happens outside the boundaries of their homeland; moreover, their decisions often affect people who live far beyond those borders.

International Relations (IR) is the study of world politics in all of its aspects: International security covers issues related to war and peace, among and within societies. International political economy focuses on the political dimensions of trade, investment, development, and poverty. International law, organizations, and ethics and norms involve the study of how legal principles and agreements and moral values contribute to the creation of order, create the basis for stable expectations, and regulate transactions among states and other participants in world affairs. IR theory exposes students to the major explanatory frameworks that have been developed for the study of international relations.

IR investigates the gamut of economic, technological, social, and cultural and military forces that create the increasing interdependence that we call "globalization." IR examines the ways in which globalization and other factors have sometimes contributed to creation of order but also often to breakdown of order, violence among and within states, and the assertions of particularity, whether based on ethnicity, nationalism, or differences in culture, or wealth. Much of IR is devoted to explaining the behavior of states, but IR also encompasses many entities besides sovereign states. These include international organizations (such as

the United Nations and its affiliate organizations); nongovernmental organizations; and intergovernmental organizations, such as the World Trade Organization, the European Union, the African Union, or Mercosur, the Latin American trading bloc.

Lehigh University has one of the few Departments of International Relations in the United States. At Lehigh, world politics is not considered simply a division of the discipline of political science. The IR Department is therefore able to offer a concentrated and multifaceted program, and one that is truly interdisciplinary. Some IR faculty study world politics as scholars of particular geographic regions, others as theorists seeking to explain the major processes of world politics regardless of where and when they occur: for instance, the causes and consequences of different forms of warfare; the rise and decline of empires; the challenges posed by environmental degradation; and the forces that create both wealth and poverty. What we share is the dedication to teaching and scholarship and the commitment to encouraging our students to engage new ideas and to subject familiar ones to thorough scrutiny.

Judging by the number of students who choose IR as their major, it is one of the most popular disciplines at Lehigh. Moreover, as befits a field that cuts across so many disciplines, we draw students who also pursue coursework, or minors, or "double majors" in fields ranging from Religion Studies, Modern Languages and Literatures, Economics, and History, to Computer Science, Biology, Engineering, and Environmental Policy.

#### The Curriculum

Students considering course work in international relations are strongly encouraged to visit the International Relations web site (<http://cas.lehigh.edu/ir>). Prospective International Relations majors should enroll in IR 010 and ECO 001 as early as possible. We recommend that IR majors fulfill the mathematics portion of their college distribution requirement with MATH 012 (Basic Statistics), although this course is not required for the major.

#### Departmental Honors

To graduate with Departmental honors, a major in international relations must:

1. successfully complete a two semester honors thesis (IR 388) in the senior year;
2. attain a GPA of at least 3.5 in the courses constituting the IR major program at the time of graduation. See department website for additional information.

#### Beyond the IR Curriculum

In close cooperation with the international education office, the department assists students interested in study abroad programs. In addition, Lehigh has an array of summer programs, which involve course work and/or internships in such countries as China, the Czech Republic and the United Kingdom.

Every semester speakers with expertise on various aspects of world affairs visit Lehigh. Some of the featured speakers in the past were Dr. Shashi Tharoor, the U.N. Under-Secretary-General for Communications and Public Information; Dr. Ernesto Zedillo, Former president of Mexico and Director of the Yale Center for the Study of Globalization; and Retired General Anthony Zinni, 40 Year Marine Corps Veteran and U.S. Peace Envoy to the Middle East.

The student-run World Affairs Club sponsors a number of activities each year, including student-faculty socials, guest speakers and related programs. It organizes the Model United Nations program to which Lehigh sends a delegation each year. From time to time, delegations are also sent to other student conferences, including West Point and the U.S. Naval Academy.

The department has an active program in conjunction with Career Services to help place students in internships. We strongly encourage students to obtain an internship. Most of these internships are likely to be in New York or Washington, D.C.

#### Upon Graduating

While a degree in international relations does not lead to a specific career in the way that, for example, accounting or engineering does, a major in international relations, by emphasizing clarity in speech and writing, analytical skills, and a detailed knowledge of world politics prepares students for careers in government, journalism, law,

nongovernmental organizations, international business, and teaching and research. Recent IR graduates currently work in all of these fields. Some have gone directly into careers upon graduating; others have enrolled in graduate school prior to employment.

**Professors.** Henri J. Barkey, PhD (University of Pennsylvania); John Gillroy, LL.M (University of Cambridge)

**Associate Professors.** Chaim D. Kaufmann, PhD (Columbia University); Kevin Narizny, PhD (Princeton University)

**Assistant Professor.** Arman Grigoryan, PhD (Columbia University)

**Emeriti.** Rajan M. Menon, PhD (University of Illinois Urbana); Bruce E. Moon, PhD (Ohio State University); Zdenek Slouka, PhD (Columbia University); Oles M. Smolansky, PhD (Columbia University); Raymond F. Wylie, PhD (University of London)

### Major in International Relations

The major consists of eleven courses for a total of 44 credits. This is the minimum requirement, however, and we strongly urge students to enrich their educations by going further. The courses required are:

#### Introductory courses

IR 010	Introduction to World Politics	4
ECO 001	Principles of Economics	4

#### Core courses

Select four courses, one from each of the following functional groups:

International Relations Theory		
IR 105	Theories of International Relations	
International Political Economy		
IR 125	International Political Economy	
IR 120	Globalization and World Politics	
International Security Studies		
IR 234	Great Power Politics	
IR 235	International Security	
International Governance		
IR 142	International Law	
IR 245	International Organization	

#### Advanced courses

Select any two IR courses numbered 300-387 (except IR 307) or IR 393 8

#### Electives

Select any IR courses other than IR 019, IR 090, IR 388 or IR 391<sup>1</sup> 12

Total Credits 44

<sup>1</sup> Core or advanced courses beyond the minimum requirements may be counted as electives. Certain courses offered by other departments may also qualify. See the Department of International Relations for a complete list.

### Minor in International Relations

The minor consists of 16 credits:

IR 010	Introduction to World Politics	4
Select one advanced IR elective numbered 300-387 (except IR 307) or IR 393		4
Select two free IR electives other than IR 019, IR 090 or IR 391		8
Total Credits		16

### Minor in International Environmental Policy

The Minor consists of 20 credits:

IR 010	Introduction to World Politics	4
Select one advanced IR elective numbered 300-387 (except IR 307) or IR 393		4
Select two free IR electives other than IR 019, IR 090 or IR 391		8
Total Credits		16

### Courses

#### IR 010 Introduction to World Politics 4 Credits

Introduction to the major principles, concepts, and theories of international relations, along with a historical background focusing on the 19th and 20th centuries. Topics to be covered include the nature of power, balance of power theories, national interest, decision-making in foreign policy, theories of war and expansion, patterns of Cooperation, and international political economy.

**Attribute/Distribution:** SS

#### IR 019 Current Issues in World Affairs 3 Credits

This is a survey course designed primarily for non-IR majors or minors. The purpose is to acquaint students with some of the concepts and historical facts behind current global issues. The content of this course will, in part, be dictated by international events as they unfold.

**Attribute/Distribution:** SS

#### IR 034 Society, Technology and War 4 Credits

This course explores the links between war and society in both directions: the impact of social, economic, and technological change on how wars are fought and the purposes for which they can be fought; as well as the impact of war mobilization needs and of war itself on how societies develop, including the rise of capitalism, democratization, economic planning and other modern institutions, and emancipation of disadvantaged groups in society, such as blacks and women in the United States. The American and French revolutions; the Civil War; World Wars I and II; Vietnam; Afghanistan and Iraq; the law of war; war propaganda; atrocities; the nuclear and information revolutions; the ongoing "revolution in military affairs;" and current trends in the status of military institutions in advanced societies.

**Attribute/Distribution:** SS

#### IR 036 International Terrorism 4 Credits

Have we seen the peak of global terrorism, or is the worst still to come? This course examines psychological, religious, and political explanations of terrorism; legal and moral statuses of terrorism; explanations for the increasing scale of terrorism and the more frequent targeting of Americans; major terrorist organizations, structures, and means of operation; suicide terrorism; threats and vulnerabilities facing the United States and Western countries today; means of coping with terrorism as an individual and through national policy; possible future developments.

**Attribute/Distribution:** SS

#### IR 056 European International Relations 4 Credits

Examines the evolution of the modern states system in Europe. Conceptual, theoretical and historical topics include the transition from feudalism to the Westphalian system, nationalism, imperialism, the causes of war and attempted peace settlements, the Cold War, the European Union, and the impact of the collapse of the USSR on the political and strategic structure of Europe.

**Attribute/Distribution:** SS

#### IR 061 Pacific Asian International Relations 4 Credits

Introduction to Pacific Asian international relations, with emphasis on post-1945 period: historical background; Cold War conflicts; China's rise to power; Japan's growing role; Korea and the NIC's; Southeast Asia; U.S. and Russian policies; current and future issues.

**Attribute/Distribution:** SS

#### IR 072 The United States in the Global Economy 4 Credits

Political problems and policy issues arising out of the economic relations between the U.S. and the rest of the world. U.S. foreign economic policy. decision-making processes and political influences on policy. Economic diplomacy. Declining U.S. economic preeminence.

**Attribute/Distribution:** SS

#### IR 074 United States Foreign Policy 4 Credits

Addresses major themes and trends in U.S. foreign policy, including its historical evolution. Assesses the interests and values that underlie the goals of policy and the beliefs that shape decisions on how to achieve those goals. Also examines issues such as the constitutional division of authority, bureaucratic politics and processes, civil-military relations, and public opinion.

**Attribute/Distribution:** SS

**IR 082 Middle East in World Affairs Since 1945 4 Credits**

Rise of Turkish, Iranian, and Arab nationalism; creation of Israel; decline of British and French power; growth of U.S. and Soviet influence; Middle East as the world's major oil producer.

**Attribute/Distribution:** SS

**IR 104 Political and Environmental Geography 4 Credits**

Geographical foundations of political phenomena and human impacts on the environment. Global focus on geographic influences on growth and development of states and empires, the nature and impact of borders, how people have altered pattern of climate, hydrology, land forms soils, and biota.

**Attribute/Distribution:** SS

**IR 105 Theories of International Relations 4 Credits**

The role of theory in historical explanation, prediction, and policy. Issues of theory design and testing. Important theoretical approaches to international relations, including Realism; the Democratic Peace; the domestic politics of foreign policy; history and mythmaking; psychological explanations. Prerequisites as noted below.

**Prerequisites:** IR 010

**Attribute/Distribution:** SS

**IR 106 Foreign Policy 4 Credits**

Investigation of foreign policy processes and repeating patterns in the United States and other countries. Roles of political systems and cultures, permanent institutions and bureaucratic politics, and elite and mass psychology.

**Attribute/Distribution:** SS

**IR 118 Issues in International Relations 1-4 Credit**

Readings on selected themes in world politics, with theme to change each semester. Offered on an occasional basis only.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** SS

**IR 119 Issues in International Relations 1-4 Credit**

Readings on selected themes in world politics, with theme to change each semester. Offered on an occasional basis only.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** SS

**IR 120 Globalization and World Politics 4 Credits**

An exploration of the economic, political, cultural, and military manifestations of globalization and the effects on the internal order of states and the relations among them. Prerequisites as noted below.

**Prerequisites:** (IR 010 or GS 010)

**Attribute/Distribution:** SS

**IR 123 Evolution of International Order 4 Credits**

Evaluates competing explanations for the origins of the modern states system, the development of capitalism, the rise of the West, and the nature of international order in non-Western subsystems.

**Attribute/Distribution:** SS

**IR 125 International Political Economy 4 Credits**

Principles governing the interaction between the economic and political components of international phenomena. Political causes and consequences of trade and investment. Foreign economic policy and its relationship to domestic economic policy and other aspects of foreign policy. Determinants of foreign economic policy. Prerequisites as noted below.

**Prerequisites:** IR 010 and ECO 001

**Attribute/Distribution:** SS

**IR 127 Research in International Relations 4 Credits**

Research skills in international relations. The role of theory, models and evidence in the explanation of international phenomena. Literature review; problem formulation; theory construction; research design, methods and measures; collection, analysis and interpretation of data; principles of hypothesis testing. Professional writing, either through individual research projects under faculty supervision or an apprenticeship in ongoing faculty research projects. Consent of instructor required.

**Attribute/Distribution:** SS

**IR 132 Nationalism and Ethnic Conflict 4 Credits**

The ideal of nationalism exerts a powerful pull on almost all people everywhere. This course investigates the sources, spread, and possible future decline of nationalism and national identity, the manipulation of nationalist feelings for political purposes, and the sources of national and ethnic conflict. We will also consider proposals for managing ethnic conflicts and their records of success (or failure). We will study recent and current cases, such as the Israeli-Palestinian conflict, ethnic relations in Iraq and Afghanistan, the Balkans, or others as current events demand. Prospects for the futures of nationalism, ethnic conflict, and ethnic conflict management. Simulations of decision-making of groups involved in ethnic conflicts.

**Attribute/Distribution:** SS

**IR 140 The United Nations 4 Credits**

Provides overview of key issues and debates in the United Nations and helps students understand the formal and informal operations of this global organization. We will explore two major questions. First, what are the major obstacles to effective international cooperation in the United Nations? Second, what does globalization mean for UN efforts to promote democracy, development, and human rights? Includes a trip to UN Headquarters in NY and an in-class UN simulation exercise. Prerequisites as noted below.

**Prerequisites:** IR 010

**Attribute/Distribution:** SS

**IR 142 International Law 4 Credits**

This course deals with the nature and sources of international law and the major theoretical and historical developments that have created the legal system of states as it now stands. Topics include: armed conflict, international trade, human rights and international environmental law.

Prerequisites as noted below.

**Prerequisites:** IR 010

**Attribute/Distribution:** SS

**IR 143 Comparative Environmental Law & Policy 4 Credits**

This course will analyze both comparative legal systems and comparative domestic schemes of environmental regulation exploring the range of alternatives for environmental law and policy as practiced in various parts of the world.

**Attribute/Distribution:** SS

**IR 161 China in World Affairs 4 Credits**

China in world affairs, emphasizing role in Pacific Rim: historical background; domestic politics; foreign and security policies; relations with regional and global powers; policies toward Asia and Third World; current and future issues.

**Attribute/Distribution:** SS

**IR 163 Japan in World Affairs 4 Credits**

Japan in world affairs, emphasizing role in Pacific Rim: historical background; domestic politics; foreign and security policies; relations with regional and global powers; policies toward Asia and Third World; current and future issues.

**Attribute/Distribution:** SS

**IR 169 International Relations of Russia and Eastern Europe 4 Credits**

The Soviet collapse and the emergence of Russia. Russia's relations with the other newly independent states that emerged following the disintegration of the Soviet Union. The international relations of Eastern Europe (including the Balkans).

**Attribute/Distribution:** SS

**IR 177 International Relations of Latin America 4 Credits**

Survey of major international and domestic crises facing Central and South America. Examines factors affecting Latin American system of states such as international debt, involvement of foreign powers, and social and political instabilities.

**Attribute/Distribution:** SS

**IR 222 Political Economy of North-South Relations 4 Credits**

Political economy of relations between developed and less developed countries. Issues arising from trade, investment, and foreign aid. Consequences of North-South transactions. Controversies over system structure and reform proposals for international institutions (e.g. World Bank, IMF, WTO). Prerequisites as noted below or consent of instructor.

**Prerequisites:** IR 125 or POLS 125

**Attribute/Distribution:** SS

**IR 234 Great Power Politics 4 Credits**

Overview of the dynamics of strategic interaction between great powers, including the causes of conflict, origins of alliances, logic of coercion, sources of order, and definition of national interests. Focus on the interwar period (multi-polarity), the Cold War (bi-polarity), and the post-Cold War period (uni-polarity). Prerequisites as noted below.

**Prerequisites:** IR 010

**Attribute/Distribution:** SS

**IR 235 International Security 4 Credits**

Explanations of international wars, civil wars, genocides, and terrorism. Arms races, escalation, and conflict resolution. The nuclear revolution and ballistic missile defense. Tools of national grand strategy, including alliances, deterrence, coercion, and institutions and norms. Current issues and near future prospects. Case studies. Prerequisites as noted below.

**Prerequisites:** IR 010

**Attribute/Distribution:** SS

**IR 245 International Organization 4 Credits**

Examines how cooperation is achieved and sustained in world politics. Under what circumstances does cooperation take place? What role do formal international organizations play? What is the relative importance of power, ideas, and economic interests? Pursues questions theoretically and in practical terms across topical issues (e.g., humanitarian intervention, environmental protection). Prerequisites as noted below.

**Prerequisites:** IR 010

**Attribute/Distribution:** SS

**IR 302 Rise and Decline of Empires 4 Credits**

An overview of the expansion, overextension, and collapse of empires. Focus on alternative theories of empires as well as historical cases. Consent of instructor required. Prerequisites as noted below.

**Prerequisites:** (IR 010)

**Attribute/Distribution:** SS

**IR 307 International Social Entrepreneurship Practicum 4 Credits**

International social entrepreneurship aims to change the world through innovation in solving social problems. Focus on the nexus between social entrepreneurship and development practice, especially in relation to NGOs. Emphasis on acquiring the tools to launch social ventures through field work and team-oriented learning by doing. Best practices in field methods for development projects in poor countries. Developing innovative ideas for poverty reduction into concrete on-ground start-up plans, and taking initial steps to implement and evaluate them. Instructor(s) permission. Does not meet the advanced seminar core requirement.

**Attribute/Distribution:** SS

**IR 321 Economic Relations of Advanced Industrial Societies 4 Credits**

Foreign economic policies of advanced industrial nations. Bilateral and multilateral economic relations; international economic regimes and institutions; interdependence and Cooperation; managing conflict. Consent of department required. Prerequisites as noted below.

**Prerequisites:** (IR 125)

**Attribute/Distribution:** SS

**IR 322 Poverty and Development 4 Credits**

Patterns and causes of poverty in poor countries. Diagnosis of development problems and evaluation of development planning. Explanations for choices of development policy, especially issues of trade, foreign aid, and foreign direct investment. Written and oral presentation of individual country research. Prerequisites as noted below, or instructor permission.

**Prerequisites:** IR 222 and IR 010

**Attribute/Distribution:** SS

**IR 323 Political Economy of Newly Industrializing Countries 4 Credits**

Issues of development, debt and adjustment in newly industrializing countries. Analysis of the differences between the development strategies adopted in Latin America and East Asia. Explanations for patterns of success and failure. Origins of underdevelopment; the politics of failed development strategies; the challenge of the increasingly competitive world economy and relations with the U.S. and other developed nations. Consent of department required. Prerequisites as noted below.

**Prerequisites:** IR 125 and IR 010

**Attribute/Distribution:** SS

**IR 333 International Environmental Law & Policy 4 Credits**

This course examines the basic international legal setting for the protection and management of the global environment. It examines how international law concerning nature is made and applied, the role of international environmental regimes or institutions, enforcement strategies, and compliance mechanisms. Emphasis will be placed on a review of various regulatory regimes for the protection of the global commons, including the history and legal sources of the Global Climate Change Convention.

**Attribute/Distribution:** SS

**IR 334 Prospects for Peace in the 21st Century 4 Credits**

Will the 21st century be more or less peaceful than the "terrible 20th?"

This course examines: globalization as a force both for and against peace, the proliferation of weapons of mass destruction, terrorism, nationalism and communal conflict, humanitarian intervention and peacekeeping, climate change and other issues affecting prospects for peace in the near future. We will also consider the special situation of American as the world's sole superpower, choices in U.S. policy between unilateral and multilateral approaches to preserving global and regional peace, and decision-making processes of the U.S. and other important actors. Consent of department required. Prerequisites as noted below.

**Prerequisites:** IR 010

**Attribute/Distribution:** SS

**IR 335 Intervention 4 Credits**

Strong states frequently intervene in the affairs of weaker societies. Since 1945, the most frequent intervener has been the United States. International norms cut both ways—sovereignty opposes intervention while an emerging "responsibility to protect" sometimes favors it. This course explores why and by what means states and international organizations intervene and what factors influence the success of interventions. We focus mainly on two types – counterinsurgency and humanitarian intervention – that have been and are likely to remain the most common. Consent of department required. Prerequisites as noted below.

**Prerequisites:** IR 010

**Attribute/Distribution:** SS

**IR 337 Conflict and Cooperation 4 Credits**

The course is designed as an advanced undergraduate seminar to students, who are interested in getting deeper familiarity with the rational choice literature on conflict and cooperation. Its primary focus is on socially suboptimal outcomes in situations that can be modeled as a prisoners' dilemma, collective action problems, bargaining failures due to incomplete information and commitment problems, etc. The applied material deals with issues like crisis bargaining, alliance politics, revolutions, interventions, trade, democratic transitions, etc.

**Attribute/Distribution:** SS



**IR 339 Global Security and the Environment 4 Credits**

This course examines the links between international security and the environment. Topics include the effects of military actions on the environment; the environment contributing to international conflict; environmental conditions as security issues; the relationship between public health and security; bioterrorism, eco-terrorism, and biological threats; environmental remediation and conflict resolution.

**Attribute/Distribution:** SS

**IR 340 International Environmental and Science Policy 4 Credits**

The politics of science behind global climate change, trans-boundary environmental pollution, international regulatory standards, and environmental risk assessment. How international/global science communities operate, how to communicate scientific research across cultures, and how to translate scientific data into international policy. Case studies include climate change, the ozone hole, avian influenza, and HIV/AIDS. Consent of department required. Prerequisites as noted below.

**Prerequisites:** IR 010

**Attribute/Distribution:** SS

**IR 343 Comparative Environmental Law & Policy 4 Credits**

This course studies the different ways in which domestic legal systems handle the regulation of humanity's relationship to the natural world. The first part of the course concentrates on comparative law that examines the evolution of distinct types of legal systems from their origins in the ancient world. The second part of the course specifically and comparatively examines environmental law as it has developed in Canada, China, the European Union and the United States. Ranges of alternatives for environmental law and policy as practiced in various parts of the world will be explored.

**Attribute/Distribution:** SS

**IR 344 International Politics of Oil 4 Credits**

Historical influence of oil in international politics and the role it plays today. Focus on differing views of producers, such as Middle Eastern and Latin American states, and consuming nations, largely the economically developed Western states. Consent of department required. Prerequisites as noted below.

**Prerequisites:** IR 010 or ECO 001

**Attribute/Distribution:** SS

**IR 345 Democratization 4 Credits**

Interdisciplinary analysis of international and transnational influences on regime transitions. Addresses the role of war, trade, colonial legacies, waves of democratization, socializations, demonstration effects, and international law; the policies of the United States, EU, OAS, UN, World Bank, and NGOs; and the efficacy of different instruments of democracy promotion. Consent of department required. Prerequisites as noted below.

**Prerequisites:** IR 010

**Attribute/Distribution:** SS

**IR 346 Contemporary Ethical Dilemmas in World Politics 4 Credits**

This course is designed to explore, challenge, and re-conceptualize the boundaries of moral community and ethical responsibility through such current dilemmas in world politics as famine, terrorism, torture, genocide, weapons of mass destruction, organized crime and more. Consent of department required. Prerequisites as noted below.

**Prerequisites:** IR 010

**Attribute/Distribution:** SS

**IR 347 Non-State Actors in a Globalized World 4 Credits**

Role of non-state political groups (e.g. international advocacy organizations, multinational corporations, news media, terrorists, etc.) in world affairs. Thematic focus on globalization, the relationship between non-state and state actors, and the implications of non-state actors for the future of world order. Themes explored through past and current events (e.g., the WTO demonstrations, 911, the CNN effect, AIDs, anti-sweatshop campaigns.) Consent of department required. Prerequisites as noted below.

**Prerequisites:** IR 010

**Attribute/Distribution:** SS

**IR 354 International Relations of the Middle East 4 Credits**

Importance of the Middle East in contemporary world politics; strategic location and natural resources as factors affecting interests of the great powers. Interplay of international, regional and internal forces. Consent of department required. Prerequisites as noted below.

**Prerequisites:** IR 010 or IR 082

**Attribute/Distribution:** SS

**IR 364 International Relations of Pacific Asia 4 Credits**

Research oriented seminar on contemporary international relations of Pacific Asia. Special emphasis on China, Japan and regional and global powers. Substantial research paper on topic of student's own choice is required. Consent of department required. Prerequisites as noted below.

**Prerequisites:** IR 061 or IR 161 or IR 163

**Attribute/Distribution:** SS

**IR 367 International Relations of Russia and other Post-Soviet States 4 Credits**

Analysis of foreign relations of Russia and the other fourteen states that emerged after the collapse of the USSR. Consent of department required. Prerequisites as noted below.

**Prerequisites:** (IR 010 or IR 169)

**Attribute/Distribution:** SS

**IR 388 Honors Thesis in International Relations 4 Credits**

International relations majors with senior standing may undertake an intensive, two-semester project under the direct guidance of a faculty member in the student's special area of interest. Students who successfully complete the thesis and whose GPA in the major at the time of graduation is 3.5 or higher receive Departmental Honors. Department permission required. May be repeated for credit. See the Department or IR website <http://cas.lehigh.edu/ir> for additional information.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** SS

**IR 389 Honors Project 1-6 Credit**

**Repeat Status:** Course may be repeated.

**IR 390 Readings in International Relations 1-4 Credit**

Directed course of readings intended for students with special competence or interest in fields of international relations not fully covered by regular course offerings. May be repeated for credit. Department permission required.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** SS

**IR 391 Internship in International Relations 1-4 Credit**

Internship in public or private agency. May be repeated for credit. Departmental permission required.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** SS

**IR 392 Independent Study 1-4 Credit**

This course enables students to work with faculty on individual projects and material not covered by the current course offerings. Department permission required.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** SS

**IR 393 Seminar in International Relations 3,4 Credits**

Advanced seminar, comparable to other 300level seminars, that focuses on discussion and research on specialized subjects in international relations. Variable subject matter. May be repeated for credit. Junior standing and department permission required.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** SS

**IR 394 Special Topics in International Relations 1-4 Credit**

Intensive, research oriented study for students with a special competence or interest in fields of international relations not fully covered by regular course offerings. May be repeated for credit. Department permission required.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** SS

## Jewish Studies

**Program Director:** Martin Kavka, Ph.D.

610-758-4869; inber@lehigh.edu

Jewish Studies faculty: Chava Weissler, Ph.D.; Nitzan Lebovic, Ph.D., the Helene and Allen Apter Chair of Holocaust Studies and Ethical Values.

The Jewish studies minor, coordinated by the Philip and Muriel Berman Center for Jewish Studies, provides students with the opportunity to explore the history, literature, religion, and social institutions of the Jewish people from its inception to the present. The diverse selection of courses highlights the interaction of Judaism with other cultures and societies in Europe, the Middle East, and the United States. The program is designed to appeal to students with varied interests and fields of concentration. Students of psychology and sociology often discover that courses in Jewish studies enhance their understanding of such topics as individual and group identity, prejudice and anti-Semitism, assimilation, and religious-cultural pluralism. Students of history will find that the study of Jewish society and culture enhances their understanding of European and American culture.

Through the study of Jewish religion and philosophy, students engage such issues as God, religious faith and doubt, spirituality, moral responsibility, evil, and human suffering. By studying Judaism comparatively with another religious tradition, students heighten their understanding of each tradition. Studying Jewish literature introduces students to a broad spectrum of literary forms and themes from diverse periods and cultural settings.

The Berman Center for Jewish Studies supplements formal course offerings through an extensive program of lectures, colloquia, films, field trips, and other cultural events. Lehigh professors conduct a "Lehigh in Israel" summer program, conditions permitting. Students seeking further information on programs in Israel and available financial awards may contact the Berman Center. Students should coordinate their minor program in Jewish studies with the director of the Center, Dr. Martin Kavka, Maginnes Hall.

### Minor in Jewish studies

Students pursuing a minor in Jewish studies must fulfill 16 credit hours from the following courses.

Select four of the following: <sup>1</sup>		16
HEBR 001	Elementary Modern Hebrew I	
HEBR 002	Elementary Modern Hebrew II	
HEBR 011	Intermediate Modern Hebrew I	
HEBR 012	Intermediate Modern Hebrew II	
HEBR 151	Hebrew Special Topics	
HEBR 152	Hebrew Special Topics II	
PHIL 129	Jewish Philosophy	
PHIL 133	Medieval Philosophy	
REL 073	The Jewish Tradition	
REL 111	Jewish Scriptures/Old Testament	
REL 112	The Beginnings of Judaism and Jewish Origins: Jewish Diversity in the Greco-Roman World	
REL 120	Newish Jewish: New Forms of Judaism in North America	
REL 121	Sources for the Life of Jesus: the Jewish and Christian Context	
REL 132	Hasidic Tales	
REL/WGSS 138	Women in Jewish History	
REL/ANTH 139	Jewish Folklore	
REL 152	American Judaism	
REL/HIST 154	The Holocaust: History and Meaning	
REL 174	Contemporary Theology	
REL 230	Kabbalah: Jewish Mystical Tradition	

REL 231	Classic Jewish Texts	
REL 371	Directed Readings	
Total Credits		16

1 A maximum of eight credit hours of Hebrew may be counted

## Joint International Relations/Modern Languages and Literatures Major

**Program directors:** Chairs of IR Department and MLL Department.

The multidisciplinary Joint IR/MLL Major is offered jointly by the Department of International Relations (IR) and the Department of Modern Languages and Literatures (MLL). The program, which offers a Bachelor of Arts, incorporates courses from both IR and MLL, as well as electives from a broad cross-section of other departments, for a challenging program that requires overseas study, language facility, and undergraduate research.

The Joint IR/MLL Major recognizes that Lehigh graduates must be adequately prepared to play an active role in the world of the 21<sup>st</sup> century. For that, they will need an acute understanding of essential issues of global politics, broad linguistic and cultural skills, significant overseas experience, and both intellectual and cultural sophistication. The Joint IR/MLL Major meets those requirements with courses in economics, international relations, language, and culture. Extended study abroad and undergraduate research in more than one language are also required. The program will help students develop a deeper and richer understanding of cultural, linguistic, and political diversity around the world.

The program requires a total of 16 courses for 60-64 credits. At least one semester of study abroad in an approved Lehigh program is required, as is undergraduate research that uses sources in at least one language other than English. Each student will have two major advisors, one each from IR and MLL.

**Professors.** Henri J. Barkey, PhD (University of Pennsylvania); Marie-Helene Chabut, PhD (University of California San Diego); Constance A. Cook, PhD (University of California Berkeley); John Gillroy, LLM (University of Cambridge); David W. Pankenier, PhD (Stanford University)

**Associate Professors.** Marie-Sophie Armstrong, PhD (University of Oregon); Chaim D. Kaufmann, PhD (Columbia University); Kiri Lee, PhD (Harvard University); Linda S. Lefkowitz, PhD (Princeton University); Kevin Narizny, PhD (Princeton University); Mary A. Nicholas, PhD (University of Pennsylvania); Miren Edurne Portela, PhD (University of North Carolina); Antonio Prieto, PhD (Princeton University); Vera S. Stegmann, PhD (Indiana University)

**Assistant Professors.** Taieb Berrada, PhD (Northwestern University); Matthew R. Bush, PhD (University of Colorado Boulder); Arman Grigoryan, PhD (Columbia University)

**Lecturer.** Stephanie Katz, BA (Pomona College)

**Professors Of Practice.** Christine Kalleeny, PhD (Emory University); Limei Shan, MS (East China Normal University)

**Emeriti.** Rajan M. Menon, PhD (University of Illinois Urbana); Bruce E. Moon, PhD (Ohio State University); Zdenek Slouka, PhD (Columbia University); Oles M. Smolansky, PhD (Columbia University); Anje C. Van Der Naald, PhD (University of Illinois Urbana); Lenora D. Wolfgang, PhD (University of Pennsylvania); Raymond F. Wylie, PhD (University of London)

### Required courses

ECO 001	Principles of Economics	4
<b>International Relations - Five Courses - 20 credits</b>		
IR 010	Introduction to World Politics	4
IR 105	Theories of International Relations	4
IR 125	International Political Economy	4
Two IR advanced courses numbered 300-387 (except IR 307) or IR 393		8

**Modern Languages and Literatures**

Four courses in one language, either Arabic, Chinese, Hebrew, Japanese, Russian, French (above the level of Spanish 2) 16

Two culture courses from an approved list or in consultation with the MLL advisor 6-8

**Independent Study**

One course which will include original research in at least one foreign language 4

**Study Abroad**

1 semester or more in an approved Lehigh program

**Electives**

Three electives from an approved list <sup>1</sup> 10-12

Total Credits 60-64

<sup>1</sup> Including courses from the departments of Sociology and Anthropology, Economics, English, International Relations, Journalism, Modern Languages and Literatures, Political Science, History, Religion, and/or programs in Africana Studies, Asian Studies, Global Citizenship, Latin American Studies, Sociology and Social Psychology, Science, Technology and Society, Women's Studies, or other courses as approved by IR and MLL advisors. (Courses must be chosen from at least two departments.)

**Journalism and Communication**

The Department of Journalism and Communication offers major and minor programs in journalism and science and environmental writing, and a minor in mass communication.

Journalism is crucial to the public life of a democracy. At its best, journalism serves as a watchdog to government, offers a voice for the powerless at home and abroad, entertains and instructs the public, represents the views of varied constituencies, monitors and protects the environment and public resources, and provides a common memory for a people.

The purpose of the journalism program is to provide students with the knowledge and skills to fulfill such roles. The program emphasizes research, writing, editing, and critical thinking and analysis. Students integrate online technology with legal and ethical thinking and a global perspective that will prepare them for numerous opportunities in and out of journalism.

In the journalism major, students take courses in writing, editing, visual literacy, law and ethics, a professional internship, and varied courses in the relationship of the media with society.

In the journalism major, students take courses in news and feature writing, editing and design, a professional internship, and varied courses in online journalism. Supported by the endowed Rodale Online Communication Program, the department has a national reputation in online journalism. All courses have online research and writing components.

A second major available to students is the science and environmental writing program. Students learn to write about pure and applied scientific research, technology, engineering, the environment and medicine and health for a variety of audiences ranging from the general public to scientists and engineers in industry and government. Students can also gain experience in the science and environmental writing field research program. A minor in science and environmental writing is available that may be valuable for students with majors in science or engineering.

An interdisciplinary minor in mass communication is also offered.

Career opportunities are numerous for graduates of the department. Students find work in traditional journalism organizations, such as newspapers, wire services, magazines, cable, television and radio stations, and other media outlets. Students find work too in new media, such as web sites and other digital production activities.

Students also find work in public relations positions, with responsibilities in government, corporations, hospitals, health care organizations, universities, sports information, nonprofit agencies and other groups.

A background in journalism, with its emphasis on research and writing, also proves to be excellent preparation for many other fields and provides a fine basis for the study and practice of law, graduate study

in a variety of disciplines, government service, teaching and business management.

Students in science and environmental writing can expect to pursue careers in science, health and environmental journalism in both the traditional and online media; public relations for scientific societies, environmental organizations, government agencies, universities or hospitals; technical writing for industry and government agencies, and other areas, such as management, administration and teaching. The program also prepares students for graduate study in science or environmental writing, journalism and other disciplines.

The interdisciplinary minor in mass communication will be useful to students interested in organizational and written communication, law, business, philosophy, government, marketing, teaching, telecommunication or other careers where understanding of communication is important.

**Professors.** Sharon M. Friedman, MA (The Pennsylvania State University); John F. Lule, PhD (University Georgia Athens)

**Associate Professor.** Kathleen K. Olson, PhD (University of North Carolina)

**Assistant Professors.** John Jirik, PhD (University Texas Austin); Jayeon Lee, PhD (Ohio State University); Jeremy J. Littau, PhD (University of Missouri Columbia)

**Lecturer.** Nancy S. Ross, MAT (University of Cincinnati)

**Emeritus.** Walter W. Trimble, MA (Ohio State University)

**Required Math Course**

Understanding statistical information has become extremely important in modern society. MATH 012, Basic Statistics, is required for students taking a journalism or science and environmental writing major. Students should take MATH 012 to fulfill the college's distribution requirement. ECO 045, Statistical Methods, is an acceptable alternative. For science/science writing double majors, calculus will be considered as a substitute for statistics.

**Journalism Major****Core Courses**

JOUR 001	Brown and White	1
JOUR 002	Brown and White	1
JOUR 003	Brown and White	1
JOUR 004	Brown and White	1
COMM 030	Media and Society	4
JOUR 021	Writing for the Media	4
JOUR 023	Editing	4
JOUR 024	Visual Communication	4
JOUR 122	Media Ethics and Law	4

**Advanced Courses**

Select one of the following: <sup>1</sup>		4
JOUR 211	Reporting	
JOUR 212	Feature Writing	
JOUR 218	Freelance Writing	
JOUR 298	( Temporary Number for Writing for the Media II)	
JOUR 361	Internship	
Senior Seminar: Journalism or Communication course at 300 level		4

**Required Elective**

Select one additional 4-credit Journalism or Communication course. <sup>2</sup>		4
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**Collateral Requirements**

Students must also complete a second major, OR a minor outside of the Department of Journalism and Communication.		15
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Total Credits		51
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- <sup>1</sup> JOUR 211, JOUR 212, JOUR 218 and JOUR 298 (Writing for the Media II) fulfill junior writing intensive requirement.
- <sup>2</sup> NOTE: Students must consult an adviser in choosing the elective course as not all courses with JOUR or COMM designations can be used.

### Journalism/Science and Environmental Writing Major

#### Core Courses

JOUR 001	Brown and White	1
JOUR 002 or JOUR 231	Brown and White Science Writing Practicum	1
Select one of the following:		4
JOUR 123	Basic Science and Technical Writing	
JOUR 311	Science and Technical Writing	
JOUR 021	Writing for the Media	
JOUR 023	Editing	4
JOUR 024	Visual Communication	4
JOUR 211	Reporting	4

#### Advanced Courses

JOUR/STS 124	Politics of Science	4
JOUR 125	Environment, the Public and the Mass Media	4
JOUR/STS/HMS 323	Health and Environmental Controversies	4
JOUR 361	Internship	4

#### Required Electives

Select one additional 4-credit Journalism or Communication course. <sup>1</sup>	4
<b>Total Credits</b>	<b>38</b>

- <sup>1</sup> NOTE: Students must consult an adviser in choosing the elective course as not all courses with JOUR or COMM designations can be used.

#### Collateral Requirements

Students must also complete 15-16 credits in science for the journalism/science and environmental writing major.

#### Required science courses

A minimum of 15-16 credits in the physical, biological, environmental or social sciences or engineering is required. These hours can be concentrated in any one area or distributed among all five areas, although an area concentration is recommended. Dual majors in journalism/science and environmental writing and a science are encouraged. Science courses should be chosen in consultation with the major adviser.

#### Science and environmental writing field research program

Available to science, environmental and technical writing students at the junior or senior level, this program provides practical experience in scientific research and science writing for students who work on and write about research projects directed by university scientists and engineers. Another segment of the program allows students to attend major scientific meetings as fully accredited science reporters. Students observe professional science writers in action and write their own stories about the scientific sessions and press conferences held at the meetings.

#### Science and Environmental Writing Minor

JOUR 001 or JOUR 231	Brown and White Science Writing Practicum	1
JOUR 021 or JOUR 123	Writing for the Media Basic Science and Technical Writing	4
JOUR 124	Politics of Science	4
JOUR 125	Environment, the Public and the Mass Media	4
JOUR 323	Health and Environmental Controversies	4
<b>Total Credits</b>		<b>17</b>

### Mass Communication Minor

#### Purpose

The Mass Communication Minor focuses on how information is disseminated and the effect on the shaping of societies. As traditional forms of mass communication change and new forms arise, it is more important than ever to understand the interplay of the media and society. In this minor, students will learn to evaluate and interpret media messages so that they can understand and participate in this increasingly complicated world. They can also choose to combine theory with practice in research, interviewing, writing, visual communication and editing to enhance their skills in those areas. Because the minor draws on the same courses, it is not open to majors in Journalism or Journalism/Science and Environmental Writing.

#### Requirements

Four 3- or 4-credit COMM or JOUR classes, with one at or above the 200 level. NOTE: Students must consult an adviser in choosing the elective courses as not all courses with JOUR or COMM designations can be used.

#### Total 15-16 credits

#### Prerequisites for Journalism Courses

NOTE: Journalism and Communication courses build on one another. Some courses thus require prerequisites before students can register for the class. Check the course schedule each semester.

#### Media Internships

All majors in journalism and journalism/science and environmental writing take professional internships during their senior year or the preceding summer. The internships provide realworld experience with newspapers, magazines, cable, television or radio stations, web sites or in public relations settings. Science writing minors may take an internship instead of working on The Brown and White.

#### Communication Courses

##### COMM 030 Media and Society 4 Credits

This introduction to the roles of mass media in U.S. and global society explores a media-saturated society. Students learn how mass media operate in relationship to society, controversies surrounding their activities, social consequences of media behavior, and theories for examining mass media. Upperclassmen allowed only by instructor's permission.

**Attribute/Distribution:** ND

##### COMM 130 Public Speaking 4 Credits

Applying the principles of public speaking to making informative and persuasive presentations effectively. Emphasis on speech composition and effective oral communication skills.

**Attribute/Distribution:** HU

##### COMM 135 Human Communication 4 Credits

Processes and functions of human communication in relationships and groups.

**Attribute/Distribution:** SS

##### COMM 143 Persuasion and Influence 4 Credits

The social, symbolic, and rhetorical means of persuasion and how this persuasive influence is expressed in politics, advertising, and the mass media. Students will gain experience in evaluating and creating persuasive communication messages and campaigns.

**Attribute/Distribution:** SS

##### COMM 160 Public Speaking (for IBE Students) 4 Credits

Applying the principles of public speaking to making informative and persuasive presentations effectively. Emphasis on speech composition and effective oral communication skills. This class is limited to students in the Integrated Business and Engineering Honors Program.

**Attribute/Distribution:** HU

**COMM 220 Public Relations 4 Credits**

Study of public relations principles and writing. Ethical, legal and public opinion environments for public relations; development of communication strategies for various audiences, including the mass media. Preparing publicity; planning and conducting news conferences; writing speeches, brochures, newsletters and reports. Prerequisites as noted below.

**Prerequisites:** (JOUR 013 or JOUR 023) and (JOUR 014 or JOUR 024)

**Attribute/Distribution:** ND

**COMM 248 Global Communication 4 Credits**

This class uses historical and cultural perspectives to study how globalization shapes and is shaped by communication and media structures and processes, with emphasis on journalism, the media industries and popular culture. Topics include: global media industries and media flow, entertainment, media hybridity, development communication and alternative media.

**Attribute/Distribution:** SS

**COMM 300 Apprentice Teaching 1-4 Credit****COMM 325 Special Topics In Communication 1-4 Credit**

**Attribute/Distribution:** SS

**COMM 327 Mass Communication and Society 4 Credits**

A review of theories and research on the relationship of mass communication to social processes. Intensive analysis of selected media products (e.g., TV news, dramas, and sitcoms; films; print; music videos, etc.). Prerequisites: Anth 1 or SSP 5 or SSP 21 or SSP 21 or Anth 11 or Anth 12.

**Prerequisites:** SSP 001 or ANTH 001

**Attribute/Distribution:** SS

**COMM 331 Business and Professional Speaking 4 Credits**

The principals of oral communication as applied to business and professional situations. Professional presentations, small group interaction and interpersonal communication in the business setting.

**Attribute/Distribution:** ND

**Journalism Courses****JOUR 001 Brown and White 1 Credit**

This course is a student's first semester on the staff of the semiweekly undergraduate newspaper. Students register for this course, attend a meeting on the first Wednesday of the semester, and are placed on the staff. Because this is an introductory training class, JOUR 001 is for students with freshman or sophomore standing; juniors only with consent of department chair.

**Attribute/Distribution:** ND

**JOUR 002 Brown and White 1 Credit**

Enrollment constitutes continued membership on the staff of the semiweekly undergraduate newspaper. These courses are taken consecutively after a student has completed JOUR 001. For a second semester on the newspaper, a student registers for JOUR 002. For a third semester, JOUR 003. For a fourth semester, JOUR 004. And so on. Prerequisites as noted below.

**Prerequisites:** JOUR 001

**Attribute/Distribution:** ND

**JOUR 003 Brown and White 1 Credit**

Enrollment constitutes continued membership on the staff of the semiweekly undergraduate newspaper. These courses are taken consecutively after a student has completed JOUR 001. For a second semester on the newspaper, a student registers for JOUR 002. For a third semester, JOUR 003. For a fourth semester, JOUR 004. And so on. Prerequisites as noted below.

**Prerequisites:** JOUR 002

**Attribute/Distribution:** ND

**JOUR 004 Brown and White 1 Credit**

Enrollment constitutes continued membership on the staff of the semiweekly undergraduate newspaper. These courses are taken consecutively after a student has completed JOUR 001. For a second semester on the newspaper, a student registers for JOUR 002. For a third semester, JOUR 003. For a fourth semester, JOUR 004. And so on. Prerequisites as noted below.

**Prerequisites:** JOUR 003

**Attribute/Distribution:** ND

**JOUR 005 Brown and White 1 Credit**

Enrollment constitutes continued membership on the staff of the semiweekly undergraduate newspaper. These courses are taken consecutively after a student has completed JOUR 001. For a second semester on the newspaper, a student registers for JOUR 002. For a third semester, JOUR 003. For a fourth semester, JOUR 004. And so on. Prerequisites as noted below.

**Prerequisites:** JOUR 004

**Attribute/Distribution:** ND

**JOUR 006 Brown and White 1 Credit**

Enrollment constitutes continued membership on the staff of the semiweekly undergraduate newspaper. These courses are taken consecutively after a student has completed JOUR 001. For a second semester on the newspaper, a student registers for JOUR 002. For a third semester, JOUR 003. For a fourth semester, JOUR 004. And so on. Prerequisites as noted below.

**Prerequisites:** JOUR 005

**Attribute/Distribution:** ND

**JOUR 007 Brown and White 1 Credit**

Enrollment constitutes continued membership on the staff of the semiweekly undergraduate newspaper. These courses are taken consecutively after a student has completed JOUR 001. For a second semester on the newspaper, a student registers for JOUR 002. For a third semester, JOUR 003. For a fourth semester, JOUR 004. And so on. Prerequisites as noted below.

**Prerequisites:** JOUR 006

**Attribute/Distribution:** ND

**JOUR 008 Brown and White 1 Credit**

Enrollment constitutes continued membership on the staff of the semiweekly undergraduate newspaper. These courses are taken consecutively after a student has completed JOUR 001. For a second semester on the newspaper, a student registers for JOUR 002. For a third semester, JOUR 003. For a fourth semester, JOUR 004. And so on. Prerequisites as noted below.

**Prerequisites:** JOUR 007

**Attribute/Distribution:** ND

**JOUR 009 Brown and White Photography 1 Credit**

Enrollment constitutes membership on the photography staff of the semiweekly undergraduate newspaper. Students should have basic camera skills and knowledge of digital photography. Classes will include review of these subjects and more advanced techniques in digital darkroom techniques. Members of the class work on a series of assignments for the newspaper. Students should have their own digital SLR camera equipment and will be expected to provide examples of their work for admission to the class. Repeatable up to 8 credits.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** ND

**JOUR 010 Brown and White 1-2 Credit**

Enrollment constitutes an editorial position on the staff of the semiweekly undergraduate newspaper. Editors are chosen by the instructors and the newspaper's editorial board. May be repeated for a maximum of eight credits. Consent of department required. Prerequisites as noted below.

**Repeat Status:** Course may be repeated.

**Prerequisites:** JOUR 001

**Attribute/Distribution:** ND

**JOUR 012 Brown and White Videography 1 Credit**

Enrollment constitutes membership on the videography staff of the student newspaper. Students should have basic camcorder skills and knowledge of editing video. Members of the class use the newspaper's video equipment and work on assignments for the newspaper's Web site. First-time students should provide examples of their work for admission to the class. Repeatable up to 8 credits; does not count in department's majors or minors.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** ND

**JOUR 021 Writing for the Media 4 Credits**

Practice gathering, writing and editing news; definition and components of news; structure and style; interviewing. Study and practice in use of social media and blogs by journalists as a way to gather and publish information. Requires freshman or sophomore standing or consent of the instructor.

**Attribute/Distribution:** ND

**JOUR 023 Editing 4 Credits**

Students will strengthen news judgment, critical thinking and writing through careful editing of articles for accuracy, fairness and clarity, including use of proper spelling, grammar, usage and style. Practice in writing headlines for print and the Web, including search engine optimization and multimedia presentation of content. Prerequisites as noted below.

**Prerequisites:** JOUR 021 or JOUR 011

**Attribute/Distribution:** ND

**JOUR 024 Visual Communication 4 Credits**

Study of and practice in techniques of graphic design for publications including websites, magazines and newspapers. Proper use of typography, grids, photographs and other visual elements; computer-based desktop publishing. Study of and practice in taking and editing video for the Internet. Prerequisites as noted below.

**Prerequisites:** JOUR 021 or JOUR 011

**Attribute/Distribution:** ND

**JOUR 101 Media, Sports and Society 4 Credits**

Analysis of social, political and economic implications of media sports coverage; emphasis placed on media coverage of events of international scope, such as the World Cup, World Series and the Olympics; special attention paid to the role of the sports press in coverage of issues such as AIDS, racism, sexism, drug use and terrorism.

**Attribute/Distribution:** SS

**JOUR 111 Sportswriting 3 Credits**

Principles and practice of writing about sports for general print and specialized publications; emphasis placed on instruction in reporting, writing and editing; topics covered include the history of sports journalism; recent trends in the field; ethical considerations, and the exploration of social and political issues through sportswriting.

**Attribute/Distribution:** ND

**JOUR 114 Technical Communication 3-4 Credits**

This online course covers basic tools needed to write about all kinds of science and technical information for academic papers, term papers, proposals, reports, theses and dissertations. Involves practice with feedback on definitions, descriptions, cause and effect relationships, process writing, concept maps, graphics, classification, comparison and more.

**Attribute/Distribution:** ND

**JOUR 115 Communicating about the Environment 4 Credits**

Introduction to the need for and ways to communicate about environmental issues to laypersons, government officials, journalists, members of the judiciary and technical experts. Explores case studies of good and bad communication about environmental issues. Internet communication, including the efficacy of placing governmental reports and databases on the Web for public consumption, will be evaluated.

**Attribute/Distribution:** SS

**JOUR 117 Environmental Health Risks and the Media 4 Credits**

This course explores the risks and effects of environmental contamination on human health and behavior as well as the role of the mass media in alerting citizens to potential environmental health risks. Environmental topics vary but usually include air and water pollution, endocrine disrupters and radioactive waste.

**Attribute/Distribution:** SS

**JOUR 122 Media Ethics and Law 4 Credits**

First Amendment theory and history; ethical and legal issues involving libel, privacy, obscenity, newsgathering, access, and fair trials; national and international concerns over censorship, prior restraint and manipulation and control of information.

**Attribute/Distribution:** SS

**JOUR 123 Basic Science and Technical Writing 4 Credits**

Study of and practice in writing about scientific and technical subjects for audiences ranging from the general public to scientists and engineers. Starts with basic science writing for lay audiences, emphasizing organization and clear writing techniques. As the course progresses, material becomes more technical, concentrating on how to write effective technical reports, descriptions, papers and memoranda. Also explores problems of conveying highly complex technical information to multiple audiences, factors that influence science communication to the public, and interactions between scientists and journalists.

**Attribute/Distribution:** SS

**JOUR 124 Politics of Science 4 Credits**

Analysis of the multidimensional interaction between the federal government and the scientific community. Explores historical growth of the sciencegovernment connection, the scientific establishment both past and present, and the role of scientific advice to the White House and Congress. Also examines scientific ethics, public attitudes toward science, sciencesociety interactions and case studies of scientific controversies.

**Attribute/Distribution:** SS

**JOUR 125 Environment, the Public and the Mass Media 4 Credits**

Extensive exploration of local, national and international environmental problems and their social, political and economic impacts. Analysis of mass media coverage of complex environmental issues and the media's effects on public opinion and government environmental policies. Examination of environmental journalism principles and practices in the United States and around the world.

**Attribute/Distribution:** SS

**JOUR 135 Human Communication 4 Credits**

Processes and functions of human communication in relationships and groups.

**Attribute/Distribution:** SS

**JOUR 141 Photojournalism 4 Credits**

Ethics and history of photojournalism; instruction and practice in basic camera techniques; scanning and digital manipulation of black and white and color photographs using Adobe PhotoShop; cropping and sizing photographs and production of layouts using Quark Express.

**Attribute/Distribution:** ND

**JOUR 166 Beyond Google – Internet Research: Principles and Practice 4 Credits**

Students often turn first to the Internet for research. Yet they often are unaware of the promise and pitfalls of Internet research. This course has three objectives: 1) Students will learn methods of identifying and locating resources on the Internet, including resources not reached by traditional search engines; 2) Students will be introduced to steps for the assessment and evaluation of information gathered from the Internet; 3) Students will explore issues of access, privacy and other legal and ethical questions that arise in Internet research.

**Attribute/Distribution:** SS

**JOUR 211 Reporting 4 Credits**

Principles and practice of news reporting; techniques for gathering, organizing and writing news. Emphasis on interviewing, research, and clear, concise writing. Students develop and write numerous stories to gain understanding of fundamental reporting concepts, including use of sources, accuracy, fairness and. Prerequisites as noted below.

**Prerequisites:** (JOUR 011 or JOUR 123) and JOUR 013

**Attribute/Distribution:** SS

**JOUR 212 Feature Writing 4 Credits**

Conceiving and developing feature stories for newspapers and magazines and websites; interviewing techniques; study of and practice in writing non-fiction using the techniques of the novelist. Prerequisites as noted below.

**Prerequisites:** (JOUR 011 or JOUR 123) and JOUR 013

**Attribute/Distribution:** ND

**JOUR 218 Freelance Writing 4 Credits**

Practice in writing for magazines, newspapers and websites. Finding the right approach for a publication and writing in that publication's style. Practice in analyzing content and audiences, and in writing. Learn research and interviewing skills and read works by well-known writers. Prerequisites as noted below.

**Prerequisites:** (JOUR 011 or JOUR 123) and (JOUR 013)

**Attribute/Distribution:** ND

**JOUR 230 Multimedia Storytelling 4 Credits**

An introduction to storytelling across multimedia styles such as video, audio, photography, social media, and written word. Course stresses experiential learning with emphasis on complementary story packaging and publishing. Students do in-class assignments and team reporting on issues of concern to local residents. Consent of instructor required.

**Attribute/Distribution:** ND

**JOUR 231 Science Writing Practicum 1-4 Credit**

Onsite experience as accredited science reporter at major scientific meetings, or writing and research in university laboratories as part of science writing field research program. May be repeated for a maximum of eight credits. Must have junior standing. Consent of instructor required. Prerequisites as noted below.

**Repeat Status:** Course may be repeated.

**Prerequisites:** JOUR 011 or JOUR 123 or JOUR 311

**Attribute/Distribution:** ND

**JOUR 232 Journalism Practicum 1-4 Credit**

Credit for supervised on- and off-campus work in journalism and communication. Course allows credit for internships attained by students who do not qualify for the senior-level journalism internship class. May be repeated for maximum of eight credits. Must have completed eight hours of journalism credits or consent of instructor required.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** ND

**JOUR 242 Web Writing & Design 4 Credits**

This course examines the ways in which writing and design are influenced by online technology. Students will learn principles and practice of hypertext, Web writing and Web design and will plan and create Web sites that tell stories using the unique features of online technology. Prerequisites: JOUR 11 or JOUR 123 or JOUR 228.

**Prerequisites:** JOUR 011 or JOUR 123 or JOUR 228

**Attribute/Distribution:** ND

**JOUR 246 International Communication 4 Credits**

The subject matter is crucial to understanding modern life: the role of international news media in world affairs. The class studies the social, political and economic contexts that frame the reporting of international events by U.S. news media, such as politics, war, disasters, and other crises, as well as U.S. reporting on international issues, such as poverty, disease, and environmental change. The course also surveys reporting practices in nations around the world, including the varying systems of journalism and mass media and the brutal censorship and repression facing many foreign journalists.

**Attribute/Distribution:** SS

**JOUR 300 Apprentice Teaching 1-4 Credit**

**Repeat Status:** Course may be repeated.

**JOUR 311 Science and Technical Writing 3-4 Credits**

Study of and practice in writing about scientific and technical issues for multiple audiences. Emphasis on developing effective writing and organizational skills and translating scientific information for a wide range of audiences. Similar in content to JOUR 123, but should be taken instead by upperclassmen (34 credits) and graduate students (34 credits). 4 credits for upperclassmen and 3 for graduate students.

**Attribute/Distribution:** SS

**JOUR 312 Advanced Science Writing 3 Credits**

Further practice, on individual basis, in science writing techniques.

Prerequisites as noted below.

**Prerequisites:** JOUR 123 or JOUR 311

**Attribute/Distribution:** SS

**JOUR 313 Special Topics in Science Communication 1-4 Credit**

Research or writing involving a topic, medium or issue in science, environmental or technical communication not covered in other courses. Must have completed eight hours in science or environmental writing or have consent of the instructor.

**Attribute/Distribution:** SS

**JOUR 314 Technical Communication 3-4 Credits**

This online course covers basic tools needed to write about all kinds of science and technical information for academic papers, term papers, proposals, reports, theses and dissertations. Involves practice with feedback on definitions, descriptions, causeandeffect relationships, process writing, concept maps, graphics, classification, comparison and more. Taken by seniors for 4 credits and graduate students for 3 credits.

**Attribute/Distribution:** ND

**JOUR 323 Health and Environmental Controversies 4 Credits**

Exploration of health and environmental controversies from the perspectives of scientific uncertainty and mass media coverage. Examines genetic engineering, biotechnology, environmental health risks and nanotechnology. Includes discussion of ethical and social responsibilities and interactions with the public.

**Attribute/Distribution:** SS

**JOUR 325 Seminar in Journalism and Communication Issues 3-4 Credits**

A seminar focusing on contemporary issues and problems facing the mass media. Topics vary. Taken by seniors for 4 credits and graduate students for 3 credits. Must have completed nine hours in journalism or communication or have consent of the instructor.

**Attribute/Distribution:** ND

**JOUR 327 Mass Communication and Society 4 Credits**

A review of theories and research on the relationship of mass communication to social processes. Intensive analysis of selected media products.

**Prerequisites:** ANTH 001 or ANTH 011 or ANTH 012 or SSP 005 or SSP 021 or PSYC 021 or SSP 001

**Attribute/Distribution:** SS

**JOUR 330 Critical Studies in Journalism 4 Credits**

This course prepares students to be critical news consumers by giving them tools to understand how journalism works. Theoretical perspectives by and about journalists help students analyze news in historical, global, political, economic and social contexts. Prerequisites as noted below or consent of instructor.

**Prerequisites:** JOUR 011 and JOUR 013

**Attribute/Distribution:** ND

**JOUR 334 Technical Writing for Engineers 3,4 Credits**

This online course is for upper-class and graduate students who plan to work in engineering and environmental services. The course covers basic grammar, punctuation, style rules, organization and clarity issues that engineers face when writing reports and proposals, including executive summaries, introductions, site descriptions, project backgrounds and research findings. Must have junior status or consent of instructor.

**JOUR 361 Internship 4 Credits**

Professionally supervised work on newspapers, magazines, Web sites radio and television stations, or with public relations organizations. Some internships involve science writing. May be repeated for a maximum of eight credits. Must have senior standing and declared major in journalism or science writing.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** ND

**JOUR 366 Online Journalism 3-4 Credits**

The course examines the social, cultural, political, legal and economic influence of online technology on journalism and the role of journalism in society. Emphasizing critical thinking and analysis, the course studies the ways in which digital technology has changed the way journalists research, write, edit and design. Taken by seniors for 4 credits and graduate students for 3 credits. Prerequisites: JOUR 11 or JOUR 123, JOUR 122, or consent of department chair.

**Prerequisites:** (JOUR 011 or JOUR 123) and JOUR 122

**Attribute/Distribution:** ND

**JOUR 389 College Scholar Project 1-8 Credit**

Opportunity for college scholars to pursue an extended project. May be repeated for credit. College wide course designation. Transcript will identify department in which project was completed. Consent of instructor required.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** ND

**JOUR 390 Honors Thesis 1-4 Credit**

Directed undergraduate research thesis required of students who apply for and qualify for graduation with departmental honors.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** ND

**JOUR 391 Special Topics in Journalism and Communication 1-4 Credit**

Directed research or writing involving a subject or issue in journalism not covered in other courses. May be repeated for credit. Must have completed twelve hours in journalism or have consent of the instructor.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** ND

**Languages**

Courses are listed alphabetically under Modern Languages and Literature (p. 171) and Classical Studies (p. 104).

**Latin American Studies**

**Program Director:** Matthew Bush, Pd. D. (U. of Colorado at Boulder)

**Email:** matthew.bush@lehigh.edu # **Phone:** 610-758-3087

**Website:** <http://las.cas2.lehigh.edu/>

*Supported by the Office of Interdisciplinary Programs 610-758-3996; incasip@lehigh.edu*

Latin American studies is a minor program designed for students who wish to develop an understanding of a neighboring region that is of vital importance to the United States. Courses in anthropology, archeology, foreign policy, history, language and literature, politics, sociology, visual arts and museum studies, allow students to explore various aspects of Latin American cultures and societies from an interdisciplinary perspective. The minor contributes to a liberal arts education by offering students an international vantage point from which they can examine their own society and prepares them to meet the challenges of an increasingly interdependent world. Additionally, the unprecedented movement of peoples and ideas between the American continents in recent decades makes the study of this region of the world an essential component for understanding the history and culture of the expanding U.S. Latino population. The minor in Latin American Studies complements, therefore, major concentrations in disciplines that have either an international or a domestic focus, and it enhances the relevance of a Lehigh education by preparing students to be citizens of a culturally diverse society and, more generally, of the Americas.

The Latin American Studies minor program requires 15 to 16 credit hours of coursework. In addition to regular Lehigh offerings, students may receive minor credit for appropriate courses at other LVAIC institutions, study abroad programs in Latin America, and various Lehigh faculty-led programs, such as "Lehigh in Martinique" and "Lehigh in Costa Rica" (both offered during the winter term). Students are encouraged to take advantage of extracurricular activities sponsored by the Latin American Studies Program, which include guest speakers, exhibits, films, etc. To declare a minor in Latin American Studies, students must complete a minor declaration form ([http://catalog.lehigh.edu/coursesprogramsandcurricula/artsandsciences/latinamericanstudies/LAS\\_Minor\\_Declaration\\_Form\\_docx.pdf](http://catalog.lehigh.edu/coursesprogramsandcurricula/artsandsciences/latinamericanstudies/LAS_Minor_Declaration_Form_docx.pdf)).

<b>History/Culture</b>		4
HIST 049	History of Latin America	
or HIST 050	History of Latin America	
or SPAN 152	Cultural Evolution of Latin America	
<b>Language</b>		4
SPAN 012	Intermediate Spanish II	
<b>Electives</b>		7-8
Select two of the following: <sup>1</sup>		
ART 273	Special Topics in Studio Practice	
ART 370	Special Topics in Museum and Curatorial Studies	
ART 375	Museum Internship	
ANTH 178	Mesoamerican Archaeology	
ART 269	Special Topics in Art History	
HIST 049	History of Latin America	
HIST 050	History of Latin America	
HIST 342	Argentina, Brazil and Chile	
HIST 368	Seminar in Latin American History	
IR 177	International Relations of Latin America	
IR 222	Political Economy of North-South Relations	
IR 323	Political Economy of Newly Industrializing Countries	
LAS/AAS/SSP 106	Race and Ethnicity in Latin America and the Spanish Speaking Caribbean	
LAS/AAS/MLL/FREN/HIST 133	Lehigh in Martinique: Globalization and Local Identity	
LAS/AAS/SSP 155	Afro-Latino Social Movements in Latin America & the Caribbean	
LAS/AAS/SSP 177	Cuba: Race, Revolution and Culture	
LAS/SPAN 211	Business Spanish	
LAS/SPAN 213	Approaches to Reading Cultural Productions in Spanish	
LAS 227	Latino Visual Arts and Culture in the USA	
LAS/SPAN 263	The Spanish American Short Story	
LAS/SPAN 265	Spanish and Latin American Cinema	
LAS/SPAN/WGSS 275	Introduction to Hispanic Women Writers	
LAS/SPAN 276	Contemporary Literature of the Southern Cone	
LAS/SPAN 320	Literature of the Spanish Caribbean	
LAS/SPAN 321	Children and Adolescents in Contemporary Spanish American Literature	
LAS/SPAN 322	The Short Novel in Contemporary Spanish American Literature	
LAS/SPAN 323	Literature and Revolution in Contemporary Cuba	
LAS/SPAN 325	Hispanic Literature of the United States	



LAS/SPAN/WGSS 326	Tradition and Resistance: Women Writers of Latin America
LAS/SSP 330	Society, Democracy and Revolution in Latin America
LAS/SPAN 342	The New Narrative Spanish American Literature
LAS/SPAN 345	Testimonial Writing in the Hispanic World
LAS/SPAN/WGSS 346	Contemporary Hispanic Women Writers: The Novelists
LAS/ANTH 378	Blood, Pyramids, and the Tree of Life
MLL 051	Contemporary Hispanic-American Literature
MLL 053	This Hispanic World and its Culture
POLS 335	Latin American Political Systems
POLS 336	U.S. Foreign Policy and Latin America
POLS 337	Religion and Politics in Latin America
POLS/GS/WGSS 342	Gender and Third World Development
<b>Total Credits</b>	<b>15-16</b>

<sup>1</sup> Elective courses (7-8 credits) chosen from the following LAS cross-listed courses or collateral courses. Credit may be received for other courses, in consultation with the Program Director.

### Courses

#### **LAS 106 Race and Ethnicity in Latin America and the Spanish Speaking Caribbean 4 Credits**

A sociological examination of race and a look at an individual's experience. We consider how concepts like "race" and "ethnicity" have been defined and how they have been institutionalized in law, government, social policy, social thought, and economic structures. We consider the importance of concepts like "race," "cultures," and "mestizaje" to our understanding of citizenship and national identity, and we address contemporary African and indigenous movements against racial inequality.

**Attribute/Distribution:** SS

#### **LAS 133 Lehigh in Martinique: Globalization and Local Identity 3,4 Credits**

History, culture and politics of the French Caribbean island of Martinique, from its position as a key site of the 18th century Atlantic World economy to becoming an official French department and outpost of the European Union. Interdisciplinary perspectives on the complex nature of social identity, historical memory and impact of globalization. No French is required. Offered during winter inter-term through Lehigh Study Abroad.

**Attribute/Distribution:** HU

#### **LAS 152 The Cultural Evolution of Latin America 4 Credits**

The historical and cultural evolution of Latin America. Discussion of representative literary works in their cultural and historical contexts. Prerequisite as listed below or consent of instructor.

**Prerequisites:** SPAN 141

#### **LAS 155 Afro-Latino Social Movements in Latin America & the Caribbean 4 Credits**

This course focuses on Afro-Latinos who make up nearly 70% of the population of the Americas. Despite the large amount of people of African descent living in the Americas, Afro-Latinos are an understudied population who face significant amounts of racial discrimination in their countries. Who are Afro-Latinos? Where do they live? How are they challenging the racism that they face? These are questions we will tackle in this course.

**Attribute/Distribution:** SS

#### **LAS 177 Cuba: Race, Revolution and Culture 4 Credits**

This course analyzes the role of race & "culture" in the Afro Cuban struggle for equality. By focusing on the arts: particularly music, film & literature, this course will analyze the development of race during Cuba's colonial period; the Afro Cuban challenge to the "race blind" political and cultural movements of the Cuban Republic. We will then wrap up the semester by addressing the significance of contemporary cultural movements that challenge the social issues currently facing Afro Cubans.

**Attribute/Distribution:** SS

#### **LAS 211 Business Spanish 4 Credits**

An introduction to business concepts and vocabulary in Spanish. Letter writing, specialized professional vocabulary, and review of grammar. Prerequisites as noted below.

**Prerequisites:** SPAN 141

**Attribute/Distribution:** HU

#### **LAS 213 Approaches to Reading Cultural Productions in Spanish 4 Credits**

An introduction to the analysis of Latin American and Spanish cultural productions (mainly literature and film).

#### **LAS 227 Latino Visual Arts and Culture in the USA 4 Credits**

The thrust of the course is to explore the phenomenon of contemporary Latino and Latin American art from several angles. Because art has no country, but the artist does, is contemporary art a product of globalization? Is Latino and Latin American art, culture and art criticism a nationalistic platform of cultures, or just a contemporary enterprise of sorts? Who's who in the current Latino and Latin American art world? Students will utilize works from the university (LUAG) collection and/or research and interview a contemporary artist at his or her studio (if possible) for essays or media projects.

#### **LAS 243 Indigenous Cultures in Spanish America 4 Credits**

A survey of Spanish American narratives that deal with the relationship between indigenous and occidental cultures. While examining works created from the late 19th century up until present day, we analyze the construction of cultural identity in several countries including Bolivia, Ecuador, and Mexico. Analysis will include works of poetry, short story, novel, essay, and film by several influential artists: Clorinda Matto de Turner, Jorge Icaza and José María Arguedas, to name just a few.

#### **LAS 263 The Spanish American Short Story 4 Credits**

Comparative study of representative works by major writers such as Quiroga, Borges, and Cortazar, among others.

#### **LAS 265 Spanish and Latin American Cinema 4 Credits**

An introduction to cinema in the Spanish-speaking world. Oral discussion and written analysis of selected films. Students view films independently.

**Prerequisites:** SPAN 141

#### **LAS 275 Introduction to Hispanic Women Writers 4 Credits**

The objective of this class is to introduce students to Hispanic contemporary female authors from Latin America, Spain, and the United States through the analysis of all literary genres (novel, short story, poetry, essay, and drama). This class provides students with a solid introduction to Hispanic women's writing from the last years of the Nineteenth Century to the present, as well as to feminist literary theory.

**Attribute/Distribution:** HU

#### **LAS 276 Contemporary Literature of the Southern Cone 4 Credits**

This course focuses on the study of the literature of Argentina, Chile, and Uruguay from the beginning of the 20th Century to the present. The class is devoted both to analyze the works of the most important authors from the Southern Cone through different literary genres (drama, novel, short story, and poetry) as well as to study how these texts represent the cultural and historical particularities of the region. Special attention is paid to the unique contexts in which this literature is produced, particularly the periods of political instability and state violence and repression. Texts by Jorge Luis Borges, Pablo Neruda, Manuel Puig, Griselda Gambaro, Cristina Peri Rossi, and Antonio Skarmeta, among others, are studied. Also, historical and theoretical readings, films, and documentaries are used to supplement the literary texts.

**Attribute/Distribution:** HU

**LAS 320 Literature of the Spanish Caribbean 4 Credits**

Study of representative works with emphasis on Cuba and Puerto Rico. Writers include Barnet, Carpentier, Sánchez, and Rodríguez Juliá. Prerequisites as noted below.

**Prerequisites:** LAS 152 or SPAN 152

**Attribute/Distribution:** HU

**LAS 321 Children and Adolescents in Contemporary Spanish American Literature 4 Credits**

Discussion of narrative techniques and the category of the self as they relate to the images of adolescence and childhood in works by such authors as Vargas Llosa, Reinaldo Arenas, José Bianco, Silvina Ocampo. Prerequisites as noted below.

**Prerequisites:** LAS 152 or SPAN 152

**Attribute/Distribution:** HU

**LAS 322 The Short Novel in Contemporary Spanish American Literature 4 Credits**

Reading and discussion of representative works by García Márquez, Onetti, Rulfo, and Bioy Casares, among others. Prerequisites as noted below.

**Prerequisites:** LAS 152 or SPAN 152

**Attribute/Distribution:** HU

**LAS 323 Literature and Revolution in Contemporary Cuba 4 Credits**

Study of works written after 1959 by dissident, nondissident, and exiled authors (Desnoes, Norberto Fuentes, Benítez Rojo, and Pedro Juan Gutiérrez, among others).

**Attribute/Distribution:** HU

**LAS 325 Hispanic Literature of the United States 4 Credits**

Discussion of fiction, poetry, drama, and film from the main groups in the U.S. Hispanic population. Discussion of Hispanic ethnic identity, bilingualism, and minority issues. Prerequisites as noted below.

**Prerequisites:** LAS 152 or SPAN 152

**Attribute/Distribution:** HU

**LAS 326 Tradition and Resistance: Women Writers of Latin America 4 Credits**

Study of poetry and narrative works by Latin American women writers. Authors include Rosario Ferré, Rosario Castellanos, Elena Poniatowska, Cristina Peri Rossi, among others. Prerequisites as noted below.

**Prerequisites:** SPAN 152

**Attribute/Distribution:** HU

**LAS 330 Society, Democracy and Revolution in Latin America 4 Credits**

Latin America is a region filled with protest and armed guerrilla movements. Since the fall of the Soviet Union in 1989, at least 5 nations in the region elected openly socialist or communist candidates, many of whom are still in power today. What is happening in Latin America? This course will focus on Latin American perspectives on democracy and social revolution. For many Latin American countries, the move to the 'left,' and the rejection of American capitalism is not that Latin American people embrace socialism, but rather it is a reflection of larger social dynamics at play... or is it?.

**Attribute/Distribution:** SS

**LAS 342 The New Narrative Spanish American Literature 4 Credits**

Critical evaluation of distinguished works of Spanish American prose fiction of the 1960's and 70's. Readings by Donoso, Fuentes, García Márquez, and Vargas Llosa, among others. Prerequisites as noted below.

**Prerequisites:** LAS 152 or SPAN 152

**Attribute/Distribution:** HU

**LAS 345 Testimonial Writing in the Hispanic World 4 Credits**

This course explores the genre testimonio, which confronts the official history of the Latin American and Spanish dictatorships and portrays the experiences and struggles of those who suffered political repression. The course focuses on the analysis of both literary and visual testimonios from the Hispanic world, as well as on theoretical issues concerning discourses of truth.

**Attribute/Distribution:** HU

**LAS 346 Contemporary Hispanic Women Writers: The Novelists 4 Credits**

This course explores the works of Hispanic women writers who have been oppositional to hegemonic cultural politics during the Twentieth Century in Latin America and Spain. Grounding the readings in their particular contexts, the class discusses the issues these writers define as important in their work, the impact of their creations in both the literary canon as well as in the politics of their countries, the use of literature as a weapon to empower minority positions, and the effect of their narratives on the changing literary canon. Special attention will be paid to issues related to interpretations of history, exile, different forms of violence and repression, expressions of desire, and sexuality.

**Attribute/Distribution:** HU

**LAS 378 Blood, Pyramids, and the Tree of Life 4 Credits**

This course explores the ways of life of the Maya people. We will take a close look at their religion, their foods, their family life, music, medicine, festivals, etc. An important part of this class explores the long tradition of the Maya, making connections between the modern Maya and the Maya of their past.

**Attribute/Distribution:** SS

## Mathematics

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Mathematics is a subject of great intrinsic power and beauty. It is the universal language of science, and is essential for a clear and complete understanding of virtually all phenomena. Mathematical training prepares a student to express and analyze problems and relationships in a logical manner in a wide variety of disciplines including the physical, engineering, social, biological, and medical sciences, business, and pure mathematics itself. This is a principal reason behind the perpetual need and demand for mathematicians in education, research centers, government, and industry.

The department offers three major programs leading to the degrees of bachelor of arts in mathematics, bachelor of science in mathematics (with a general mathematics and an applied mathematics option), and bachelor of science in statistics. It also offers several minor programs for undergraduates.

At the graduate level, it offers programs leading to the degrees of master of science in mathematics, master of science in applied mathematics, master of science in statistics, doctor of philosophy in mathematics, and doctor of philosophy in applied mathematics.

The Division of Applied Mathematics and Statistics is a part of the Department of Mathematics.

**Calculus Sequences**

Many degree programs throughout the university include a mathematics requirement consisting of a sequence in calculus. The Department of Mathematics offers three calculus sequences:

MATH 021 & MATH 022 & MATH 023	Calculus I and Calculus II and Calculus III	12
MATH 031 & MATH 032 & MATH 033	Honors Calculus I and Honors Calculus II and Honors Calculus III	12
MATH 051 & MATH 052	Survey of Calculus I and Survey of Calculus II	7

The MATH 021, MATH 022, MATH 023 sequence is a systematic development of calculus. Most students of mathematics, science, engineering, and business will take some or all of this sequence.

As an honors sequence, the MATH 031, MATH 032, MATH 033 sequence covers essentially the same material but in greater depth and with more attention to rigor and proof. This sequence should be considered by students who have demonstrated exceptional ability in mathematics. Students who are contemplating a major in mathematics are strongly encouraged to consider this sequence.

The MATH 051, MATH 052 sequence is a survey of calculus. MATH 081 is a survey course with business applications. This sequence is not sufficient preparation for most subsequent mathematics courses.

Students contemplating further study in mathematics should consider MATH 021, MATH 022 instead.

MATH 075, MATH 0766 is a two-semester sequence that substitutes for MATH 021, covering the same material but at a slower pace.

The MATH 031, MATH 032, MATH 033 sequence will be accepted in place of the other two sequences. MATH 021, MATH 022 will be accepted in place of MATH 051, MATH 052. Credit will be awarded for only one course in each of the following groups:

#### Group 1

MATH 021	Calculus I	4
MATH 075/076	Calculus I, Part A	2
MATH 031	Honors Calculus I	4
MATH 051	Survey of Calculus I	4
MATH 081	Calculus with Business Applications	4

#### Group 2

MATH 022	Calculus II	4
MATH 032	Honors Calculus II	4
MATH 052	Survey of Calculus II	3

#### Group 3

MATH 023	Calculus III	4
MATH 033	Honors Calculus III	4

If two courses in the same group are taken, credit will be awarded for the more advanced course; 3x is the most advanced, while 5x is the least advanced.

**Professors.** Huai-Dong Cao, PhD (Princeton University); Donald M Davis, PhD (Stanford University); Bennett Eisenberg, MA (Massachusetts Institute of Technology); Wei-Min Huang, PhD (University of Rochester); Garth Timothy Isaak, PhD (Rutgers University); David L. Johnson, PhD (Massachusetts Institute of Technology); Terrence J. Napier, PhD (University of Chicago); Eric P. Salathe, PhD (Brown University); Lee J. Stanley, PhD (University of California Berkeley); Steven H. Weintraub, PhD (Princeton University); Joseph E. Yukich, PhD (Massachusetts Institute of Technology)

**Associate Professors.** Vladimir T. Dobric, PhD (University of Zagreb); Bruce A. Dodson, PhD (SUNY College Stony Brook); Mark Skandera, PhD (Massachusetts Institute of Technology); Xiaofeng Sun, PhD (Stanford University); Susan Szczepanski, PhD (Rutgers University New Brunswick); Ramamirtham Venkataraman, PhD (Brown University); Ping-Shi Wu, PhD (University of California Davis); Linghai Zhang, PhD (University of Minnesota Minneapolis)

**Assistant Professors.** Soutir Bandyopadhyay, PhD (Texas A&M University); Daniel Conus, PhD (Swiss Federal Institute of Technology); Robert W. Neel, PhD (Harvard University)

**Lecturer.** Vincent E Coll, PhD (University of Pennsylvania)

**Emeriti.** Samir A. Khabbaz, PhD (University of Kansas); Jerry P. King, PhD (University of Kentucky Fort Knox); Clifford S. Queen, PhD (Ohio State University); Murray Schechter, PhD (New York University); Andrew K Snyder, PhD (Lehigh University); Albert Wilansky, PhD (Brown University)

#### Undergraduate Degree Programs

The Department of Mathematics offers degree programs in Mathematics and Statistics. These programs have the flexibility and versatility needed to prepare students for a wide variety of careers in government, industry, research and education.

Students in the degree programs in mathematics must satisfy three types of requirements beyond those required by the college: Core Mathematics Requirements, Major Requirements and General Electives. The Core Mathematics Requirement ensures a common core of knowledge appropriate for students in each program. The Major Program Electives consist of courses with specific mathematical or statistical content chosen by the student in consultation with the major advisor to complement the student's interest and career aspirations. With these further breadth and greater depth of knowledge are achieved. The General Electives consist of additional courses chosen from among

those offered by the university faculty. Students can use these electives to pursue interests beyond the major, or may use these to expand upon the basic requirements of the degree program. Students are strongly encouraged to use some of these electives to earn a minor in another discipline.

Students in the degree program in statistics must satisfy four types of requirements beyond those required by the college: Required Major Courses, Major Electives, Professional Electives and Free Electives.

Each student is provided a faculty advisor to guide an individual program and supervise the selection of electives.

#### B.A. with a major in Mathematics

The B.A. program in mathematics emphasizes fundamental principles as well as the mastery of techniques required for the effective use of mathematics. The program provides a solid foundation for those who want to pursue a mathematically oriented career or advanced study in any mathematically oriented field.

#### Requirements

##### College Distribution Requirements excluding mathematics

31-34 credits 31-34

##### Core Mathematics Requirements

Select one of the following: 12

MATH 021 & MATH 022 & MATH 023	Calculus I and Calculus II and Calculus III	
MATH 031 & MATH 032 & MATH 033	Honors Calculus I and Honors Calculus II and Honors Calculus III	
MATH 163	Introductory Seminar	3
MATH 012 or MATH 231	Basic Statistics Probability and Statistics	4
MATH 242	Linear Algebra	3-4
MATH 205 or MATH 320	Linear Methods Ordinary Differential Equations	3
MATH 301	Principles of Analysis I	3-4
MATH 208 or MATH 316	Complex Variables Complex Analysis	3

##### Major Requirements

MATH 243 Algebra 3-4  
Select at least 6 credits in electives at or above the 200-level 6  
chosen in consultation with the major advisor. At most one course may be taken outside the department

##### General Electives

Select electives in consultation with faculty advisor 41-47  
Total Credits 112-124

This program requires a total of 120 credit hours.

A student must achieve an average of 2.0 or higher in major courses.

#### B.S. in Mathematics

The BS in Mathematics program provides a more extensive and intensive study of mathematics and its applications. Students can pursue the General Mathematics Option or the Applied Mathematics Option. These programs are especially recommended for students intending to pursue advanced study in mathematics or applied mathematics. The General Mathematics Option is recommended for students who wish to pursue mathematics either by itself or in combination with a related field (e.g., physics, computer science or economics). The Applied Mathematics Option provides a broad background in the major areas of applicable mathematics.

##### General Mathematics Option

##### Requirements

##### College Distribution Requirements excluding mathematics

31-34 credits 31-34

##### Core Mathematics Requirements

Select one of the following: 12

MATH 021 & MATH 022 & MATH 023	Calculus I and Calculus II and Calculus III	
MATH 031 & MATH 032 & MATH 033	Honors Calculus I and Honors Calculus II and Honors Calculus III	
MATH 163	Introductory Seminar	3
MATH 231 or MATH 309	Probability and Statistics Theory of Probability	3
MATH 242	Linear Algebra	3-4
MATH 205 or MATH 320	Linear Methods Ordinary Differential Equations	3
MATH 301	Principles of Analysis I	3-4
MATH 208 or MATH 316	Complex Variables Complex Analysis	3

**Major Requirements**

MATH 243	Algebra	3-4
Select four elective courses (at least 14 credits) at or above the 200 level. At most two courses may be taken outside the department		14
ENGR 010	Applied Engineering Computer Methods	2

One or two approved CSE courses 3-4

**General Electives**

Select electives in consultation with faculty advisor		27-33
Total Credits		110-123

This program requires a total of 120 credit hours.

A student must achieve an average of 2.0 or higher in major courses.

**Applied Mathematics Option Requirements****College Distribution Requirements excluding mathematics**

31-34 credits

**Core Mathematics Requirements**

Select one of the following:

MATH 021 & MATH 022 & MATH 023	Calculus I and Calculus II and Calculus III	
MATH 031 & MATH 032 & MATH 033	Honors Calculus I and Honors Calculus II and Honors Calculus III	
MATH 163	Introductory Seminar	3
MATH 231 or MATH 309	Probability and Statistics Theory of Probability	3
MATH 242	Linear Algebra	3-4
MATH 205 or MATH 320	Linear Methods Ordinary Differential Equations	3
MATH 301	Principles of Analysis I	3-4
MATH 208 or MATH 316	Complex Variables Complex Analysis	3

**Major Requirements**

Select five elective courses (at least 17 credits) at or above the 200 level chosen in consultation with the major advisor to establish a concentration as described below. At most two courses may be taken outside the department. 17

ENGR 010	Applied Engineering Computer Methods	2
One or two approved CSE courses		3-4

**General Electives**

Select electives in consultation with faculty advisor		28-33
Total Credits		68-76

In consultation with the major advisor, a student must establish a concentration in a particular area of applied mathematics. The courses

chosen must have specific mathematical or statistical content and together constitute a coherent program. At most two courses may be taken outside the Department of Mathematics. Students, in consultation with the major advisor, can design a concentration which reflects a particular area of interest or choose to pursue one of the following:

**Concentration in Applied Analysis**

Electives must include:

MATH 230	Numerical Methods	3
MATH 322	Methods of Applied Analysis I	3
MATH 341	Mathematical Models and Their Formulation	3

Total Credits 9

**Concentration in Discrete Mathematics and Theoretical Computer Science**

Electives must include:

Select at least three of the following:		9-10
MATH 305	Enumerative Combinatorics	
MATH 311	Graph Theory	
MATH 329	Computability Theory	
MATH 340	Design and Analysis of Algorithms	

Total Credits 9-10

**Concentration in Probability and Statistics**

Electives must include:

Select at least three of the following:		9-11
MATH 309	Theory of Probability	
MATH 310	Random Processes and Applications	
MATH 312	Statistical Computing and Applications	
MATH 334	Mathematical Statistics	
MATH 338	Linear Models in Statistics with Applications	

Total Credits 9-11

This program requires a total of 120 credit hours.

A student must achieve an average of 2.0 or higher in major courses.

**B.S. in Statistics**

Statistics provides a body of principles for designing the process of data collection, for summarizing and interpreting data, and for drawing valid conclusions from data. It thus forms a fundamental tool in the natural and social sciences as well as business, medicine, and other areas of research. Mathematical principles, especially probability theory, underlie all statistical analyses.

**College Distribution Requirements excluding mathematics**

31-34 credits 31-34

**Required Major courses**

Select one of the following: 12

MATH 021 & MATH 022 & MATH 023	Calculus I and Calculus II and Calculus III	
MATH 031 & MATH 032 & MATH 033	Honors Calculus I and Honors Calculus II and Honors Calculus III	

MATH 012 or MATH 231	Basic Statistics Probability and Statistics	4
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Select one of the following: 3-4

MATH 043	Survey of Linear Algebra	
MATH 205	Linear Methods	
MATH 242	Linear Algebra	
MATH 309	Theory of Probability	3
MATH 310	Random Processes and Applications	3-4
MATH 312	Statistical Computing and Applications	3-4
MATH 334	Mathematical Statistics	3-4

MATH 338	Linear Models in Statistics with Applications	3-4
MATH 374	Statistical Project	3
ENGR 010	Applied Engineering Computer Methods	2
Two approved computing science courses or one approved computer science course		3-4
<b>Major Electives</b>		
At least three courses with specific mathematical or statistical content chosen with the approval of the faculty advisor		12
<b>Professional Electives</b>		
Courses selected from two or three fields of application of statistics and probability		21
<b>Free Electives</b>		
Select 6-11 credits in free electives		6-11
<b>Total Credits</b>		112-126

**Departmental Honors**

Students may earn departmental honors by writing a thesis during their senior year. Students are accepted into the program during their junior year by the department chairperson. This acceptance is based upon the student's grades and a thesis proposal, which the student must prepare in conjunction with a thesis advisor selected by the student. An oral presentation as well as a written thesis are required for completion of the program.

**Minor Programs**

The department offers minor programs in different branches of the mathematical sciences. The requirement consists of MATH 023 or MATH 033 and four additional courses shown below for each of the programs. At most one of these five courses in the minor program may also be required in the major program. For substitutions, the student should consult the chairperson.

**Minor in Pure Mathematics**

MATH 242	Linear Algebra	3-4
MATH 243	Algebra	3-4
MATH 301	Principles of Analysis I	3-4
Select one of the following:		3-4
MATH 302	Principles of Analysis II	
MATH 303	Mathematical Logic	
MATH 307	General Topology I	
MATH 316	Complex Analysis	
MATH 342	Number Theory	
<b>Total Credits</b>		12-16

**Minor in Applied Mathematics**

Select three of the following:		9-10
MATH 205	Linear Methods	
MATH 208	Complex Variables	
MATH 230	Numerical Methods	
MATH 231	Probability and Statistics	
MATH 242	Linear Algebra	
MATH 320	Ordinary Differential Equations	
MATH 322	Methods of Applied Analysis I	
MATH 323	Methods of Applied Analysis II	
MATH 341	Mathematical Models and Their Formulation	3
<b>Total Credits</b>		12-13

**Minor in Probability and Statistics**

MATH 012	Basic Statistics	4
or MATH 231	Probability and Statistics	
MATH 309	Theory of Probability	3
Select two of the following:		6-8
MATH 310	Random Processes and Applications	
MATH 312	Statistical Computing and Applications	

MATH 334	Mathematical Statistics	
MATH 338	Linear Models in Statistics with Applications	
<b>Total Credits</b>		13-15
<b>Minor in Actuarial Science</b>		
MATH 309	Theory of Probability	3
MATH 310	Random Processes and Applications	3-4
MATH 202	Actuarial Exam I	1
or MATH 203	Actuarial Exam II - Financial Mathematics	
ECO 029	Money, Banking, and Financial Markets	3
ACCT 108	Fundamentals of Accounting	3
or ACCT 151	Introduction to Financial Accounting	
<b>Total Credits</b>		13-14

For information on examinations of actuarial societies, students may consult their minor advisor.

**Graduate Programs in Mathematics**

The department offers graduate programs leading to the degrees of master of science in mathematics, applied mathematics, or statistics, and the doctor of philosophy in mathematics or applied mathematics.

The Department does not offer a doctorate in statistics. However, students may choose statistics or mathematical statistics as a concentration in the doctor of philosophy programs in mathematics and applied mathematics. The Department is a part of the interdisciplinary program in Analytical Finance. For details on the Master of Science in Analytical Finance see the Interdisciplinary Graduate Study and Research, Analytical Finance section.

To begin graduate work in mathematics a student must present evidence of adequate undergraduate preparation. The undergraduate program should have included a year of advanced calculus, a semester of linear algebra, and a semester of abstract algebra.

**M.S. in Mathematics or Applied Mathematics**

The master's program requires 30 credit hours of graduate courses with at least 18 hours at the 400 level. With the permission of the chairperson, up to six hours of these courses can be replaced by a thesis. All students in the master's program must also pass a comprehensive examination. The M.S. degree can serve both as a final degree in mathematics or as an appropriate background for the Ph.D. degree.

**M.S. in Statistics**

This program requires 30 credit hours of graduate courses with at least 18 hours of 400-level STAT or MATH courses. The choice of courses must be approved by the graduate advisor, and up to six hours of coursework may be replaced with a thesis. All students in the program must also pass a comprehensive examination.

The M.S. program in statistics has two tracks:

**statistics track**

The statistics track has recommended courses:

MATH 309	Theory of Probability	3
STAT 412	Statistical Computing and Applications	3
STAT 434	Mathematical Statistics	3
MATH 462	Modern Nonparametric Methods in Statistics	3

**Electives**

STAT 410	Random Processes and Applications	3
STAT 438	Linear Models In Statistics with Applications	3
STAT 461	Topics In Mathematical Statistics	3
Select three other possible electives:		9
STAT 408	Seminar in Statistics and Probability	
STAT 409	Seminar in Statistics and Probability	
EDUC 411	Multivariate Statistical Models	

IE 332	Product Quality	
IE 409	Time Series Analysis	
IE 410	Design of Experiments	
ECO 460	Time Series Analysis	
ECO 463	Topics in Game Theory	
CSE 411	Advanced Programming Techniques	
MECH 445	Nondeterministic Models in Engineering	

Total Credits		30
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#### stochastic modeling track

MATH 309	Theory of Probability	3
MATH 401	Real Analysis I	3
STAT 410	Random Processes and Applications	3
STAT 463	Advanced Probability	3

#### Electives

MATH 341	Mathematical Models and Their Formulation	3
STAT 434	Mathematical Statistics	3
STAT 438	Linear Models In Statistics with Applications	3
STAT 464	Advanced Stochastic Processes	3

Select two other possible electives:		6
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STAT 408	Seminar in Statistics and Probability	
STAT 409	Seminar in Statistics and Probability	
MATH 402	Real Analysis II	
MATH 430	Numerical Analysis	
MATH 467	Financial Calculus I	
MATH 468	Financial Calculus II	
ECO 463	Topics in Game Theory	
CSE 411	Advanced Programming Techniques	
MECH 445	Nondeterministic Models in Engineering	
IE 316	Optimization Models and Applications	
IE 339	Stochastic Models and Applications	
IE 409	Time Series Analysis	
IE 416	Dynamic Programming	
IE 439	Queueing Systems	

Total Credits		30
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#### Ph.D. in Mathematics

The plan of work toward the doctor of philosophy degree will include a comprehensive examination, a qualifying examination, and an advanced topic examination. A language exam may be required at the discretion of the thesis committee. The qualifying examination tests the student's command of algebra and real analysis. The content of the advanced topic examination is determined by a department committee. A general examination, the doctoral dissertation and its defense complete the work for the Ph.D. degree.

Each candidate's plan of work must be approved by a special committee of the department. A Ph.D. student is required to have 18 credits of approved graduate level course work beyond the master's level. After completion of 18 credits a student is required to take at least one course per academic year other than MATH 409, MATH 410, and MATH 499.

#### Ph.D. in Applied Mathematics

The plan of work toward the doctor of philosophy degree will include a comprehensive examination, a qualifying examination, and an advanced topic examination. A language examination may be required at the discretion of the thesis committee. The *Ph.D. in Applied Mathematics* qualifying examination tests the student's command of *Statistics and Applied Probability* or of *Real Analysis and Differential Equations*. The content of the advanced topic examination is determined by a department committee. A general examination, the doctoral dissertation and its defense complete the work for the Ph.D. degree.

Each candidate's plan of work must be approved by a special committee of the department. A Ph.D. student is required to have 18 credits of approved graduate level course work beyond the master's level. After completion of 18 credits a student is required to take at least one course per academic year other than MATH 409, MATH 410, and MATH 499.

#### Mathematics Courses

##### MATH 000 Preparation for Calculus 2 Credits

Intensive review of fundamental concepts in mathematics utilized in calculus, including functions and graphs, exponentials and logarithms, and trigonometry. This course is for students who need to take MATH 51 or 21, but who require remediation in precalculus. In particular, students who fail the MATH 51 Readiness Exam must pass MATH 0 before being admitted to MATH 51. The credits for this course do not count toward graduation, but do count toward GPA and current credit count. Consent of department required.

**Attribute/Distribution:** MA

##### MATH 005 Introduction to Mathematical Thought 3 Credits

Meaning, content, and methods of mathematical thought illustrated by topics that may be chosen from number theory, abstract algebra, combinatorics, finite or nonEuclidean geometries, game theory, mathematical logic, set theory, topology.

**Attribute/Distribution:** MA

##### MATH 009 Introduction to Finite Mathematics 4 Credits

Systems of linear equations, matrices, introduction to linear programming. Sets, counting methods, probability, random variables, introduction to Markov chains.

**Attribute/Distribution:** MA

##### MATH 012 Basic Statistics 4 Credits

A first course in the basic concepts and methods of statistics with illustrations from the social, behavioral, and biological sciences. Descriptive statistics; frequency distributions, mean and standard deviation, two-way tables, correlation and regression; random sampling, rules of probability, probability distributions and parameters, parameter estimation, confidence intervals, hypothesis testing, statistical significance. Note: Mathematics and Statistics majors may not receive credit for both MATH 012 & ECO 045.

**Attribute/Distribution:** MA

##### MATH 021 Calculus I 4 Credits

Functions and graphs; limits and continuity; derivative, differential, and applications; indefinite and definite integrals; trigonometric, logarithmic, exponential, and hyperbolic functions.

**Attribute/Distribution:** MA

##### MATH 022 Calculus II 4 Credits

Applications of integration; techniques of integration; separable differential equations; infinite sequences and series; Taylor's Theorem and other approximations; curves and vectors in the plane. Prerequisites as noted below.

**Prerequisites:** MATH 021 or MATH 076 or MATH 031 or MATH 097

**Attribute/Distribution:** MA

##### MATH 023 Calculus III 4 Credits

Vectors in space; partial derivatives; Lagrange multipliers; multiple integrals; vector analysis; line integrals; Green's Theorem, Gauss's Theorem. Prerequisites as noted below.

**Prerequisites:** MATH 022 or MATH 032

**Attribute/Distribution:** MA

##### MATH 031 Honors Calculus I 4 Credits

Same topics as in MATH 021, but taught from a more thorough and rigorous point of view.

**Attribute/Distribution:** MA

##### MATH 032 Honors Calculus II 4 Credits

Same topics as in MATH 022, but taught from a more thorough and rigorous point of view. Prerequisites as noted below.

**Prerequisites:** (MATH 031)

**Attribute/Distribution:** MA

##### MATH 033 Honors Calculus III 4 Credits

Same topics as in MATH 023, but taught from a more thorough and rigorous point of view.

**Attribute/Distribution:** MA

**MATH 043 Survey of Linear Algebra 3 Credits**

Matrices, vectors, vector spaces and mathematical systems, special kinds of matrices, elementary matrix transformations, systems of linear equations, convex sets, introduction to linear programming.

**Attribute/Distribution:** MA

**MATH 051 Survey of Calculus I 4 Credits**

Limits. The derivative and applications to extrema, approximation, and related rates. Exponential and logarithm functions, growth and decay. Integration. Trigonometric functions and related derivatives and integrals.

**Attribute/Distribution:** MA

**MATH 052 Survey of Calculus II 3 Credits**

Techniques of integration. Differential equations. Probability and calculus. Partial derivatives and extrema. Multiple integrals and applications. Prerequisites as noted below.

**Prerequisites:** MATH 051 or MATH 021 or MATH 031 or MATH 076 or MATH 097 or MATH 081

**Attribute/Distribution:** MA

**MATH 075 Calculus I, Part A 2 Credits**

Covers the same material as the first half of MATH 021. Meets three hours per week, allowing more class time for each topic than does MATH 021.

**Attribute/Distribution:** MA

**MATH 076 Calculus I, Part B 2 Credits**

Continuation of MATH 075, covering the second half of MATH 021. Meets three hours per week. Final exam for this course is similar to the MATH 021 final. Prerequisites as noted below.

**Prerequisites:** MATH 075

**Attribute/Distribution:** MA

**MATH 081 Calculus with Business Applications 4 Credits**

Limits and continuity; exponential, logarithmic and trigonometric functions; derivatives; extrema; approximations; indefinite and definite integrals. Applications with emphasis on business and economics.

**Attribute/Distribution:** MA

**MATH 130 Biostatistics 4 Credits**

Elements of statistics and probability with emphasis on biological applications. Statistical analysis of experimental and observational data. Prerequisites as noted below.

**Prerequisites:** MATH 052 or MATH 022

**MATH 163 Introductory Seminar 3 Credits**

An introduction to the discipline of mathematics designed for students considering a major in mathematics. The course will provide an introduction to rigorous mathematical reasoning and will survey some area of mathematics. Topics covered will vary.

**Attribute/Distribution:** MA

**MATH 171 Readings 1-3 Credit**

Study of a topic in mathematics under individual supervision. Intended for students with specific interests in areas not covered in the listed courses. Consent of department chair required.

**Attribute/Distribution:** MA

**MATH 201 Problem Solving 1 Credit**

Practice in solving problems from mathematical contests using a variety of techniques. Permission of instructor required.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** MA

**MATH 202 Actuarial Exam I 1 Credit**

Preparation for the first actuarial exam – probability. Problems in calculus and probability with insurance applications. Prerequisites as noted below.

**Prerequisites:** (MATH 023 or MATH 033) and (MATH 231)

**Attribute/Distribution:** MA

**MATH 203 Actuarial Exam II - Financial Mathematics 1 Credit**

Preparation for the second actuarial exam - financial mathematics. Mathematics of interest and investments, interest rate measurement, present value, annuities, loan repayment schemes, bond valuation. Practice in solving problems from past exams. Prerequisites as noted below.

**Prerequisites:** MATH 022

**Attribute/Distribution:** MA

**MATH 205 Linear Methods 3 Credits**

Linear differential equations and applications; matrices and systems of linear equations; vector spaces; eigenvalues and application to linear systems of differential equations. Prerequisites as noted below.

**Prerequisites:** MATH 022 or MATH 032

**Attribute/Distribution:** MA

**MATH 208 Complex Variables 3 Credits**

Functions of a complex variable; calculus of residues; contour integration; applications to conformal mapping and Laplace transforms. Prerequisites as noted below.

**Prerequisites:** MATH 023 or MATH 033

**Attribute/Distribution:** MA

**MATH 214 Topics in Philosophical Logic 4 Credits**

Topics may include the many systems of non-classical logic, truth theory, the impact of incompleteness and undecidability results on philosophy, the foundational projects of various philosopher/mathematicians, or the work of an important figure in the history of philosophical logic. Permission of instructor required.

**Attribute/Distribution:** MA

**MATH 229 Geometry 3,4 Credits**

Discussion of geometry as an axiomatic system. Euclid's postulates. History of and equivalent versions of Euclid's fifth postulate. Finite projective geometries. NonEuclidean geometries based upon negation of the fifth postulate: Geometry on the sphere; Hyperbolic and elliptic geometries. Examination of the concepts of "straight", angle, parallel, symmetry and duality in each of these geometries. Applications of the different geometries will be considered.

**Attribute/Distribution:** MA

**MATH 230 Numerical Methods 3 Credits**

Representation of numbers and rounding error; numerical solution of equations; quadrature; polynomial and spline interpolation; numerical solution of initial and boundary value problems. Knowledge of either FORTRAN or PASCAL required. Prerequisites as noted below.

**Prerequisites:** (MATH 205)

**Can be taken Concurrently:** MATH 205

**Attribute/Distribution:** MA

**MATH 231 Probability and Statistics 3 Credits**

Probability and distribution of random variables; populations and random sampling; chi-square and t distributions; estimation and tests of hypotheses; correlation and regression theory of two variables. Prerequisites as noted below.

**Prerequisites:** MATH 022 or MATH 032 or MATH 052

**Attribute/Distribution:** MA

**MATH 234 Fractal Geometry 3 Credits**

Metric spaces and iterated function systems; various types of fractal dimension; Julia and Mandelbrot sets. Other topics such as chaos may be included. Small amount of computer use. Prerequisites as noted below.

**Prerequisites:** MATH 023 or MATH 033

**Attribute/Distribution:** MA

**MATH 242 Linear Algebra 3-4 Credits**

Solution of systems of linear equations, matrices, vector spaces, bases, linear transformations, eigenvalues, eigenvectors, additional topics as time permits. Prerequisites as noted below or consent of instructor.

**Prerequisites:** MATH 022 or MATH 032

**Attribute/Distribution:** MA

**MATH 243 Algebra 3,4 Credits**

Introduction to basic concepts of modern algebra: groups, rings, and fields. Prerequisites as noted below.

**Prerequisites:** (MATH 163 or MATH 261) and (MATH 242 or MATH 205)

**Attribute/Distribution:** MA

**MATH 261 Discrete Structures 3 Credits**

Topics in discrete mathematical structures chosen for their applicability to computer science and engineering. Sets, propositions, induction, recursion; combinatorics; binary relations and functions; ordering, lattices and Boolean algebra; graphs and trees; groups and homomorphisms. Prerequisites as noted below.

**Prerequisites:** (MATH 021 or MATH 031 or MATH 076)

**Attribute/Distribution:** MA

**MATH 271 Readings 1-3 Credit**

Study of a topic in mathematics under individual supervision. Intended for students with specific interests in areas not covered in the listed courses. Consent of department chair required. May be repeated for credit.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** MA

**MATH 291 Undergraduate Research 1-4 Credit**

Research in mathematics or statistics under the direction of a faculty member. Department permission required. May be repeated for credit.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** ND

**MATH 301 Principles of Analysis I 3-4 Credits**

Existence of limits, continuity and uniform continuity; HeineBorel Theorem; existence of extreme values; mean value theorem and applications; conditions for the existence of the Riemann integral; absolute and uniform convergence; emphasis on theoretical material from the calculus of one variable. Prerequisites as noted below.

**Prerequisites:** MATH 023 or MATH 033

**Attribute/Distribution:** MA

**MATH 302 Principles of Analysis II 3-4 Credits**

Continuation of MATH 301. Functions of several variables; the implicit function theorem, and further topics with applications to analysis and geometry. Prerequisites as noted below.

**Prerequisites:** MATH 301

**Attribute/Distribution:** MA

**MATH 303 Mathematical Logic 3-4 Credits**

Detailed proofs are given for the basic mathematical results relating the syntax and semantics of firstorder logic (predicate logic): the Soundness and Completeness (and Compactness) Theorems, followed by a brief exposition of the celebrated limitative results of Gödel, Turing, and Church on incompleteness and undecidability. The material is conceptually rigorous and mathematically mature; the necessary background is a certain degree of mathematical sophistication or a basic knowledge of symbolic logic. Consent of instructor required.

**Attribute/Distribution:** MA

**MATH 304 Axiomatic Set Theory 3-4 Credits**

A development of set theory from axioms; relations and functions; ordinal and cardinal arithmetic; recursion theorem; axiom of choice; independence questions. Consent of instructor required.

**Attribute/Distribution:** MA

**MATH 305 Enumerative Combinatorics 3 Credits**

An introduction to basic theoretical results and techniques of enumerative combinatorics such as combinatorial identities, generating functions, inclusion/exclusion, recurrence relations, bijective proofs and permutations. Additional topics will be covered as time permits. Prerequisites as noted below or consent of instructor.

**Prerequisites:** MATH 242 and (MATH 163 or MATH 261 or CSE 261)

**Attribute/Distribution:** MA

**MATH 306 Introduction to Biomedical Engineering and Mathematical Biology 3 Credits**

Study of human physiology, including the cardiovascular, nervous and respiratory systems, and renal physiology. Mathematical analysis of physiological processes, including transport phenomena. Mathematical models of excitation and propagation in nerve. Biomechanics of the skeletal muscle system. Mathematical models in population dynamics and epidemiology. Independent study projects.

**Attribute/Distribution:** MA

**MATH 307 General Topology I 3-4 Credits**

An introductory study of topological spaces, including metric spaces, separation and countability axioms, connectedness, compactness, product spaces, quotient spaces, function spaces. Prerequisites as noted below.

**Prerequisites:** MATH 301

**Attribute/Distribution:** MA

**MATH 309 Theory of Probability 3 Credits**

Probabilities of events on discrete and continuous sample spaces; random variables and probability distributions; expectations; transformations; simplest kind of law of large numbers and central limit theorem. The theory is applied to problems in physical and biological sciences. Prerequisites as noted below.

**Prerequisites:** MATH 023 or MATH 033 or MATH 052

**Attribute/Distribution:** MA

**MATH 310 Random Processes and Applications 3-4 Credits**

Theory and applications of stochastic processes. Limit theorems, introduction to random walks, Markov chains, Poisson processes, birth and death processes, and Brownian motion. Applications to financial mathematics, biology, business and engineering. Prerequisites as noted below.

**Prerequisites:** MATH 309 or MATH 231

**Attribute/Distribution:** MA

**MATH 311 Graph Theory 3 Credits**

An introduction to basic theoretical results and techniques of graph theory such as trees, connectivity, matchings, coloring, planar graphs and Hamiltonicity. Additional topics will be covered as time permits. Prerequisites as noted below or consent of instructor.

**Prerequisites:** MATH 163 or MATH 261

**Attribute/Distribution:** MA

**MATH 312 Statistical Computing and Applications 3-4 Credits**

Use of statistical computing packages; exploratory data analysis; Monte Carlo methods; randomization and resampling, application and interpretation of a variety of statistical methods in real world problems. Prerequisites as noted below.

**Prerequisites:** MATH 012 or MATH 231

**Attribute/Distribution:** MA

**MATH 316 Complex Analysis 3-4 Credits**

Concept of analytic function from the points of view of the CauchyRiemann equations, power series, complex integration, and conformal mapping. Prerequisites as noted below.

**Prerequisites:** MATH 301

**Attribute/Distribution:** MA

**MATH 320 Ordinary Differential Equations 3-4 Credits**

The analytical and geometric theory of ordinary differential equations, including such topics as linear systems, systems in the complex plane, oscillation theory, stability theory, geometric theory of nonlinear systems, finite difference methods, general dynamical systems. Prerequisites as noted below.

**Prerequisites:** MATH 205 or (MATH 023 or MATH 033) and (MATH 242)

**Attribute/Distribution:** MA

**MATH 321 Topics in Discrete Mathematics 3 Credits**

Selected topics in areas of discrete mathematics. May be repeated for credit. Consent of department chair required.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** MA



**MATH 322 Methods of Applied Analysis I 3 Credits**

Fourier series, eigenfunction expansions, Sturm-Liouville problems, Fourier integrals and their application to partial differential equations; special functions. Emphasis is on a wide variety of formal applications rather than logical development. Prerequisites as noted below or consent of instructor.

**Prerequisites:** MATH 205

**Attribute/Distribution:** MA

**MATH 323 Methods of Applied Analysis II 3 Credits**

Green's functions; integral equations; variational methods; asymptotic expansions, method of saddle points; calculus of vector fields, exterior differential calculus. Prerequisites as noted below.

**Prerequisites:** MATH 322

**Attribute/Distribution:** MA

**MATH 327 Groups and Rings 3,4 Credits**

An intensive study of the concepts of group theory including the Sylow theorems, and of ring theory including unique factorization domains and polynomial rings. Prerequisites as noted below or consent of instructor.

**Prerequisites:** MATH 242 and MATH 243

**Attribute/Distribution:** MA

**MATH 329 Computability Theory 3-4 Credits**

Core development of classical computability theory: enumeration, index and recursion theorems, various models of computation and Church's Thesis, uncomputability results, introduction to reducibilities and their degrees (in particular, Turing degrees, or degrees of uncomputability), computable operators and their fixed points.

**Attribute/Distribution:** MA

**MATH 331 Differential Geometry of Curves and Surfaces 3 Credits**

Local and global differential geometry of curves and surfaces in Euclidean 3-space. Frenet formulas for curves, isoperimetric inequality, 4-vertex theorem; regular surfaces, first fundamental form, Gauss map, second fundamental form; curvatures for curves and surfaces and their relations; The Gauss-Bonnet theorem.

**MATH 334 Mathematical Statistics 3,4 Credits**

Populations and random sampling; sampling distributions; theory of statistical estimation; criteria and methods of point and interval estimation; theory of testing statistical hypotheses. Prerequisites as noted below.

**Prerequisites:** MATH 309

**Attribute/Distribution:** MA

**MATH 338 Linear Models in Statistics with Applications 3,4 Credits**

Least square principles in multiple regression and their interpretations; estimation, hypotheses testing, confidence and prediction intervals, modeling, regression diagnostic, multicollinearity, model selection, analysis of variance and covariance; logistic regression. Introduction to topics in time series analysis such as ARMA, ARCH, and GARCH models. Applications to natural sciences, finance and economics. Use of computer packages. Prerequisites as noted below.

**Prerequisites:** (MATH 012 or MATH 231) and (MATH 043 or MATH 205 or MATH 242)

**Attribute/Distribution:** MA

**MATH 340 Design and Analysis of Algorithms 3 Credits**

Algorithms for searching, sorting, manipulating graphs and trees, finding shortest paths and minimum spanning trees, scheduling tasks, etc.: proofs of their correctness and analysis of their asymptotic runtime and memory demands. Designing algorithms: recursion, divide-and-conquer, greediness, dynamic programming. Limits on algorithm efficiency using elementary NP-completeness theory. Credit will not be given for both MATH 340 (CSE 340) and MATH 441 (CSE 441). Prerequisites as noted below.

**Prerequisites:** (MATH 022 or MATH 032) and (CSC 261 or MATH 261)

**Attribute/Distribution:** MA

**MATH 341 Mathematical Models and Their Formulation 3 Credits**

Mathematical modeling of engineering and physical systems with examples drawn from diverse disciplines. Emphasis is on building models of real world problems rather than learning mathematical techniques. Prerequisites as noted below.

**Prerequisites:** MATH 205

**Attribute/Distribution:** MA

**MATH 342 Number Theory 3-4 Credits**

Basic concepts and results in number theory, including such topics as primes, the Euclidean algorithm, Diophantine equations, congruences, quadratic residues, quadratic reciprocity, primitive roots, number-theoretic functions, distribution of primes, Pell's equation, Fermat's theorem, partitions. Consent of instructor required.

**Prerequisites:** MATH 301

**Attribute/Distribution:** MA

**MATH 343 Introduction To Cryptography 3,4 Credits**

Classical elementary cryptography: Caesar cipher, other substitution ciphers, block ciphers, general linear ciphers. Fast random encryption (DES and AES: Advanced Encryption Standard). Public key systems (RSA and discrete logs). Congruences, modular arithmetic, fast exponentiation, polynomials, matrices. Distinction between polynomial time (primality), Subexponential time (factoring) and fully Exponential computation (elliptic curves). Introduction to sieving and distributed computation. Consent of instructor required.

**MATH 350 Special Topics 3 Credits**

A course covering special topics not sufficiently covered in listed courses. Consent of department chair required. May be repeated for credit.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** MA

**MATH 371 Readings 1-3 Credit**

The study of a topic in mathematics under appropriate supervision, designed for the individual student who has studied extensively and whose interests lie in areas not covered in the listed courses. Consent of department chair required. May be repeated for credit.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** MA

**MATH 374 Statistical Project 3 Credits**

Supervised field project or independent reading in statistics or probability. Consent of department chair required.

**Attribute/Distribution:** MA

**MATH 391 Senior Honors Thesis 3 Credits**

Independent research under faculty supervision, culminating in a thesis presented for departmental honors. May be repeated once for credit. Consent of department chair required.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** MA

**MATH 401 Real Analysis I 3 Credits**

Set theory, real numbers; introduction to measures, Lebesgue measure; integration, general convergence theorems; differentiation, functions of bounded variation, absolute continuity;  $L_p$  spaces. Prerequisites as noted below or consent of instructor.

**Prerequisites:** MATH 301

**MATH 402 Real Analysis II 3 Credits**

Metric spaces; introduction to Banach and Hilbert space theory; Fourier series and Fejer operators; general measure and integration theory, Radon-Nikodym and Riesz representation and theorems; Lebesgue-Stieltjes integral. Prerequisites as noted below.

**Prerequisites:** MATH 307 or MATH 401

**MATH 403 Topics in Real Analysis 3 Credits**

Intensive study of topics in analysis with emphasis on recent developments. Requires permission of the department chair.

**Repeat Status:** Course may be repeated.

**MATH 404 Topics in Mathematical Logic 3 Credits**

Intensive study of topics in mathematical logic. Consent of instructor required. May be repeated for credit.

**Repeat Status:** Course may be repeated.

**MATH 405 Partial Differential Equations I 3 Credits**

Classification of partial differential equations; methods of characteristics for first order equations; methods for representing solutions of the potential, heat, and wave equations, and properties of the solutions of these equations; maximum principles. Prerequisites as noted below.

**Prerequisites:** MATH 301

**MATH 406 Partial Differential Equations II 3 Credits**

Continuation of MATH 405. Emphasis on second order equations with variable coefficients and systems of first order partial differential equations.

**MATH 408 Algebraic Topology I 3 Credits**

Polyhedra; fundamental groups; simplicial and singular homology.

**MATH 409 Mathematics Seminar 1-6 Credit**

An intensive study of some field of mathematics not offered in another course. Consent of department chair required.

**MATH 410 Mathematics Seminar 1-6 Credit**

Continuation of the field of study in MATH 409 or the intensive study of a different field. Consent of department required.

**MATH 416 Complex Function Theory 3 Credits**

Continuation of MATH 316.

**MATH 421 Introduction To Wavelets 3 Credits**

Continuous and discrete signals; review of Fourier analysis; discrete wavelets; time frequency spaces; Haar and Walsh systems; multiresolution analysis; Hilbert spaces; quadratic mirror filters; fast wavelet transforms; computer code; applications to filtering, compression, and imaging. Prerequisites as noted below or consent of instructor.

**Prerequisites:** ECE 108 or MATH 205

**MATH 423 Differential Geometry I 3 Credits**

Differential manifolds, tangent vectors and differentials, submanifolds and the implicit function theorem. Lie groups and Lie algebras, homogeneous spaces. Tensor and exterior algebras, tensor fields and differential forms, de Rham cohomology, Stokes' theorem, the Hodge theorem. Must have completed MATH 301, or MATH 243 or MATH 205 with permission of instructor.

**MATH 424 Differential Geometry II 3 Credits**

Curves and surfaces in Euclidean space; mean and Gaussian curvatures, covariant differentiation, parallelism, geodesics, Gauss-Bonnet formula. Riemannian metrics, connections, sectional curvature, generalized Gauss-Bonnet theorem. Further topics. Prerequisites as noted below.

**Prerequisites:** MATH 423

**MATH 428 Fields And Modules 3 Credits**

Field theory, including an introduction to Galois theory; the theory of modules, including tensor products and classical algebras. Prerequisites as noted below.

**Prerequisites:** MATH 327 or MATH 327

**MATH 430 Numerical Analysis 3 Credits**

Multistep methods for ordinary differential equations; finite difference methods for partial differential equations; numerical approximation of functions. Use of computer required.

**MATH 431 Calculus Of Variations 3 Credits**

Existence of a relative minimum for single and multiple integral problems; variational inequalities of elliptic and parabolic types and methods of approximating a solution.

**MATH 435 Functional Analysis I 3 Credits**

Banach spaces and linear operators; separation and extension theorems; open mapping and uniform boundedness principles; weak topologies; local convexity and duality; Banach algebras; spectral theory of operators; and compact operators.

**MATH 441 Advanced Algorithms 3 Credits**

This is a graduate-level version of CSE/MATH 340, Design and Analysis of Algorithms, covering that course's content, plus matroid theory, linear programming, max-flow, computational geometry, matching patterns in strings, randomized algorithms, and approximation algorithms for NP-complete problems. Credit will not be given for both MATH 340 (CSE 340) and MATH 441 (CSE 441).

**MATH 444 Algebraic Topology II 3 Credits**

Continuation of MATH 408. Cohomology theory, products, duality.

**MATH 445 Topics in Algebraic Topology 3 Credits**

Selected topics reflecting the interests of the professor and the students.

**MATH 449 Topics In Algebra 3 Credits**

Intensive study of topics in algebra with emphasis on recent developments. Consent of department chair required. May be repeated for credit with the consent of the department chair.

**Repeat Status:** Course may be repeated.

**MATH 450 Special Topics 3 Credits**

Intensive study of some field of the mathematical sciences not covered in listed courses. Consent of department chair required. May be repeated for credit with the consent of the department chair.

**Repeat Status:** Course may be repeated.

**MATH 455 Topics In Number Theory 3 Credits**

Selected topics in algebraic and/or analytic number theory. Consent of instructor required. May be repeated for credit with consent of the department chair.

**Repeat Status:** Course may be repeated.

**MATH 461 Topics In Mathematical Statistics 3 Credits**

An intensive study of one or more topics such as theory of statistical tests, statistical estimation, regression, analysis of variance, nonparametric methods, stochastic approximation, and decision theory. May be repeated for credit with consent of the department chair.

**Repeat Status:** Course may be repeated.

**MATH 462 Modern Nonparametric Methods in Statistics 3 Credits**

Classical and modern methods of nonparametric statistics; order and rank statistics; tests based on runs, signs, ranks, and order statistics; distribution free statistical procedures for means, variances, correlations, and trends; relative efficiency; Kolmogorov-Smirnov statistics; statistical applications of Brownian process; modern techniques such as robust methods, nonparametric smoothing, and bootstrapping; additional topics such as nonparametric regression and dimension reduction.

**MATH 463 Advanced Probability 3 Credits**

Measure theoretic foundations; random variables, integration in a measure space, expectations; convergence of random variables and probability measures; conditional expectations; characteristic functions; sums of random variables, limit theorems.

**MATH 464 Advanced Stochastic Process 3 Credits**

Theory of stochastic processes; stopping times; martingales; Markov processes; Brownian motion; stochastic calculus; Brownian bridge, laws of suprema; Gaussian processes.

**MATH 465 Topics in Probability 3 Credits**

Selected topics in probability. Consent of department chair required. May be repeated for credit with consent of the department chair.

**Repeat Status:** Course may be repeated.

**MATH 467 Financial Calculus I 3 Credits**

Basic mathematical concepts behind derivative pricing and portfolio management of derivative securities. Development of hedging and pricing by arbitrage in the discrete time setting of binary trees and Black-Scholes model. Introduction to the theory of Stochastic Calculus, Martingale representation theorem, and change of measure. Applications of the developed theory to a variety of actual financial instruments.

**MATH 468 Financial Calculus II 3 Credits**

Models and mathematical concepts behind the interest rates markets. Heath-Jarrow-Morton model for random evolution of the term structure of interest rates and short rate models. Applications of the theory to a variety of interest rates contracts including swaps, caps, floors, swaptions. Development of multidimensional stochastic calculus and applications to multiple stock models, quantos, and foreign currency interest rate models. Prerequisites as noted below.

**Prerequisites:** MATH 467

**MATH 470 Proseminar 3 Credits**

Preparation for entering the mathematics profession. Seminar will concentrate on methods of teaching mathematics, and will include other topics such as duties of a professor and searching for a job. Consent of department chair required.

**MATH 471 Homological Algebra 3 Credits**

Modules, tensor products, categories and functors, homology functors, projective and injective modules.

**MATH 472 Group Representations 3 Credits**

Linear representations and character theory with emphasis on the finite and compact cases.

**MATH 475 Topics in Geometry 3 Credits**

Selected topics in geometry, such as geometric analysis, algebraic geometry, complex geometry, characteristic classes, geometric flows or geometric measure theory, with emphasis on recent developments. Consent of department chair required. May be repeated for credit with consent of the department chair.

**Repeat Status:** Course may be repeated.

**MATH 485 Topics in Financial Mathematics 3 Credits**

Selected topics in financial mathematics. Consent of department chair required. May be repeated for credit with consent of the department chair.

**Repeat Status:** Course may be repeated.

**MATH 490 Thesis 1-6 Credit****MATH 499 Dissertation 1-15 Credit**

**Repeat Status:** Course may be repeated.

**Statistics Courses****STAT 408 Seminar in Statistics and Probability 1-6 Credit**

Intensive study of some field of statistics or probability not offered in another course. Consent of department required.

**STAT 409 Seminar in Statistics and Probability 1-6 Credit**

Intensive study of some field of statistics or probability not offered in another course. Consent of department required.

**STAT 410 Random Processes and Applications 3 Credits**

See MATH 310.

**STAT 412 Statistical Computing and Applications 3 Credits**

See MATH 312.

**STAT 434 Mathematical Statistics 3 Credits**

See MATH 334.

**STAT 438 Linear Models In Statistics with Applications 3 Credits**

See MATH 338.

**Prerequisites:** (MATH 012 or MATH 231) and (MATH 043 or MATH 205 or MATH 242)

**STAT 461 Topics In Mathematical Statistics 3 Credits**

See MATH 461.

**STAT 462 Nonparametric Statistics 3 Credits**

See MATH 462.

**STAT 463 Advanced Probability 3 Credits**

See MATH 463.

**STAT 464 Advanced Stochastic Processes 3 Credits**

See MATH 464.

**Modern Languages and Literatures**

Knowledge of other languages opens the door to other cultures, traditions, and perspectives on the world, and promotes deeper insight into one's own language and culture. Proficiency in modern languages is indispensable in a broad range of professions such as journalism, government, international affairs, law, the armed forces, and business. A bachelor of arts degree with a major in languages provides excellent preparation for professional careers in law, business, and the media. Language study is required for graduate study in many disciplines, as well as for research in science and technology. International experience is personally enriching and enhances career prospects.

**Languages offered**

Lehigh offers Arabic, Mandarin Chinese, French, German, Hebrew, Japanese, Russian, and Spanish. Courses include oral, reading, and writing skills, literature, film, culture, civilization, and professional areas such as business and health careers. A number of literature and culture courses are given in English, but most offerings stress classroom use of the target language. Facilities include an International Multimedia Resource Center (IMRC). Within the IMRC in Maginnes Hall is a state-of-the-art multimedia computer lab (Maginnes 470) dedicated primarily to modern languages.

**Language requirements**

The Global Studies major, the Joint IR/MLL major, as well as the honors major in international relations require language study. The college scholar program in the College of Arts and Sciences, the major in Asian Studies, the minors in Latin American Studies, and Asian Studies require language study. Students taking the B.A. in international relations are expected to study a language. Some doctoral programs also require competence in a language other than English, usually assessed by the Department of Modern Languages and Literatures.

**Advising**

Because of the sequential nature of language study and the variety of specializations available, the department pays special attention to student advising. Students whose experience, skills, and placement scores (Advanced Placement or College Board Achievement Test) do not give them a clear indication of their level of placement should consult with their instructor or the department chair. Faculty members responsible for more advanced advising are currently as follows: Chinese major, Cook; Chinese minor, Pankenier; French major, Chabut; French minor, Armstrong; German major and minor, Stegmann; Japanese minor, Lee; Russian minor, Nicholas; Spanish major, Prieto; Spanish minor, Lefkowitz.

**Professors.** Marie-Helene Chabut, PhD (University of California San Diego); Constance A. Cook, PhD (University of California Berkeley); David W. Pankenier, PhD (Stanford University)

**Associate Professors.** Marie-Sophie Armstrong, PhD (University of Oregon); Kiri Lee, PhD (Harvard University); Linda S. Lefkowitz, PhD (Princeton University); Mary A. Nicholas, PhD (University of Pennsylvania); Miren Edurne Portela, PhD (University of North Carolina); Antonio Prieto, PhD (Princeton University); Vera S. Stegmann, PhD (Indiana University)

**Assistant Professors.** Taieb Berrada, PhD (Northwestern University); Matthew R. Bush, PhD (University of Colorado Boulder)

**Lecturer.** Stephanie Katz, BA (Pomona College)

**Professors Of Practice.** Christine Kalleeny, PhD (Emory University); Limei Shan, MS (East China Normal University)

**Emeriti.** Anje C. Van Der Naald, PhD (University of Illinois Urbana); Lenora D. Wolfgang, PhD (University of Pennsylvania)

**Major Programs**

The department offers major programs in Chinese, French and Francophone Studies, German, Spanish and Hispanic Studies, and Joint IR/MLL. The candidate for the major is expected to demonstrate adequate written and oral command of the language, as well as knowledge of its literature and culture. A period of study abroad is strongly recommended.

Double majors and Arts-Engineering majors including a language component are well-received by employers. Studies in the two areas are carefully coordinated by major advisers.

**Major in Chinese**

The major in Chinese will require 36 credits: a minimum of 24 credits in courses taught in Chinese, plus 8 credits at the 200 or 300 level of Chinese language and literature (marked CHIN). Courses offered in English in MLL on Chinese literature and history may be included in the major and a maximum of two courses outside of MLL in the Asian Studies Program that are concerned specifically with China, such as those available in International Relations, Political Science, Religion, Sociology, etc., by approval of the major adviser.

**Major in German**

The major in German requires 32 credits in German language, literature, and culture beyond German 12. This includes all German courses that are 100 level and above, and emphasis should be on 200 and 300 level courses. One of these courses may be taken in English when the class is taught by a German faculty member and when the writing assignments are completed in German. For specific course requirements, see the language major adviser.

Majors in German are strongly encouraged to participate in a study abroad program in a German speaking country for the equivalent of one semester or more. Study abroad at approved programs may be incorporated into the German language major to a maximum of 16 credits. In order to have credits from foreign institutions count toward their major, students must obtain approval from the German language adviser prior to their departure.

*Requirements for the Honors Major in German (40 credits)*

Requirements are the same as for the regular major in German, plus 8 additional hours of advanced literature, to be completed as course work or with an honors thesis of a comprehensive format, and maintenance of a 3.20 average in the major.

**Major in French and Francophone Studies**

- Core courses: 16 credits including
  - French 143 Advanced Written French (4)
  - French 144 Advanced Oral French (4)
  - French 252 Introduction to Literary Analysis (4)
  - One of the following (3-4)
    - French 259 Contemporary France (4)
    - French 255 Introduction to the Francophone World (4)
    - French 133 Lehigh in Martinique: Globalization and Local Identity (3-4)
- Advanced course work: 16 credits, or four courses (200 or 300 level), with at least three courses at the 300 level. One of these courses may be taken in English when taught by a French faculty member.
- Collateral requisites:
  - 6-8 credits from a list of approved courses taken in other programs and departments.

These courses must be approved by the French major adviser.

Majors in French and Francophone Studies are strongly encouraged to participate in a study program in a French-speaking part of the world for the equivalent of one semester or more. Up to 12 credits for courses taken during one semester abroad (16 credits during one year) may count toward the major. In order to have credits from foreign institutions count toward their major, students must obtain approval from the French major adviser prior to their departure.

*Requirements for the Departmental Honors Major (40 credits):*

Requirements as for the major, plus 8 additional hour of advanced literature (honors thesis of a comprehensive type) and maintenance of a 3.20 average in the major.

**Major in Spanish and Hispanic Studies**

- Core courses: 12 credits
  - Span 141. Advanced Spanish Grammar (4 credits)
  - Span 151. The Cultural Evolution of Spain (4 credits)
  - Span 152. The Cultural Evolution of Latin America (4 credits)
- Advanced course work: 12 credits, or three courses at the 300 level.
- Electives: 8 credits at the 100 or 200 level.
- Collateral requisites
  - 6-8 credits from a list of approved courses taken in other programs and departments.

These courses must be approved by the Spanish major adviser.

Majors in Spanish and Hispanic Studies are strongly encouraged to participate in a study program in a Spanish-speaking country for the equivalent of one semester or more. Up to 12 credits for courses taken during one semester abroad (16 credits during one year) may count toward the major. In order to have credits from foreign institutions count toward their major, students must obtain approval from the Spanish major adviser prior to their departure.

*Requirements for the Departmental Honors Major (40 credits)*

Requirements as for the major, plus 8 additional hours of advanced literature (honors thesis of a comprehensive type) and maintenance of a 3.20 average in the major.

**Joint IR/MLL Major**

**Program directors.**

Chairs of IR Department and MLL Department.

The multidisciplinary Joint IR/MLL Major is offered jointly by the Department of International Relations (IR) and the Department of Modern Languages and Literatures (MLL). The program, which offers a Bachelor of Arts, incorporates courses from both IR and MLL, as well as electives from a broad cross-section of other departments, for a challenging program that requires overseas study, language facility, and undergraduate research.

The Joint IR/MLL Major recognizes that Lehigh graduates must be adequately prepared to play an active role in the world of the 21<sup>st</sup> century. For that, they will need an acute understanding of essential issues of global politics, broad linguistic and cultural skills, significant overseas experience, and both intellectual and cultural sophistication. The Joint IR/MLL Major meets those requirements with courses in economics, international relations, language, and culture. Extended study abroad and undergraduate research in more than one language are also required. The program will help students develop a deeper and richer understanding of cultural, linguistic, and political diversity around the world.

The program requires a total of **16 courses for 60-64 credits**. At least one semester of study abroad in an approved Lehigh program is required, as is undergraduate research that uses sources in at least one language other than English. Each student will have two major advisors, one each from IR and MLL.

Required courses (50-52 credits) as follows:

ECO 001

5 courses in International Relations (20 credits), as follows:

IR 10

IR 125

IR 105

Two IR advanced courses number 300-387 (except 307) or 393.

*6 courses in Modern Languages and Literatures (22-24 credits), as follows:*

Four courses (16 credits) in one language, either Arabic, Chinese, Hebrew, Japanese, or Russian; French (above the level of French 2), German (above the level of German 2), or Spanish (above the level of Spanish 2)

Two culture courses (6-8 credits) from an approved list or in consultation with the MLL advisor:

*1 independent study (4 credits). The course will include original research in at least one foreign language.*

*Study abroad.* 1 semester or more in an approved Lehigh program.

*Electives (10-12 credits), as follows:*

3 electives from an approved list, including courses from the departments of Sociology and Anthropology, Economics, English, International Relations, Journalism, Modern Languages and Literatures, Political Science, History, Religion, and/or programs in Africana Studies, Asian Studies, Global Citizenship, Latin American Studies, Sociology and Social Psychology, Science, Technology and Society, Women's Studies, or other courses as approved by IR and MLL advisors. (Courses must be chosen from at least two departments. )

**Minor programs**

The department offers minor programs in Chinese, French, German, International Communication, International Film, Japanese, Russian,

and Spanish, and coordinates these studies with a student's major requirements in any college.

### Requirements for the Minor

French, German, Spanish: Sixteen credit hours are required above Intermediate II; one or two courses at the 200 level, one or two courses at the 300 level.

Chinese, Japanese, Russian: A minimum of 16 credit hours.

See end of department section for International Communication and International Film.

A maximum of 8 credits may be transferred for the minor.

### Related programs

These are available in Asian Studies, Global Studies, Jewish Studies, Latin American Studies, and Women's Studies. Students are urged to take elective courses on related subjects, either within or outside the department, as approved by their adviser.

### Preliminary Courses

These may be replaced by other courses when a student qualifies for advanced standing.

Elementary I (4) Intermediate I (4)

Elementary II (4) Intermediate II (4)

### Advanced courses

Except where otherwise noted, 200 or 300-level courses are open to students having completed eight credit hours beyond Intermediate II. Exceptions require the consent of the instructor.

### Language of instruction

All courses are taught in the target language except MLL courses listed under "International Cultures and Literatures Taught in English." Students thereby become accustomed to considering the language as an active means of communication and not solely as an object of study.

### Language placement

Students are normally placed in language courses on the basis of years of a language taken in high school, CEEB Achievement Test score, or the departmental equivalent (instructor's test, interview, or questionnaire). Students may change levels within a language during the first two weeks of class. Students who consider themselves capable of higher-level performance may apply to the instructor during the first two weeks of the semester for more advanced placement. They may also be allowed by the department chair to be admitted for credit to a lower-level language course after consultation with the instructor. **Students who have had three years or more of a language in high school and drop to first-semester level will not receive credit for the course. No course under 100 level may be taken for credit once a higher course has been passed.**

### Courses in English

The department offers elective courses in English on literary, cultural, and social subjects listed under "International Culture and Literature Taught in English".

These courses may, in most cases, be taken to fulfill preliminary distribution requirements. One of these courses may be included in the major.

### Minor in International Film

#### Description

The minor in International Film affords students the opportunity to examine a wide cross-section of world cinema. It is designed to provide a critical understanding of historical trends and current issues in film across various regions of the world. Covering national cinemas from ASIA, Europe, and Latin America, course offerings will allow students to explore diverse approaches to film that are rooted in the history, culture, and society of different countries in each region.

The minor consists of 16 credits. All students must take a required core course (MLL 100), and the remaining courses are to be chosen from the list of electives below, in consultation with the minor advisor. (One

course may be taken outside of the MLL department with the minor advisor's approval.)

### Core course

MLL 100 Introduction to International Film (4)

### Elective courses

MLL/ASIA/WS/GCP 073 Film, Fiction, and Gender in Modern China (4)

FREN 322 Contemporary French Films (4)

GERM/GCP/MLL 231 New German Cinema (4)

SPAN 265 Spanish and Latin American Cinema (4)

### Minor in International Communication

#### Description:

The Minor in International Communication is designed for students who have already reached the intermediate level in their language studies and wish to develop international communication skills from a global perspective.

The minor consists of 16 credits. Students must take 124 as a core course, and one advanced language course in their language (above 100 level), and two other courses from the list of electives below in consultation with the minor advisor. These two courses must be chosen from a region that is different from their language area in order to broaden their communication skills. (One course may be taken outside of the MLL department with the minor advisor's approval.)

#### Courses:

Required:

Negotiating across cultures (MLL 124)

Globalization and Cultures (MLL/GC 006)

One advanced language course (above 100 level)

Electives:

MLL 027 Russian Classics (4)

MLL 053 This Hispanic World and its Culture (4)

MLL/ASIA/HIST 075 Chinese Civilization (4)

MLL/ASIA/HIST 076 Understanding Contemporary China (4)

MLL 195 Lehigh in Spain (4)

FREN 159 The French-speaking World and its Culture (4)

GERM 163 German Civilization and Culture (4)

SPAN 151 Cultural Evolution of Spain (4)

SPAN 152 Cultural Evolution of Latin America (4)

and other courses pre-approved by the adviser.

### Study Abroad and Travel Grants

The department encourages students of languages to spend a summer, a semester, or a full year on an approved program of study abroad. Exchange agreements with partner institutions are continually being developed. The department offers a limited number of travel grants for study abroad to qualified students. Applications should be submitted by the first week of November for the spring and summer semesters and by the first week of April for summer and fall. Applications for Study Abroad in Asia are also reviewed by the Asian Studies faculty when funds are available. For credit, transfer students must consult in advance with their major adviser, language adviser, other appropriate departments, the Office of International Education, and when appropriate, the Office of Financial Aid.

Lehigh offers summer programs through the Lehigh in Shanghai Internship Program. The Lehigh Valley Association of Independent Colleges (LVAIC) offers programs in Bonn (Germany), Cuernavaca (Mexico), and Seville (Spain) for eight credits each. A faculty member acting as program director accompanies the students. Courses are taught at intermediate and advanced levels by qualified instructors from host institutions. Summer programs sponsored by the Lehigh-LVAIC Center for Jewish Studies include Hebrew in Israel. Credits are fully transferable under normal LVAIC cross-registration procedures. Interested students should consult with the Department of Modern Languages and Literatures, Maginnes Hall.

These courses are offered by Lehigh or under the Cooperation agreement with the Lehigh Valley Association of Independent Colleges.

Summer or semester study abroad at approved programs may be incorporated into language majors and minors with the permission of the appropriate advisor to a maximum of 16 credits toward the major and eight credits toward the minor.

**CHIN, FREN, GERM, JPNS, RUSS, SPAN 91. Language and Culture Abroad I (1-8)**

Intensive study of conversation in the language of the country; reading, development of writing skills and selected aspects of the culture. (HU)

**CHIN, FREN, GERM, JPNS, RUSS, SPAN 191. Language and Culture Abroad II (1-8)**

Intensive study of conversation in the language of the country; rapid review of basic grammar, the reading and analysis of moderately difficult texts, development of rudimentary writing skills, supplemented study of selected aspects of contemporary civilization. Prerequisites: consent of chair and proficiency examination in the target country. (HU)

**CHIN, FREN, GERM, JPNS, RUSS, SPAN 291. Language and Culture Abroad III (1-8)**

Intensive practice of speaking and writing in the language of the country aimed at providing the student with extensive proficiency of expression and the ability to discriminate linguistic usage. Idiomatic expressions and an introduction to stylistics. Reading and analysis of more difficult texts, supplemented by in-depth study of selected aspects of contemporary civilization. Prerequisites: consent of chair and proficiency examination in the target country. (HU)

**CHIN 384. Research in Chinese Language and Culture Abroad (1-8)**

For students with advanced language skills to do research or work in Chinese abroad above the third year level. (HU)

**International Cultures and Literatures Taught in English**

These courses on international cultures and comparative topics carry no prerequisites; knowledge of the language is not required.

Language majors may count one MLL course taught in English for credit toward a major requirement. Interested students should consult their language major advisors. For course descriptions, see under each language area below.

**Hebrew**

The department offers courses both separately and in the context of the Jewish studies minor (Section III).

**Japanese**

See Asian Studies major and minor.

**Arabic Courses**

**ARAB 001 Elementary Arabic I 4 Credits**

The general objective of this course is to familiarize students with the sounds and the letters of Arabic, along with basic communication skills. Students are required to use Arabic in class discussion. Attendance and class participation are necessary to achieve the above-stated goals. Upon completion of this course, students will be able to read, write, speak, and understand Arabic at the elementary level.

**Attribute/Distribution:** HU

**ARAB 002 Elementary Arabic II 4 Credits**

Continuation of ARAB 001. Emphasis on communicative ability in oral and writing skills and use of the language. Students develop ability to communicate with native speakers on a variety of everyday topics; introductions, descriptions of people and things, disseminating information, stating preferences, describing locations, etc. Students will be able to read, write, speak, and understand authentic materials on familiar topics, as well as recognize and understand various grammatical rules and their application in context, and expand their cultural awareness.

**Attribute/Distribution:** HU

**ARAB 011 Intermediate Arabic I 4 Credits**

Development of communication skills and cultural awareness through reading materials and viewing films. Grammar is presented in context. Emphasis on communicative ability in oral and writing skills, and on the use and cultural aspects of the language through authentic materials. Students learn how to communicate effectively and appropriately while satisfying their intellectual curiosity to learn about the civilization and culture, current as well as historical dimensions. Prerequisites as noted below.

**Prerequisites:** ARAB 002

**Attribute/Distribution:** HU

**ARAB 012 Intermediate Arabic II 4 Credits**

Enhancement of communication skills, proficiency, competence, and use of the language. Students will enhance and develop their ability to understand the spoken word and to converse on a variety of topics; discuss, narrate, and read authentic materials that cover a variety of issues and topics; e.g., educational, cultural, and factual; write short paragraphs; recognize and use grammatical rules in context; and expand cultural awareness through class discussion and reading materials. Frequently taught in the target language to emphasize and reinforce classroom use. Students will be able to read, write, speak, and understand Arabic at the upper intermediate level.

**Attribute/Distribution:** HU

**ARAB 099 Special Topics 1-4 Credit**

**Repeat Status:** Course may be repeated.

**ARAB 190 Special Topics I 1-4 Credit**

Develop communication skills, emphasize and reinforce classroom use. Translate articles from newspapers, write short stories, and converse on a variety of topics. Directed study, reading, and writing. Periodic consultations and reports.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**ARAB 191 Special Topics II 1-4 Credit**

Continuation of ARAB 190. Literary and linguistic topics not covered in regular classes.

**Attribute/Distribution:** HU

**ARAB 231 Third Year Arabic I 4 Credits**

Enhance fluency, particularly conversational Arabic. Emphasis on comprehension of written and spoken language. Dialogue, reading, and analysis of texts to enhance critical thinking, as well as promote mastery of the language. Immersion in overall increase in fluency. Advanced level geared towards command and comprehension of conversation and written texts, textbooks, and media (i.e., newspaper, magazine).

**Attribute/Distribution:** HU

**ARAB 232 Third Year Arabic II 4 Credits**

Continuation of Third Year Arabic I. Emphasis on comprehension of written and spoken language. Dialogue, reading, and analysis of texts to enhance critical thinking, as well as promote mastery of the language. Immersion in overall increase in fluency. Advanced level geared towards command and comprehension of conversation and written texts, textbooks, and media (i.e., newspaper, magazine).

**Attribute/Distribution:** HU

**ARAB 300 Apprentice Teaching 1-4 Credit**

**Repeat Status:** Course may be repeated.

**ARAB 341 Fourth Year Arabic I 4 Credits**

Enhance fluency, particularly conversational and written Arabic. Reading and analysis of texts to enhance critical thinking, and promote mastery of the language. Immersion and overall increase in fluency. Students will be expected to communicate with classmates and the instructor in Arabic and to make presentations in Arabic pertaining to current events. Increased use of Arabic during classroom instruction. Students expected to come prepared to present something that utilizes the language: poems, personal stories or experiences, current event articles etc.

**Attribute/Distribution:** HU

**ARAB 342 Fourth Year Arabic II 4 Credits**

Continuation of Fourth Year Arabic I. Enhance fluency, particularly conversational and written Arabic. Emphasis on reading and analysis of texts to enhance critical thinking, promote mastery of the language. Immersion and overall increase in fluency. Students will be expected to communicate with classmates and the instructor in Arabic and to make presentations in Arabic pertaining to current events. Increased use of Arabic during classroom instruction. Students expected to come prepared to present something that utilizes the language: poems, personal stories or experiences, current event articles etc.

**Attribute/Distribution:** HU

**Chinese Courses****CHIN 001 Beginning Chinese Reading and Writing I 2 Credits**

Introduction to the Chinese writing system and beginning character acquisition; reading practice with pinyin transcription system. (Fall) Non-heritage speakers are strongly encouraged to take the Spoken course of the same level during the same semester as this Reading and Writing course or permission of the instructor.

**Attribute/Distribution:** HU

**CHIN 002 Beginning Chinese Reading and Writing II 2 Credits**

Continuation of CHIN 001: continued character acquisition, reading practice in pinyin and simple character texts. Non-heritage speakers are strongly encouraged to take the Spoken course of the same level during the same semester as this Reading and Writing course.

**Attribute/Distribution:** HU

**CHIN 003 Beginning Spoken Chinese I 2 Credits**

Introduction to Mandarin Chinese pronunciation, the pinyin transcription system, and modern colloquial Chinese; emphasis on oral proficiency. Not open to native speakers. Students are strongly encouraged to take Reading and Writing course of the same level during the same semester as this Spoken course.

**Attribute/Distribution:** HU

**CHIN 004 Beginning Spoken Chinese II 2 Credits**

Continuation of CHIN 003: further practice with text based dialogues in modern colloquial Chinese; emphasis on oral proficiency. Not open to native speakers. Students are strongly encouraged to take Reading and Writing course of the same level during the same semester as this Spoken course.

**Attribute/Distribution:** HU

**CHIN 011 Intermediate Chinese Reading and Writing I 2 Credits**

Continued focus on vocabulary/character acquisition and text-based reading and writing exercises using Chinese characters. Non-heritage speakers are strongly encouraged to take the Spoken course of the same level during the same semester as this Reading and Writing course.

**Attribute/Distribution:** HU

**CHIN 012 Intermediate Chinese Reading and Writing II 2 Credits**

Continuation of CHIN 011: vocabulary/character acquisition and text-based reading and writing exercises using Chinese characters. Non-heritage speakers are strongly encouraged to take the Spoken course of the same level during the same semester as this Reading and Writing course.

**Attribute/Distribution:** HU

**CHIN 013 Intermediate Spoken Chinese I 2 Credits**

Further development of communicative skills in Chinese using situational dialogues and class discussion; emphasis on oral proficiency. Not open to native speakers. Students are strongly encouraged to take Reading and Writing course of the same level during the same semester as this Spoken course.

**Attribute/Distribution:** HU

**CHIN 014 Intermed Spoken Chinese II 2 Credits**

Continuation of CHIN 013: further development of communicative skills in Chinese using situational dialogues and class discussion; emphasis on oral proficiency. Not open to native speakers. Students are strongly encouraged to take Reading and Writing course of the same level during the same semester as this Spoken course.

**Attribute/Distribution:** HU

**CHIN 021 Survival Chinese 2 Credits**

A brief introduction to the language and culture. Focus on speaking and listening skills. Lessons based on practical situations for living or traveling in China.

**Attribute/Distribution:** HU

**CHIN 091 Chinese Language & Culture Abroad I 1-8 Credit**

Intensive study of conversation in the language of the country; reading, development of writing skills and selected aspects of the culture.

**Attribute/Distribution:** HU

**CHIN 111 Advanced Chinese Reading & Writing I 2 Credits**

Reading, translation, and writing practice using text-based exercises, short stories, essays, and other selected materials. Non-heritage speakers are strongly encouraged to take the Spoken course of the same level during the same semester as this Reading and Writing course.

**Attribute/Distribution:** HU

**CHIN 112 Advanced Chinese Reading & Writing II 2 Credits**

Continuation of CHIN 111: reading, translation, writing exercises using text-based exercises, short stories, essays, and other selected materials. Non-heritage speakers are strongly encouraged to take the Spoken course of the same level during the same semester as this Reading and Writing course.

**Attribute/Distribution:** HU

**CHIN 113 Advanced Spoken Chinese I 2 Credits**

Topical discussions and oral presentations in Chinese. Students are strongly encouraged to take Reading and Writing course of the same level during the same semester as this Spoken course.

**Attribute/Distribution:** HU

**CHIN 114 Advanced Spoken Chinese II 2 Credits**

Continuation of CHIN 113: topical discussions and oral presentations in Chinese. Students are strongly encouraged to take Reading and Writing course of the same level during the same semester as this Spoken course.

**Attribute/Distribution:** HU

**CHIN 122 Intermediate Business Chinese 2 Credits**

Chinese business environment and business terminology. Emphasis on reading comprehension and translation.

**Attribute/Distribution:** HU

**CHIN 134 Chinese Short Stories 2 Credits**

Supplementary reading course designed for students who finished, or are at intermediate level Chinese. Focus on improved reading and speaking proficiency. Reading materials will strengthen understanding of both contemporary and historical Chinese culture.

**Attribute/Distribution:** HU

**CHIN 191 Chinese Language & Culture Abroad III 1-8 Credit**

Intensive study of conversation in the language of the country; rapid review of basic grammar, the reading and analysis of moderately difficult texts, development of rudimentary writing skills, supplemented study of selected aspects of contemporary civilization. Consent of department required. Must have proficiency examination in the target country.

**Attribute/Distribution:** HU

**CHIN 251 Chinese Special Topics 1-4 Credit**

Materials not covered in regular courses. Students can help design the course.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**CHIN 252 Business Chinese 2 Credits**

Directed readings on the Chinese business environment and business terminology. Emphasis on reading comprehension and translation. May be repeated for credit. Prerequisites as noted below or consent of instructor.

**Repeat Status:** Course may be repeated.

**Prerequisites:** CHIN 112 or CHIN 114

**Attribute/Distribution:** HU

**CHIN 253 Chinese Fiction 2 Credits**

Students read modern Chinese short stories or a novel. Emphasis on reading comprehension and translation. May be repeated for credit. Prerequisites as noted below or consent of instructor.

**Repeat Status:** Course may be repeated.

**Prerequisites:** CHIN 112 or CHIN 114

**Attribute/Distribution:** HU

**CHIN 254 Intensive Chinese Conversation 2 Credits**

Conversational practice based on topical readings. For advanced speakers only. May be repeated for credit. Prerequisites as noted below or consent of instructor.

**Prerequisites:** CHIN 112 or CHIN 114

**Attribute/Distribution:** HU

**CHIN 255 Newspaper Readings In Chinese 2 Credits**

Newspaper readings in Chinese. Emphasis on reading comprehension and translation. May be repeated for credit. Prerequisites as noted below or consent of instructor.

**Repeat Status:** Course may be repeated.

**Prerequisites:** CHIN 112 or CHIN 114

**Attribute/Distribution:** HU

**CHIN 291 Chinese Language & Culture Abroad III 1-8 Credit**

Intensive practice of speaking and writing in the language of the country aimed at providing the student with extensive proficiency of expression and the ability to discriminate linguistic usage. Idiomatic expressions and an introduction to stylistics. Reading and analysis of more difficult texts, supplemented by in-depth study of selected aspects of contemporary civilization. Consent of department required. Must have proficiency examination in the target country.

**Attribute/Distribution:** HU

**CHIN 300 Apprentice Teaching 1-4 Credit**

**Repeat Status:** Course may be repeated.

**CHIN 371 Advanced Readings in Chinese 1-4 Credit**

Directed study of an author, genre, or period not covered in regular courses. May be repeated once for credit. Can be combined with ASIA 371 to include readings in English. Consent of instructor required.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**CHIN 384 Research in Chinese Language and Culture Abroad 1-8 Credit**

For students with advanced language skills to do research or work in Chinese abroad, above the third year level. Independent Study.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**French Courses****FREN 001 Elementary French I 4 Credits**

Multimedia approach to the study of French. Introduction to French conversation, grammar, and culture.

**Attribute/Distribution:** HU

**FREN 002 Elementary French II 4 Credits**

Continuation of FREN 001.

**Attribute/Distribution:** HU

**FREN 011 Intermediate French I 4 Credits**

Further acquisition of the fundamentals of French conversation, writing, and culture. Multimedia approach.

**Attribute/Distribution:** HU

**FREN 012 Intermediate French II 4 Credits**

Continuation of FREN 011.

**Attribute/Distribution:** HU

**FREN 099 French Special Topics 1-6 Credit****FREN 133 Lehigh in Martinique: Globalization and Local Identity 3,4 Credits**

History, culture, and politics of the French Caribbean island of Martinique, from its position as a key site of the 18th century Atlantic World economy to becoming an official French department and outpost of the European Union. Interdisciplinary perspectives on the complex nature of social identity, historical memory and impact of globalization. No French is required. Offered during winter inter-term through Lehigh Study Abroad.

**Attribute/Distribution:** HU

**FREN 143 Advanced Written French 4 Credits**

Intensive practice in written French and introduction to literary criticism.

**Attribute/Distribution:** HU

**FREN 144 Advanced Oral French 4 Credits**

Emphasis on comprehension and oral performance of the French language. Student acquires confidence in speaking French through discussions of current issues, articles, novels, movies, and other topics. Required for French majors.

**Attribute/Distribution:** HU

**FREN 199 French Special Topics 1-6 Credit****FREN 237 Introduction to the Francophone World 4 Credits**

Introduction to the Francophone world through a series of texts, films, articles, etc. from Francophone Europe, North Africa, sub-Saharan Africa, Canada, Vietnam, and the Caribbean. Students will become acquainted with Francophone cultures and literatures while developing their interpretative and writing skills. In French.

**FREN 251 Postcolonizing France: North African Immigration 4 Credits**

Depictions of North African immigrants (legal or illegal) and French citizens of North African descent in postcolonial France in novels, film, and Rap music. Explore key concepts such as hospitality, minority ethnic settlement, multiculturalism, nationality and citizenship, racism, extreme-right politics, and anti-discrimination policy, and attempt to see how North African postcolonial identities are articulated in relation to perceptions of French national identity, republican values, universalism, etc.

**Attribute/Distribution:** HU

**FREN 252 Introduction to Literary Analysis 4 Credits**

Exposure to representative French and Francophone works from the Middle Ages to the Twenty-First Century offering various critical strategies needed to read and interpret a literary text.

**Attribute/Distribution:** HU

**FREN 255 Introduction to the Francophone World 4 Credits**

Introduction to the Francophone world through a series of texts, films, articles, etc. from Francophone Europe, North Africa, Sub-Saharan Africa, Canada, Vietnam, and the Caribbean. Students will become acquainted with Francophone cultures and literatures while developing their interpretative and writing skills. In French.

**FREN 259 Contemporary France 3-4 Credits**

How is France defining itself today as a European nation in a global world? Issues to be explored include: family, gender, race and religion, the education and social systems, immigration, and politics. Strongly recommended for students who plan to study abroad in France.

**Attribute/Distribution:** HU

**FREN 271 French Readings 4 Credits**

Study of the works of some author or group of authors, or of a period, or of a literary theme. May be repeated once for credit.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**FREN 272 French Culture of Business 4 Credits**

A course on the fundamentals of business in France. We will learn about banking, marketing, advertising, the stock market, and many other aspects of business in France. We will learn about foreign ventures in France, such as Disney and McDonald's. We will learn how to open a bank account, apply for a job, and what life is like in a French company. Ideal for someone who wants to intern or work for an international company or a company with a French connection. Taught in French.



**FREN 281 French Cultural Program 1-6 Credit**

A program in a French-speaking country offering formal language courses and cultural opportunities.

**Attribute/Distribution:** HU

**FREN 299 French Special Topics 1-6 Credit****FREN 300 Apprentice Teaching 1-4 Credit****FREN 311 French Classicism 4 Credits**

French classical theater, novel, and criticism, with emphasis on Corneille, Racine, Moliere, Pascal, Lafayette, Malherbe, and Boileau.

**Attribute/Distribution:** HU

**FREN 312 Modernity in the Maghreb 4 Credits**

Emergence of the modern self through a comparative study of textual as well as visual representations of postcolonial subjects by male and female writers and film makers. Study of the way the sociopolitical context of countries such as Morocco, Algeria, and Tunisia informs the constitution of subjectivity within a multicultural and multilingual community. Issues such as patriarchy, nationalism, colonialism, postcolonialism, identity, gender, and Islam in North African literature and film from Franco-Arab traditions.

**Attribute/Distribution:** HU

**FREN 313 The Age Of Enlightenment 4 Credits**

The Philosophes and Encyclopédistes of the eighteenth century, with emphasis on Voltaire, Rousseau, Montesquieu, and Diderot.

**Attribute/Distribution:** HU

**FREN 316 Nineteenth Century French Literature 4 Credits**

Study of major nineteenth century novelists and poets.

**Attribute/Distribution:** HU

**FREN 318 French Drama in the Twentieth Century 3 Credits**

Contemporary French drama with an analysis of its origins and movements.

**Attribute/Distribution:** HU

**FREN 320 Contemporary French Fiction 4 Credits**

Reading and discussion of contemporary works of fiction (post1980). Study of how these works fit into the context of French literature and relate more specifically to major literary currents of the twentieth century.

**Attribute/Distribution:** HU

**FREN 321 Twentieth-Century French Short Fiction 4 Credits**

Examination, within the framework of short fiction, of the major literary currents that have made up twentieth-century literature. Works by Sartre, Camus, Robbe-Grillet, Le Clézio, Echenoz, Sallenave, Toussaint, Diebar, Ben Jelloun, and others.

**Attribute/Distribution:** HU

**FREN 322 Contemporary French Films 4 Credits**

French Films from the late 1950s to the present. Introduction to cinematographic language and exploration of the issues of gender, power, and madness. Films by Truffaut, J-L Godard, C. Denis, A. Varda, J-J Beineix, E. Rohmer, and others.

**Attribute/Distribution:** HU

**FREN 324 The Outsider In French Fiction 4 Credits**

Focus on otherness/difference in French fiction from the eighteenth to the twentieth century. Reading and discussion of short stories and novels by Graffigny, Diderot, Maupassant, Gide, Camus, Duras, Beauvoir, Le Clézio and others.

**Attribute/Distribution:** HU

**FREN 327 Women Writing In French 4 Credits**

Reading and discussion of works written by women in French. The emphasis is on 19th and 20th century writers, such as G. Sand, Colette S. de Beauvoir, M. Duras, and Andrée Chédid.

**Attribute/Distribution:** HU

**FREN 369 French Readings 4 Credits**

Advanced study of an author, period, or theme. Topics vary. May be repeated once for credit. Consent of instructor required.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**FREN 370 French Internship 1-8 Credit**

Designed to give advanced qualified students the chance to acquire field experience and training with selected firms and governmental agencies in French-speaking countries. Assigned readings, written reports, and employer performance evaluations are required. Consent of instructor required.

**Attribute/Distribution:** HU

**FREN 371 French Independent Study 1-8 Credit**

Special topics under faculty guidance, including honors thesis. May be repeated once for credit. Consent of instructor required.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**FREN 389 Honors Project 1-6 Credit****FREN 399 French Special Topics 1-6 Credit****German Courses****GERM 001 Elementary German I 4 Credits**

Fundamentals of German; reading and simple texts; simple conversation and composition; vocabulary building. Three class hours plus one laboratory or drill hour each week. No previous German required.

**Attribute/Distribution:** HU

**GERM 002 Elementary German II 4 Credits**

Continuation of GERM 1, including reading of more advanced texts. Three class hours plus one laboratory or drill hour each week.

**Attribute/Distribution:** HU

**GERM 011 Intermediate German I 4 Credits**

Review of grammar, composition, reading of intermediate texts, vocabulary building.

**Attribute/Distribution:** HU

**GERM 012 Intermediate German II 4 Credits**

Continuation of GERM 011.

**Attribute/Distribution:** HU

**GERM 091 German Language & Culture I Abroad 1-8 Credit**

Intensive study of conversation in the language of the country; reading, development of writing skills and selected aspects of the culture.

**GERM 163 German Civilization and Culture 4 Credits**

Cultural, historical, and political evolution of Germany and German-speaking countries in Europe.

**Attribute/Distribution:** HU

**GERM 167 German Conversation and Composition 4 Credits**

Intensive practice in spoken and written German.

**Attribute/Distribution:** HU

**GERM 169 Business German 4 Credits**

German in business, the professions, international, and social relations. Letter writing, comprehension of technical texts, specialized vocabulary, and grammar review.

**Attribute/Distribution:** HU

**GERM 181 German Cultural Program 1-8 Credit**

Summer program abroad. Formal instruction in the language and the culture of a German-speaking country.

**Attribute/Distribution:** HU

**GERM 191 German Language & Culture II Abroad 1-8 Credit**

Intensive study of conversation in the language of the country; rapid review of basic grammar, the reading and analysis of moderately difficult texts, development of rudimentary writing skills, supplemented study of selected aspects of contemporary civilization. Consent of chair and proficiency examination in the target country is required.

**GERM 211 German Drama 4 Credits**

Drama as a literary genre; plays from various periods of German literature.

**Attribute/Distribution:** HU

**GERM 218 Goethe's "Faust" 4 Credits**

Study of Goethe's play with an introduction to the Faust tradition and Faustian themes in modern literature.

**Attribute/Distribution:** HU

**GERM 231 New German Cinema 4 Credits**

Viewing, discussion, and written analysis of selected German films.

**Attribute/Distribution:** HU

**GERM 240 Contemporary Germany 4 Credits**

Readings and conversations in German about topics including the social and natural sciences, technology, the environment, politics, daily life, and sports. Practice in spoken and written German.

**Attribute/Distribution:** HU

**GERM 250 German Special Topics 1-4 Credit**

Literary and linguistic topics not covered in regular courses. May be repeated for credit.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**GERM 260 Multicultural Germany 4 Credits**

A look at Germany from the perspective of its "others"—the immigrants. Literary and cultural texts, and films on ethnic diversity and integration.

**Attribute/Distribution:** HU

**GERM 267 Advanced German Conversation and Composition 4 Credits**

A continuation of GERM 167. Practice of speaking and writing skills in German through readings of more complex texts.

**Attribute/Distribution:** HU

**GERM 269 Advanced Professional German 4 Credits**

A continuation of Business German with an emphasis on specific economic issues affecting contemporary Germany, Switzerland, and Austria. Preparation for the national exam "Certificate for the Professions" and the "International Business German Examination".

**Attribute/Distribution:** HU

**GERM 281 German Cultural Program 1-8 Credit**

Study abroad. Formal instruction in German and direct contact with the people and the culture during at least one month in a German-speaking country. Consent of German study abroad adviser required.

**Attribute/Distribution:** HU

**GERM 291 German Language Culture II Abroad 1-8 Credit**

Intensive practice of speaking and writing in the language of the country aimed at providing the student with extensive proficiency of expression and the ability to discriminate linguistic usage. Idiomatic expressions and an introduction to stylistics. Reading and analysis of more difficult texts, supplemented by in-depth study of selected aspects of contemporary civilization. Consent of chair and proficiency examination in the target country is required.

**GERM 300 Apprentice Teaching 1-4 Credit****GERM 301 Survey Of German Literature 4 Credits**

An overview of German literary traditions through the nineteenth century, focusing on the Middle Ages, Renaissance, Reformation, Baroque, Enlightenment, Classicism, Romanticism, Realism, and Naturalism.

**Attribute/Distribution:** HU

**GERM 303 Grimm's' Fairy Tales: Folklore, Feminism, Film 4 Credits**

This intercultural history of the Grimms' fairy tales investigates how folktale types and gender stereotypes developed and became models for children and adults. The course covers the literary fairy tale in Germany as well as Europe and America. Versions of "Little Red Riding Hood", "Cinderella", or "Sleeping Beauty" exist not only in the Grimms' collection but in films and many forms of world literature. Modern authors have rewritten fairy tales in feminist ways, promoting social change. Taught in English. German language students may receive a German component.

**Attribute/Distribution:** HU

**GERM 305 Modern German Literature 4 Credits**

Topics in German literature of the twentieth and twenty-first century.

**Attribute/Distribution:** HU

**GERM 320 Berlin: Transformations of a Metropolis 4 Credits**

A literary and cultural history of Berlin from its foundation to the present. After a historical overview, we will focus on the modern period that covers the Weimar Republic, the Third Reich, the divided city of the postwar era, the fall of the wall, and the continuing process of redefining Berlin's identity as Germany's old and new capital.

**Attribute/Distribution:** HU

**GERM 345 German Short Stories 4 Credits**

Readings of short prose texts in German.

**Attribute/Distribution:** HU

**GERM 350 German Special Topics 1-4 Credit**

Literary or linguistic topics not covered in regular courses. May be repeated for credit. Consent of instructor required.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**Hebrew Courses****HEBR 001 Elementary Modern Hebrew I 4 Credits**

Classroom and laboratory instruction to develop hearing, speaking, reading, and writing the language. Cultural, ethnic, and religious dimensions of Israeli society. Tapes, textual materials, short stories. No previous study of Hebrew required.

**Attribute/Distribution:** HU

**HEBR 002 Elementary Modern Hebrew II 4 Credits**

Continuation of Hebrew I utilizing the audio-lingual approach.

Fundamentals of the language, structure and sounds; the Hebrew verb; reading and vocalized stories; written exercises; tapes; short stories.

**Attribute/Distribution:** HU

**HEBR 011 Intermediate Modern Hebrew I 4 Credits**

Classroom and laboratory instruction to develop fundamental patterns of conversation and grammar; composition, reading of texts, laboratory work and sight reading; comprehension, speaking, reading and writing of unvocalized materials.

**Attribute/Distribution:** HU

**HEBR 012 Intermediate Modern Hebrew II 4 Credits**

Continuation of Hebrew 011. Reading of texts, including selected short stories, outside reading and supplementary material; increased emphasis on oral presentation.

**Attribute/Distribution:** HU

**HEBR 151 Hebrew Special Topics 1-4 Credit**

Literary or linguistic topics not covered in regular courses. May be repeated for credit. Consent of instructor required. Taught in Hebrew.

**Repeat Status:** Course may be repeated.

**HEBR 152 Hebrew Special Topics II 4 Credits**

Continuation of HEBR 151. Literary or linguistic topics not covered in regular courses. May be repeated for credit. Consent of instructor required. Taught in Hebrew.

**Repeat Status:** Course may be repeated.

**Japanese Courses****JPNS 001 Elementary Japanese I 4 Credits**

This course introduces the basic grammatical structures commonly found in daily situations in Japan. All four aspects of language skills are introduced. Hiragana, Katakana, and approximately 50 Kanji are introduced.

**Attribute/Distribution:** HU

**JPNS 002 Elementary Japanese II 4 Credits**

Continuation of JPNS 001. Approximately 100 Kanji are introduced. Prerequisites as noted below.

**Prerequisites:** JPNS 001

**Attribute/Distribution:** HU

**JPNS 011 Intermediate Japanese I 4 Credits**

Continuation of JPNS 002. This course introduces more complex grammatical structures and develops all four aspects of language skills. Slightly more emphasis on reading and writing. Approximately 100 Kanji are introduced. Prerequisites as noted below.

**Prerequisites:** JPNS 002

**Attribute/Distribution:** HU

**JPNS 012 Intermediate Japanese II 4 Credits**

Continuation of JPNS 011. Prerequisites as noted below.

**Prerequisites:** JPNS 011

**Attribute/Distribution:** HU

**JPNS 099 Japanese Special Topics 1-4 Credit****JPNS 131 Advanced Japanese Reading and Writing I 3 Credits**

Reading, translation, and writing practice using authentic Japanese materials. Prerequisites as noted below or consent of instructor.

**Prerequisites:** JPNS 012

**Attribute/Distribution:** HU

**JPNS 132 Advanced Japanese Reading and Writing II 3 Credits**

Continuation of Advanced Japanese Reading and Writing I.

Prerequisites as noted below or consent of instructor.

**Prerequisites:** JPNS 141 or JPNS 131

**Attribute/Distribution:** HU

**JPNS 141 Advanced Japanese I 4 Credits**

This course emphasizes advanced reading comprehension on topics related to Japan. Approximately 100 Kanji are introduced. Prerequisites as noted below.

**Prerequisites:** JPNS 012

**Attribute/Distribution:** HU

**JPNS 142 Advanced Japanese II 4 Credits**

Continuation of JPNS 141. Prerequisites as noted below.

**Prerequisites:** JPNS 141

**Attribute/Distribution:** HU

**JPNS 145 Advanced Japanese Conversation and Culture I 4 Credits**

This course emphasizes oral skills and culture by discussing topics related to modern Japan. Advanced writing skills, especially the knowledge of Kanji, are introduced individually. Prerequisites as noted below or consent of instructor.

**Prerequisites:** JPNS 012

**Attribute/Distribution:** HU

**JPNS 146 Advanced Japanese Conversation and Culture II 4 Credits**

Continuation of JPNS 145. Emphasis on advanced oral and writing skills, and knowledge of the culture. Prerequisites as noted below or consent of instructor.

**Prerequisites:** JPNS 145

**Attribute/Distribution:** HU

**JPNS 151 Advanced Spoken Japanese 1 Credit**

Emphasis on comprehension and oral performance of the Japanese language through discussion of current issues and other topics. May be repeated for credit. Prerequisites as noted below or consent of instructor.

**Repeat Status:** Course may be repeated.

**Prerequisites:** JPNS 012

**Attribute/Distribution:** HU

**JPNS 152 Advanced Spoken Japanese II 1 Credit**

Continuation of JPNS 151. Emphasis on comprehension and oral performance of Japanese language through discussion of current issues and other topics. Variable content. May be repeated for credit. Prerequisites as noted below or consent of instructor.

**Repeat Status:** Course may be repeated.

**Prerequisites:** JPNS 151

**Attribute/Distribution:** HU

**JPNS 199 Japanese Special Topics 1-4 Credit****JPNS 231 Advanced Japanese Reading and Writing I 2 Credits**

Reading, translation, and writing practice using authentic Japanese materials. Prerequisites as noted below or consent of instructor.

**Prerequisites:** JPNS 1%

**Attribute/Distribution:** HU

**JPNS 232 Advanced Japanese Reading and Writing II 2 Credits**

Continuation of Advanced Japanese Reading and Writing I.

Prerequisites as noted below or consent of instructor.

**Prerequisites:** JPNS 142 or JPNS 231

**Attribute/Distribution:** HU

**JPNS 290 Japanese Special Topics 1-4 Credit**

Literary or linguistics topics not covered in regular courses. May be repeated for credit. Consent of instructor required.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**JPNS 291 Advanced Japanese and Culture Abroad 1-8 Credit**

Intensive practice of speaking and writing in the language of the country aimed at providing the student with extensive proficiency of expression and the ability to discriminate linguistic usage. Idiomatic expressions and an introduction to stylistics. Reading and analysis of more difficult texts, supplemented by in-depth study of selected aspects of contemporary civilization. Consent of chair and proficiency examination in the target country required.

**Attribute/Distribution:** HU

**JPNS 299 Japanese Special Topics 1-4 Credit****JPNS 300 Apprentice Teaching 1-4 Credit**

**Repeat Status:** Course may be repeated.

**JPNS 390 Japanese Special Topics 1-4 Credit**

Literary or linguistics topics not covered in regular courses. May be repeated for credit. Consent of instructor required.

**Repeat Status:** Course may be repeated.

**Modern Languages Literature Courses****MLL 006 Globalization and Cultures 4 Credits**

This course is a reflection on the processes of globalization and their consequences, both good and bad, on the world's societies and on our concepts of culture and identity. It provides a multidisciplinary examination of what cultures gain and lose from their interaction with the rest of the world and what it means to be a citizen of a globalized yet diverse world.

**Attribute/Distribution:** HU

**MLL 027 Russian Classics 4 Credits**

Russian classics in translation. May be repeated for credit.

**Attribute/Distribution:** HU

**MLL 051 Contemporary Hispanic-American Literature 4 Credits**

Reading and discussion of distinguished Latin American writers: Borges, García Márquez, Cortázar, and Vargas Llosa.

**Attribute/Distribution:** HU

**MLL 053 This Hispanic World and its Culture 4 Credits**

Characteristics and values of the people of Spain and Latin America in literary works and other material. Hispanic cultural contributions to Western civilization.

**Attribute/Distribution:** HU

**MLL 068 Japanese Language: Past and Present 4 Credits**

Historical and contemporary aspects of the Japanese language, including the origins of Japanese in relation to Korean, the influence of Chinese, syntactic features which reflect the hierarchical character of Japanese society, differences in female and male speech, and use of foreign loan words. Prerequisites as noted below.

**Prerequisites:** JPNS 001

**Attribute/Distribution:** HU

**MLL 073 Film, Fiction, and Gender in Modern China 4 Credits**

Study of the struggle for an individual "modern" identity out of traditionally defined roles for men and women as depicted by Chinese writers and filmmakers. Class, texts, and films in English. Students interested in setting up a corollary Chinese language component for credit as Chin 251, may discuss this possibility with the professor.

**Attribute/Distribution:** HU

**MLL 074 Chinese Cultural Program 1-8 Credit**

A summer program in China, taught in English.

**Attribute/Distribution:** HU

**MLL 075 Chinese Civilization 4 Credits**

The development of traditional Chinese thought, beliefs, technology, and institutions from a historical perspective.

**Attribute/Distribution:** HU, SS

**MLL 076 Understanding Contemporary China 4 Credits**

An overview of recent history, politics, economy, religion, problems of modernization, popular culture. Contemporary Chinese society viewed against the backdrop of tradition and the tumultuous history of twentieth-century China.

**Attribute/Distribution:** SS

**MLL 078 Asian-American Studies 4 Credits**

A survey of issues concerning Asians living in the United States from the perspectives of history, language, literature, and film.

**Attribute/Distribution:** HU

**MLL 079 Digital Bridges 2 Credits**

Run as an independent study; research ancient Chinese bridges, gardens, and pavilions. Digitize images and website design. Create photographic documentation of the Bridge Project. Produce documentary from historical materials concerning history of Chinese students at Lehigh. Bridge Project students could continue project work in Shanghai and Beijing. May be repeated for credit.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**MLL 099 Modern Languages & Literature Special Topics 1-6 Credit****MLL 100 Introduction to International Film 4 Credits**

An introduction to international film traditions and theory. We look at the importance of cinema as both art and entertainment and consider the social, political, and economic role of film in national and global contexts.

**Attribute/Distribution:** HU

**MLL 124 Negotiating Across Cultures 4 Credits**

The world is shrinking! Yet as geographical distances between peoples collapse, our misunderstandings seem to expand. Explore difference, erode barriers, and learn tactics for successfully bridging cultural gaps. Learn the ins-and-outs of cross-cultural communication from specialists in all walks of life and from a diverse array of sources. (H/S).

**MLL 125 Immortal Images: Traditional Chinese Literature in Translation 4 Credits**

Explore age-old themes in literature as diverse as pre-modern novels, ghost stories, poetry, divination manuals, and medical texts. Students interested in setting up a corollary Chinese language component for credit as CHIN 251, may discuss this with the professor.

**Attribute/Distribution:** HU

**MLL 127 ORIENTations: Approaches to Modern Asia 4 Credits**

An introduction to East, Southeast, and South Asia at the beginning of the 21st century. How is globalization transforming Asian societies? How are Asians represented (or misrepresented) in the West? How do Asian peoples view Western influences on them? What distinguishes our perspectives on politics, individual liberty, civic responsibility, religious faith and practice, work, etc? How is the trend toward globalization in the coming "Asian Century" likely to be affected by the growing assertiveness of nations like China and India? (H/S).

**MLL 133 Lehigh in Martinique: Globalization and Local Identity 3,4 Credits**

History, culture, and politics of the French Caribbean island of Martinique, from its position as a key site of the 18th century Atlantic world economy to becoming an official French department and outpost of the European Union. Interdisciplinary perspectives on the complex nature of social identity, historical memory, and impact of globalization. No French is required. Offered during winter inter-term through Lehigh Study Abroad.

**Attribute/Distribution:** HU

**MLL 140 Introduction to Linguistics 4 Credits**

Relationship between language and mind; formal properties of language; language and society; how languages change over time.

**Attribute/Distribution:** SS

**MLL 165 Love and Revolution in Shanghai 4 Credits**

Project-based course examines human relationships and political-economic changes in Shanghai through the lens of literature, film, and a selection of other readings. Discussion of conflicts between and influences of pre-communist, communist, and capitalist systems as played out in the Shanghai urban arena.

**Attribute/Distribution:** HU

**MLL 177 China Enters the Modern Age 4 Credits**

The collapse of the imperial order and China's agonizing transformation into a modern nation-state over the past 150 years. The impact of imperialism, war, radical social change, and protracted revolution on Chinese traditions, values, and institutions.

**Attribute/Distribution:** HU, SS

**MLL 199 Modern Languages & Literature Special Topics 1-4 Credit****MLL 211 German Drama 4 Credits**

Drama as a literary genre; plays from various periods of German literature.

**Attribute/Distribution:** HU

**MLL 218 Goethe's "Faust" 4 Credits**

Study of Goethe's play with an introduction to the Faust tradition and Faustian themes in modern literature.

**Attribute/Distribution:** HU

**MLL 231 New German Cinema 4 Credits**

Viewing, discussion, and written analysis of selected German films.

**Attribute/Distribution:** HU

**MLL 260 Multicultural Germany 4 Credits**

A look at Germany from the perspective of its "others"--the immigrants. Literary and cultural texts, and films on ethnic diversity and integration.

**Attribute/Distribution:** HU

**MLL 299 Modern Languages & Literature Special Topics 1-6 Credit****MLL 300 Apprenticeship Teaching 1-4 Credit****MLL 303 Grimms' Fairy Tales: Folklore, Feminism, Film 4 Credits**

This intercultural history of the Grimms' fairy tales investigates how folktale types and gender stereotypes developed and became models for children and adults. The course covers the literary fairy tale in Germany as well as Europe and America. Versions of "Little Red Riding Hood", "Cinderella", or "Sleeping Beauty" exist not only in the Grimms' collection but in films and many forms of world literature. Modern authors have rewritten fairy tales in feminist ways, promoting social change. Taught in English. German language students may receive a German component.

**Attribute/Distribution:** HU

**MLL 321 Intercultural Communication 4 Credits**

Language is ambiguous by nature and discourse is interpreted in cultural and linguistic contexts. This course covers different cultural and linguistic strategies individuals use to communicate with each other, essential concepts for interacting with individuals from other cultural and linguistic backgrounds, and different strategies of communication as defined by specific cultures. Covering the theory and practice of intercultural interaction, this course examines assumptions about language and culture, and includes practical advice to help students develop the cultural sensitivity essential for communication today.

**Attribute/Distribution:** HU

**MLL 399 Modern Languages & Literature Special Topics 1-6 Credit****MLL 403 Grimms' Fairy Tales: Folklore, Feminism, Film 3 Credits**

This intercultural history of the Grimms' fairy tales investigates how folktale types and gender stereotypes developed and became models for children and adults. The course covers the literary fairy tale in Germany as well as Europe and America. Versions of "Little Red Riding Hood", "Cinderella", or "Sleeping Beauty" exist not only in the Grimms' collection but in films and many forms of world literature. Modern authors have rewritten fairy tales in feminist ways, promoting social change. Taught in English. German language students may receive a German component.

**Russian Courses****RUSS 001 Elementary Russian I 4 Credits**

Classroom and laboratory, audio, and video introduction to the fundamentals of conversational and grammatical patterns; practice in pronunciation, simple conversation, reading, and writing.

**Attribute/Distribution:** HU

**RUSS 002 Elementary Russian II 4 Credits**

Continuation of RUSS 001.

**Attribute/Distribution:** HU

**RUSS 011 Intermediate Russian I 4 Credits**

Classroom and laboratory practice in conversation. Development of reading and writing skills.

**Attribute/Distribution:** HU

**RUSS 012 Intermediate Russian II 4 Credits**

Continuation of RUSS 011.

**Attribute/Distribution:** HU

**RUSS 141 Russian Conversation and Composition I 4 Credits**

Intensive practice in oral and written Russian and oral comprehension.

Readings and discussions on Russian literature and culture.

**Attribute/Distribution:** HU

**RUSS 142 Russian Conversation and Composition II 4 Credits**

Continuation of RUSS 141.

**Attribute/Distribution:** HU

**RUSS 199 Russian Special Topics 1-6 Credit****RUSS 215 Russian Classics: Russian Literature with Variable Topic and Credit 1-4 Credit**

May be repeated for credit.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**RUSS 231 Russians In Real World I 4 Credits**

Readings and conversations about selected nonliterary topics including the social and natural sciences, business, economics, the environment, current political events in Russia and throughout the former Soviet republics.

**Attribute/Distribution:** HU

**RUSS 232 Russians In Real World II 4 Credits**

A continuation of RUSS 231.

**Attribute/Distribution:** HU

**RUSS 251 Russian Special Topics 1-4 Credit**

Intensive study of literary or linguistic topics.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**RUSS 252 Russian Special Topics 1-4 Credit**

Intensive study of literary or linguistic topics.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**RUSS 300 Apprentice Teaching 1-4 Credit****RUSS 370 Russian Internship 1-6 Credit**

Designed to give advanced qualified students the chance to acquire field experience and training with selected firms and governmental agencies in Russian-speaking countries. Assigned readings, written reports, and employer performance evaluations are required. Consent of faculty committee required.

**Attribute/Distribution:** HU

**RUSS 389 Honors Project 1-8 Credit****RUSS 391 Russian Special Topics 1-4 Credit**

Independent study of research under faculty guidance on a literary, linguistic, or methodological topic. May be repeated once for credit. May be used to satisfy the doctoral language requirement. Consent of instructor required.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**Spanish Courses****SPAN 001 Elementary Spanish I 4 Credits**

Basic conversational Spanish illustrating essential grammatical principles. Reading of simple texts and writing. Lab required.

**Attribute/Distribution:** HU

**SPAN 002 Elementary Spanish II 4 Credits**

Continuation of SPAN 1. Lab required.

**Attribute/Distribution:** HU

**SPAN 011 Intermediate Spanish I 4 Credits**

Limited review of elementary grammar concepts and introduction to more advanced grammar and vocabulary. Emphasis on discussion, reading, and writing about short literary works and current topics in the Spanish-speaking world.

**Attribute/Distribution:** HU

**SPAN 012 Intermediate Spanish II 4 Credits**

Continuation of SPAN 011.

**Attribute/Distribution:** HU

**SPAN 091 Spanish Language & Culture Abroad 1-8 Credit**

Intensive study of conversation in the language of the country; reading, development of writing skills and selected aspects of the culture.

**SPAN 133 Spanish Phonetics and Pronunciation 4 Credits**

Comparison of Spanish and English sounds; descriptions of Spanish vowels and consonants in their various positions. Oral practice with special emphasis on accent and intonation patterns.

**Attribute/Distribution:** HU

**SPAN 141 Advanced Spanish Grammar 4 Credits**

Intensive review of Spanish grammar with stress on finer points.

Analysis of syntax and style. Improvement of grammar through composition. Heritage speakers should substitute with another 100-level class.

**Attribute/Distribution:** HU

**SPAN 142 Advanced Conversational Spanish 4 Credits**

Conversational practice stressing the building of vocabulary based on literary texts and topics of general interest. Designed to stimulate fluent and spontaneous use of spoken Spanish. Course does not count toward completion of major.

**Attribute/Distribution:** HU

**SPAN 151 Cultural Evolution Spain 4 Credits**

The historical and cultural evolution of Spain. Discussion of major literary works in their cultural and historical contexts.

**Attribute/Distribution:** HU

**SPAN 152 Cultural Evolution of Latin America 4 Credits**

The historical and cultural evolution of Latin America. Discussion of representative literary works in their cultural and historical contexts.

**Attribute/Distribution:** HU

**SPAN 191 Spanish Language & Culture Abroad II 1-8 Credit**

Intensive study of conversation in the language of the country; rapid review of basic grammar, the reading and analysis of moderately difficult texts, development of rudimentary writing skills, supplemented study of selected aspects of contemporary civilizations. Prerequisites: consent of chair and proficiency examination in the target country.

**SPAN 199 Spanish Special Topics 3,4 Credits**

For students who take a course, not offered at Lehigh, at another institution. May be repeated once for credit. Consent of instructor required.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**SPAN 211 Business Spanish 4 Credits**

An introduction to business concepts and vocabulary in Spanish. Letter writing, specialized professional vocabulary, and review of grammar. Prerequisites as noted below.

**Prerequisites:** SPAN 141

**Attribute/Distribution:** HU

**SPAN 212 Spanish Writing Skills 4 Credits**

Improving writing proficiency through practice in composition and translation.

**Attribute/Distribution:** HU

**SPAN 213 Introduction to Hispanic Literature and Film 4 Credits**

An introduction to the analysis of Latin American and Spanish cultural productions (mainly literature and film).

**Attribute/Distribution:** HU

**SPAN 243 Indigenous Cultures in Spanish America 4 Credits**

A survey of Spanish American narratives that deal with the relationship between indigenous and occidental cultures. While examining works created from the late 19th century up until present day, we analyze the construction of cultural identity in several countries including Bolivia, Ecuador, and Mexico. Analysis will include works of poetry, short story, novel, essay, and film by several influential artists: Clorinda Matto de Turner, Jorge Icaza and José María Arguedas, to name just a few.

**SPAN 263 The Spanish American Short Story 4 Credits**

Comparative study of representative works by major writers such as Quiroga, Borges, and Cortazar, among others.

**Attribute/Distribution:** HU

**SPAN 265 Spanish and Latin American Cinema 4 Credits**

An introduction to cinema in the Spanish-speaking world. Oral discussion and written analysis of selected films. Students view films independently.

**Attribute/Distribution:** HU

**SPAN 270 Communicating in Spanish for Medical Personnel 4 Credits**

For prospective medical personnel communicating with Spanish-speaking patients. Dialogues, healthcare vocabulary. Review of grammar. Prerequisites as noted below.

**Prerequisites:** SPAN 141

**Attribute/Distribution:** HU

**SPAN 275 Introduction to Hispanic Women Writers 4 Credits**

The objective of this class is to introduce students to Hispanic contemporary female authors from Latin America, Spain, and the United States through the analysis of all literary genres (novel, short story, poetry, essay, and drama). This class provides students with a solid introduction to Hispanic women's writing from the last years of the Nineteenth Century to the present, as well as to feminist literary theory.

**Attribute/Distribution:** HU

**SPAN 276 Contemporary Literature Of The Southern Cone 4 Credits**

This course focuses on the study of the literature of Argentina, Chile, and Uruguay from the beginning of the 20th Century to the present. The class is devoted both to analyze the works of the most important authors from the Southern Cone through different literary genres (drama, novel, short story, and poetry) as well as to study how these texts represent the cultural and historical particularities of the region. Special attention is paid to the unique contexts in which this literature is produced, particularly the periods of political instability and state violence and repression. Texts by Jorge Luis Borges, Pablo Neruda, Manuel Puig, Griselda Gambaro, Cristina Peri Rossi, and Antonio Skarmeta, among others, are studied. Also, historical and theoretical readings, films, and documentaries are used to supplement the literary texts.

**SPAN 290 Spanish Special Topics 2-4 Credits**

Study of an author or theme, or completion of a special project. Topics may vary. May be repeated once for credit.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**SPAN 291 Spanish Language & Culture Abroad III 1-8 Credit**

Intensive practice of speaking and writing in the language of the country aimed at providing the student with extensive proficiency of expression and the ability to discriminate linguistic usage. Idiomatic expressions and an introduction to stylistics. Reading and analysis of more difficult texts, supplemented by in-depth study of selected aspects of contemporary civilization. Prerequisites: consent of chair and proficiency examination in the target country.

**SPAN 300 Apprentice Teaching 1-4 Credit**

**Repeat Status:** Course may be repeated.

**SPAN 303 Don Quixote 4 Credits**

Reading and critical analysis of the original text. Focus on the place of the novel in World Literature and the universality of the applications of the novel.

**Attribute/Distribution:** HU

**SPAN 305 Spanish Literature of the Middle Ages 4 Credits**

Reading and discussion of outstanding works such as El Cid, El Libro de Buen Amor and La Celestina. Topics vary.

**Attribute/Distribution:** HU

**SPAN 308 Spanish Novel Since 1939 4 Credits**

The evolution of the novel from post civil war to the present. Reading of Cela, Laforet, Delibes, Rodoreda, and Marsé, among others.

**Attribute/Distribution:** HU

**SPAN 320 Literature Of Spanish Caribbean 4 Credits**

Study of representative works with emphasis on Cuba and Puerto Rico. Writers include Barnet, Carpentier, Sánchez, and Rodríguez Juliá.

**Attribute/Distribution:** HU

**SPAN 321 Children and Adolescents in Contemporary Spanish American Literature 4 Credits**

Discussion of narrative techniques and the category of the self as they relate to the images of adolescence and childhood in works by such authors as Vargas Llosa, Reinaldo Arenas, José Bianco, Silvina Ocampo.

**Attribute/Distribution:** HU

**SPAN 322 The Short Novel in Contemporary Spanish American Literature 4 Credits**

Reading and discussion of representative works by García Márquez, Onetti, Rulfo, and Bioy Casares, among others.

**Attribute/Distribution:** HU

**SPAN 323 Literature and Revolution in Contemporary Cuba 4 Credits**

Study of works written after 1959 by dissident, nondissident, and exiled authors (Desnoes, Norberto Fuentes, Benítez Rojo, and Pedro Juan Gutiérrez, among others).

**Attribute/Distribution:** HU

**SPAN 325 Hispanic Literature Of The United States 4 Credits**

Discussion of fiction, poetry, drama, and film from the main groups in the U.S. Hispanic population. Discussion of Hispanic ethnic identity, bilingualism, and minority issues.

**Attribute/Distribution:** HU

**SPAN 326 Tradition and Resistance: Women Writers of Latin America 4 Credits**

Study of poetry and narrative works by Latin American women writers. Authors include Rosario Ferré, Rosario Castellanos, Elena Poniatowska, and Cristina Peri Rossi, among others. Prerequisites as noted below.

**Prerequisites:** SPAN 152

**Attribute/Distribution:** HU

**SPAN 342 The New Narrative in Spanish American Literature 4 Credits**

Critical evaluation of distinguished works of Spanish American prose fiction of the 1960's and 70's. Readings by Donoso, Fuentes, García Márquez, and Vargas Llosa, among others.

**Attribute/Distribution:** HU

**SPAN 345 Testimonial Writing of the Hispanic World 4 Credits**

This course explores the genre testimonio, which confronts the official history of the Latin American and Spanish dictatorships and portrays the experiences and struggles of those who suffered political repression. The course focuses on the analysis of both literary and visual testimonios from the Hispanic world, as well as on theoretical issues concerning discourses of truth.

**Attribute/Distribution:** HU

**SPAN 346 Contemporary Hispanic Women Writers: The Novelists 4 Credits**

This course explores the works of Hispanic women writers who have been oppositional to hegemonic cultural politics during the Twentieth Century in Latin America and Spain. Grounding the readings in their particular contexts, the class discusses the issues these writers define as important in their work, the impact of their creations in both the literary canon as well as in the politics of their countries, the use of literature as a weapon to empower minority positions, and the effect of their narratives on the changing literary canon. Special attention will be paid to issues related to interpretations of history, exile, different forms of violence and repression, expressions of desire, and sexuality.

**Attribute/Distribution:** HU

**SPAN 379 Spanish Internship 2-4 Credits**

Designed to give advanced qualified students the chance to acquire field experience and training with selected firms and governmental agencies in Spanish-speaking countries or U.S. agencies serving the Hispanic community. Assigned readings, written reports, and employer performance evaluations are required. Students must be registered through an educational institution to receive credit. Consent of instructor required. Prerequisites as noted below.

**Prerequisites:** SPAN 141

**Attribute/Distribution:** HU

**SPAN 389 Honors Project 1-8 Credit**

**Repeat Status:** Course may be repeated.

**SPAN 390 Spanish Special Topics 2-4 Credits**

Study of an author, theme or period. Topics vary. May be repeated once for credit. Consent of instructor required.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**Music**

The study of music develops skills which will serve the student well in any career: self-discipline, teamwork, problem solving and leadership. A student graduating with the B.A. degree in music will have a strong foundation in music theory and substantial exposure to western music from the Middle Ages to the present. This curriculum will prepare a student for graduate studies in musicology, music theory, composition, jazz, conducting, or performance. A music major or minor taken in conjunction with a business major may lead to a variety of careers in arts management or in the recording and music publishing industries. For some a double major or a minor in music will not lead to a career but to a lifelong involvement with an art form that gives lasting satisfaction.

The music department (<http://music.cas2.lehigh.edu>) also offers significant performance experiences in instrumental and vocal ensembles, large and small, and in private instruction. The Zoellner Arts Center (<http://zoellner.cas2.lehigh.edu>) facilities include a Listening Library, practice rooms, a composition and digital class piano studio, a fine recording studio, classrooms and rehearsal rooms. Most importantly, the center boasts its concert facility, Baker Hall. With its 1000-seat capacity and excellent acoustics, it is flexible both on the stage (concert or theater mode) and in seating arrangements. The fully adjustable pit can serve opera or musical theatre, can provide additional seating, or can become an extension of the stage.

**Professors.** Paul F. Salerni, PhD (Harvard University); Steven P. Sametz, DMUS (University of Wisconsin); Nadine J. Sine, PhD (New York University)

**Associate Professors.** Eugene O. Albulescu, MA (Indiana University); William Warfield, MA (Manhattan School of Music)

**Lecturer.** David B. Diggs, MMUS (Suny College Stony Brook)

**Professors Of Practice.** Michael Jorgensen, DMUS (Florida State University); Sun Min Lee, MA (Westminster Choir College)

**Emeritus.** Jerry T. Bidlack, MA (Boston University)

**Major program**

The music program offers two separate programs, each earning the Bachelor of Arts degree, the B.A. in Music and the B.A. in Music Composition.

The Bachelor of Arts in Music (36-credit minimum) is for those students who wish to have double majors, who might choose a related field (e.g., arts management, part-time performance careers in orchestras) or who simply want a concentrated exposure to music study. Students choose between five different concentrations: performance; history and literature; theory and composition; jazz; conducting. For those who intend to pursue graduate study in music or a performing career, the major program should be viewed as the minimum requirement. Such students should regularly seek the advice of department faculty in expanding their program to suit their particular needs and goals.

**Performance Concentration****Theory and Musicianship Skills**

MUS 011	Basic Musicianship	2
MUS 002	Keyboard Harmony I	1
MUS 082	Harmony I	3
MUS 003	Keyboard Harmony II	1
MUS 007	Aural Skills	1
MUS 083	Harmony II	3
MUS 004	Keyboard Harmony III	1
MUS 008	Aural Skills II	1

**Music History**

Select two of the following:		6
MUS 233	Medieval and Renaissance Music	
MUS 234	Baroque and Classical Music	
MUS 235	Romantic Music	
MUS 236	Music Since 1900	
MUS 336	Seminar in the History of Musical Style	3

**Additional Requirements**

Lessons, ensembles and recitals	11
Music electives	3
<b>Total Credits</b>	<b>36</b>

The student must perform a half recital in the junior year, a full recital in the senior year, and juries during the sophomore and junior years. Jury Requirement: see website at <http://www.lehigh.edu/music>

**History Concentration****Theory and Musicianship Skills**

MUS 011	Basic Musicianship	2
MUS 002	Keyboard Harmony I	1
MUS 082	Harmony I	3
MUS 003	Keyboard Harmony II	1
MUS 007	Aural Skills	1
MUS 083	Harmony II	3
MUS 004	Keyboard Harmony III	1
MUS 008	Aural Skills II	1

**Music History**

MUS 233	Medieval and Renaissance Music	3
MUS 234	Baroque and Classical Music	3
MUS 235	Romantic Music	3
MUS 236	Music Since 1900	3
MUS 336	Seminar in the History of Musical Style	3

**Additional Requirements**

Electives, lessons, and ensembles <sup>1</sup>	8	
MUS 350	Senior Project <sup>2</sup>	1-6
<b>Total Credits</b>	<b>37-42</b>	

<sup>1</sup> At least three must be in performance.

<sup>2</sup> The students must produce a major research project during the senior year.

**Composition and Theory Concentration**

<b>Theory</b>		
MUS 082	Harmony I	3
MUS 003	Keyboard Harmony II	1
MUS 007	Aural Skills	1
MUS 083	Harmony II	3
MUS 004	Keyboard Harmony III	1
MUS 008	Aural Skills II	1
MUS 243	Counterpoint	4
MUS 245	Classical and Romantic Forms	4

**Music History**

MUS 336	Seminar in the History of Musical Style	3
Select one of the following:		
MUS 233	Medieval and Renaissance Music	
MUS 234	Baroque and Classical Music	
MUS 235	Romantic Music	
MUS 236	Music Since 1900	

**Composition**

MUS 253	Composition I	4
MUS 254	Composition II	4

**Additional Requirements**

Lessons or ensembles	4
Total Credits	36

Students must produce a substantial composition or theoretical analysis under the direction of department faculty during the senior year. A keyboard test is required to enter composition class.

**Jazz Concentration****Music Theory and Musicianship Skills**

MUS 011	Basic Musicianship	2
MUS 002	Keyboard Harmony I	1
MUS 082	Harmony I	3
MUS 003	Keyboard Harmony II	1
MUS 007	Aural Skills	1
MUS 083	Harmony II	3
MUS 004	Keyboard Harmony III	1
MUS 008	Aural Skills II	1

**Jazz Theory**

MUS 139	Jazz Theory	3
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**Jazz History**

MUS 128	Jazz History I	3
MUS 129	Jazz History II	3
MUS 236	Music Since 1900	3

**Small Jazz groups**

Select a minimum of 4 credits:		4
MUS 049	Small Jazz Ensembles	

**Jazz Performance**

Select six credits:		6
MUS 024	Jazz Ensemble	
MUS 025	Jazz Band	

**Additional Requirement**

MUS 350	Senior Project (for variable credit) <sup>1</sup>	1-6
Total Credits		36-41

<sup>1</sup> Under faculty direction.

**Conducting Concentration****Music Theory and Musicianship Skills**

MUS 011	Basic Musicianship	2
MUS 002	Keyboard Harmony I	1
MUS 082	Harmony I	3
MUS 003	Keyboard Harmony II	1

MUS 007	Aural Skills	1
MUS 083	Harmony II	3
MUS 004	Keyboard Harmony III	1
MUS 008	Aural Skills II	1

**Music History**

MUS 336	Seminar in the History of Musical Style	3
Select two of the following:		
MUS 233	Medieval and Renaissance Music	
MUS 234	Baroque and Classical Music	
MUS 235	Romantic Music	
MUS 236	Music Since 1900	

**Conducting**

MUS 321	Conducting I	2
MUS 322	Conducting II	2

Select at least two of the following:

MUS 311	Conducting Internship (one must be in orchestra)	4
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**Additional Requirement**

Performance Electives (lessons and ensembles)	6
Total Credits	36

A piano proficiency exam must be completed before the end of the sophomore year. The student must undertake a senior project under faculty direction.

**Bachelor of Arts in Music Composition**

The Bachelor of Arts in Music Composition is designed for students committed to pursuing music composition beyond the undergraduate level. It is an intensive composition program with a 54-credit minimum.

**Music Theory**

MUS 082	Harmony I	3
MUS 003	Keyboard Harmony II	1
MUS 007	Aural Skills	1
MUS 083	Harmony II	3
MUS 004	Keyboard Harmony III	1
MUS 008	Aural Skills II	1
MUS 139	Jazz Theory	3
MUS 243	Counterpoint	4
MUS 245	Classical and Romantic Forms	4
MUS 331	Advanced Analysis	4

**Music History**

MUS 236	Music Since 1900	3
MUS 336	Seminar in the History of Musical Style	3

Select one of the following:

MUS 129	Jazz History II	3
MUS 233	Medieval and Renaissance Music	
MUS 234	Baroque and Classical Music	
MUS 235	Romantic Music	

**Composition**

MUS 253	Composition I	4
MUS 254	Composition II	4

Select two semesters of the following:

MUS 353	Composition Seminar	6
MUS 321	Conducting I (one semester)	2

**Electives**

Select four credits of music electives.		4
Total Credits		54

Students will have to pass a piano proficiency exam by the end of the sophomore year. Students will compile a composition portfolio by the end of the senior year.



**Minor programs****Minor in Music**

The minor requires a minimum of 17 credits and may include MUS 090. The program is designed to be flexible but must include:

MUS 011	Basic Musicianship	2
MUS 002	Keyboard Harmony I	1
MUS 082	Harmony I	3
MUS 003	Keyboard Harmony II	1
MUS 007	Aural Skills	1
One history or literature course		3
Select two performance courses:		2
MUS 022 - MUS 079		
Four credits from department offerings		4
<b>Total Credits</b>		<b>17</b>

**Minor in Music Industry**

The music industry minor is intended to provide exposure to basic information, issues and skills useful for students who may want to pursue entry level positions in the music business or to promote their own work. There are six required courses:

MUS 161	Production and Marketing of Sound Recordings	3
MUS 164	Management Of Careers in Performing Arts	3
MUS 261	Recording Techniques I	3
MUS 010 or MUS 011	Basic Skills in Music Basic Musicianship	2
MUS 361	Music Internship	3
ACCT 108 or ACCT 151	Fundamentals of Accounting Introduction to Financial Accounting	3
<b>Total Credits</b>		<b>17</b>

**Music Option**

Although Music and Engineering/Science is not a major in itself, Lehigh attracts many engineering and science students who wish to continue their active involvement in music and the music department. For those students who are interested in pursuing this option, music can be taken as a dual degree (B.S. or B.A.), minor or elective.

**Concert Requirement**

Majors and minors must enroll in MUS 100 and attend concerts approved by the music department for a minimum of three semesters.

**Departmental Honors**

A student must have a 3.75 average in courses in the major to pursue honors. Candidates for departmental honors should submit to the department chair a written proposal, prepared in consultation with a faculty project adviser by the end of the junior year. The project which must go beyond required course work could result in a research paper, a composition or a performance. Upon acceptance of the proposal by the department faculty, the student should register for MUS 350 for one to six credits, which may be taken all at once or over the senior year. The awarding of departmental honors will be contingent on the quality of the completed project. Students who complete two concentrations in the major may also petition for consideration.

**Private lessons**

Lessons in most instruments and voice may be taken for one credit per semester. They must be arranged through the department at set fees that are not included in tuition. Please note that registering for lessons cannot guarantee availability due to difficulties in scheduling. To avoid overloading, students may take lessons for no credit by registering in the department office.

**Performing groups**

Admission to performing ensembles is by audition (except Choral Union, Symphonic Band and Marching 97.) Students receive one credit per semester by registering for the appropriate course number. Although there is no limit to the number of these courses that may be taken,

students should check with their adviser to determine the number that may be applied toward graduation.

**Course Offerings**

Please note that many upper level courses have no prerequisites beyond MUS 010 or MUS 011 and are open to anyone with basic knowledge of musical terminology.

**Courses****MUS 002 Keyboard Harmony I 1 Credit**

For intended majors and minors only. Co-requisite: MUS 11. Beginning piano skills designed to enable the student to use the piano as a tool. Major and minor scales in both hands, forming chords, elementary sight reading. Students may test out upon examination. Co-Requisite: MUS 011.

**Prerequisites:** MUS 011

**Can be taken Concurrently:** MUS 011

**Attribute/Distribution:** HU

**MUS 003 Keyboard Harmony II 1 Credit**

Continuation of MUS 2. Diatonic progressions in major and minor and more advanced sight reading. Students may test out upon examination. Co-Requisite: MUS 082. Prerequisites as noted below.

**Prerequisites:** MUS 011

**Attribute/Distribution:** HU

**MUS 004 Keyboard Harmony III 1 Credit**

Additional keyboard skills, including progressions with secondary chords, modulations, and sight reading. Students may test out upon examination. Co-Requisite: MUS 083. Prerequisites as noted below.

**Prerequisites:** MUS 082

**Attribute/Distribution:** HU

**MUS 007 Aural Skills 1 Credit**

Sight singing, rhythm exercises, and ear training through dictation exercises. Corequisite: MUS 082.

**Prerequisites:** MUS 011 and MUS 082

**Can be taken Concurrently:** MUS 082

**Attribute/Distribution:** HU

**MUS 008 Aural Skills II 1 Credit**

Continuation of MUS 007. Corequisite: MUS 083.

**Prerequisites:** MUS 007 and MUS 082

**Can be taken Concurrently:** MUS 082

**Attribute/Distribution:** HU

**MUS 010 Basic Skills in Music 2 Credits**

Rudiments of musical notation, beginning skills in sight singing, ear training, rhythm and keyboard. Intended for anyone who does not plan to major or minor.

**Attribute/Distribution:** HU

**MUS 011 Basic Musicianship 2 Credits**

For intended majors and minors. Development of basic skills in using notation, sight singing and ear training. Co-requisite: MUS 2.

**Attribute/Distribution:** HU

**MUS 012 Surveys In Music 3 Credits**

Varied topics in music for the non-major such as Italian opera, Keyboard Music, and the Symphony. Emphasis on developing listening skills and acquaintance with important works in the genre.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**MUS 021 Marching Band 1 Credit**

No audition required for admission.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** ND

**MUS 022 Wind Ensemble 1 Credit**

Admission by audition.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**MUS 023 Symphonic Band 1 Credit**

No audition required for admission.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**MUS 024 Jazz Ensemble 1 Credit**

Up to six credits may be used for graduation credit in CEAS and CBE.

Admission by audition.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**MUS 025 Jazz Band 1 Credit**

Up to six credits may be used for graduation credit in CEAS and CBE.

Admission by audition.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**MUS 027 Jazz Orchestra 1 Credit**

Student/community/professional musicians performing classic, contemporary and original big band literature.

**Repeat Status:** Course may be repeated.

**MUS 031 University Choir 1 Credit**

Admission by audition.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**MUS 032 Choral Union 1 Credit**

No audition required for admission.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**MUS 033 Glee Club 1 Credit**

Admission by audition.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**MUS 034 Freshman Lab Choir 0 Credits**

Admission by audition.

**Attribute/Distribution:** HU

**MUS 035 Dolce Women's Choir 1 Credit**

Women from university choir sing treble music.

**Repeat Status:** Course may be repeated.

**MUS 048 Chamber Music Collegium 1 Credit**

Admission by audition.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**MUS 049 Small Jazz Ensembles 1 Credit**

Admission by audition.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**MUS 061 Philharmonic Orchestra 1 Credit**

Admission by audition.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**MUS 065 Class Guitar for Beginners 1 Credit**

Beginning techniques and skills for guitar, either acoustic or electric. For students with less than a year of guitar instruction. Students supply their own instruments.

**Attribute/Distribution:** HU

**MUS 066 Class Voice for Beginners 1 Credit**

Group instruction for beginning students of voice, including breathing and vocal production techniques; diction; beginning solo pieces.

**Attribute/Distribution:** HU

**MUS 067 Class Drum Set for Beginners 1 Credit**

Rudiments of drum set playing for students with less than a year of drum instruction.

**Attribute/Distribution:** HU

**MUS 068 Class Piano for Beginners I 1 Credit**

Instruction for beginning piano students, including rudiments of musical notation in relation to the keyboard; beginning pieces for solo piano and the group.

**Attribute/Distribution:** HU

**MUS 069 Class Piano for Beginners II 1 Credit**

A continuation of MUS 68. After a second semester of class piano, the student should be ready to benefit from private lesson instruction.

**Attribute/Distribution:** HU

**MUS 071 Private Piano Study 1 Credit**

Up to six credits may be used for graduation credit in CEAS and CBE.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**MUS 072 Private Vocal Study 1 Credit**

Private instruction. Fees associated with course.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**MUS 073 Private String Study 1 Credit**

Private instruction. Fees associated with course.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**MUS 074 Private Woodwind Study 1 Credit**

Private instruction. Fees associated with course.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**MUS 075 Private Brass Study 1 Credit**

Private instruction. Fees associated with course.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**MUS 076 Private Percussion Study 1 Credit**

Private instruction. Fees associated with course.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**MUS 077 Private Organ Study 1 Credit**

Private instruction. Fees associated with course.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**MUS 079 Private Electric Guitar Study 1 Credit**

Private instruction. Fees associated with course.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**MUS 082 Harmony I 3 Credits**

Exercises in writing in four-part chorale style. This includes all diatonic chords and non-harmonic tones. MUS 3 and 7 must be taken concurrently. Prerequisites as noted below.

**Prerequisites:** MUS 011

**Attribute/Distribution:** HU

**MUS 083 Harmony II 3 Credits**

Continuation of MUS 82 including modulation, chromatic chords, analysis. MUS 4 and 8 must be taken concurrently. Prerequisites as noted below.

**Prerequisites:** MUS 082 and MUS 007

**Attribute/Distribution:** HU

**MUS 084 Private Drumset Study 1 Credit**

Up to six credits may be used for graduation credit in CEAS and CBE.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**MUS 100 Concert Requirement 0 Credits**

Three concerts approved by the department (for majors and minors).

**Repeat Status:** Course may be repeated.

**MUS 128 Jazz History I 3 Credits**

A study of the roots of jazz. Starting in West Africa, the course traces the synthesis of African and European elements to 1945. Musicians covered are Gottshalk, Bolden, Morton, Armstrong, Hawkins, Basie, Ellington and others.

**Attribute/Distribution:** HU

**MUS 129 Jazz History II 3 Credits**

A survey of modern jazz from 1945 to the present. Musicians covered include Parker, Gillespie, Monk, Davis, Coltrane, Hancock, and Coleman. Can be taken independently of Jazz History I, but the first course would be helpful.

**Attribute/Distribution:** HU

**MUS 130 Jazz Masters 3 Credits**

An in-depth study of the music of a single major figure in jazz history, such as Miles Davis, Ornette Coleman, Duke Ellington. May be repeated for credits as title varies.

**Attribute/Distribution:** HU

**MUS 139 Jazz Theory 3 Credits**

Study of the music theory that is the foundation of a good jazz solo, composition or arrangement. Study of the modes of the major and melodic minor scale, chord/scale theory using major, melodic minor, diminished, and whole-tone scales. Basic chord progressions, functional analysis of jazz tunes, and ear training are also included. Prerequisites as noted below.

**Prerequisites:** MUS 082

**Attribute/Distribution:** HU

**MUS 151 Vocal Diction 1 Credit**

Introduction to the use of the International Phonetic Alphabet. Application to French, Italian, German and English diction using art song repertoire. Preparation of a song in each language.

**Attribute/Distribution:** HU

**MUS 161 Production and Marketing of Sound Recordings 3 Credits**

Foundations for organizing a recording project to be carried out by the class, which works in teams. This course will focus especially on artist negotiations, recording techniques, music publishing and manufacturing.

**Attribute/Distribution:** ND

**MUS 164 Management Of Careers in Performing Arts 3 Credits**

An overview of what performing artists and managers experience during cycles of career development. Topics include recognition of talent, positioning in the marketplace, creating support structures and attainment of personal goals. Students will be required to apply practical techniques in furthering the career of a chosen artist.

**Attribute/Distribution:** ND

**MUS 170 Private Instruction for Performance Concentrators 2 Credits**

Lesson fees apply. Repeatable for credit. Restricted to music majors concentrating in performance.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**MUS 171 Accompanying 1 Credit**

Introduction to ensemble performance including sight-reading techniques, application of chord progressions and beginning improvisation techniques at the keyboard. May be repeated for credit.

**Attribute/Distribution:** HU

**MUS 233 Medieval and Renaissance Music 3 Credits**

Development of musical style from early Christian chant to the sacred and secular forms of the late 16th century, viewed in cultural contexts.

**Prerequisites:** MUS 011 or MUS 080

**Attribute/Distribution:** HU

**MUS 234 Baroque and Classical Music 3 Credits**

The major genres and composers of the 17th and 18th centuries studied in their cultural context.

**Prerequisites:** MUS 011

**Attribute/Distribution:** HU

**MUS 235 Romantic Music 3 Credits**

Study of the major composers and their works from late Beethoven to Mahler and Strauss.

**Prerequisites:** MUS 011

**Attribute/Distribution:** HU

**MUS 236 Music Since 1900 3 Credits**

Beginning with the major trends at the turn of the century, a study of the important composers and works of the last century to the present.

**Prerequisites:** MUS 011

**Attribute/Distribution:** HU

**MUS 237 Advanced Violin Technique 1 Credit**

To teach advanced violin or viola students execution of various bow strokes, left-hand technique, complex rhythms and ensemble skills.

**MUS 243 Counterpoint 4 Credits**

Writing and analyzing pieces in Renaissance and Baroque contrapuntal styles. Prerequisites as noted below.

**Prerequisites:** MUS 083

**Attribute/Distribution:** ND

**MUS 245 Classical and Romantic Forms 4 Credits**

Analyzing and writing pieces in classical and romantic forms. Exercises in chromatic harmony. Prerequisites as noted below.

**Prerequisites:** MUS 243

**Attribute/Distribution:** ND

**MUS 247 Advanced Musicianship 1 Credit**

To teach students advanced exercises in sight singing and ear training. Prerequisites as noted below.

**Prerequisites:** MUS 008

**MUS 251 Special Topics 1-3 Credit**

Study of musical topics in history or composition not covered in regular courses. May be repeated for credit as title varies. Consent of instructor required.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**MUS 253 Composition I 4 Credits**

Writing for acoustic and electronic instruments based on 20th century models. Acoustic orchestration, digital synthesis, effects processing. Use of the computer for score preparation and as a compositional tool. Prerequisites as noted below or consent of instructor.

**Prerequisites:** MUS 083 and MUS 008

**Attribute/Distribution:** ND

**MUS 254 Composition II 4 Credits**

Continuation of MUS 253. Prerequisites as noted below.

**Prerequisites:** (MUS 253)

**Attribute/Distribution:** ND

**MUS 261 Recording Techniques I 3 Credits**

Recording music in various popular and classical styles using state of the art studio equipment. Topics include microphone choice, placement, mixing, effects processing, digital editing and post production.

**Attribute/Distribution:** ND

**MUS 262 Recording Techniques II 3 Credits**

Continuation of Recording Techniques I. Prerequisites as noted below.

**Prerequisites:** (MUS 261)

**Attribute/Distribution:** ND

**MUS 291 Independent Study 1-3 Credit**

Individually supervised work in history or composition, or continuation of projects begun in regular courses. May be repeated for credit. Consent of department chair required.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**MUS 300 Apprentice Teaching 1-3 Credit**

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** ND

**MUS 311 Conducting Internship 2 Credits**

Work under the direction of one of the faculty directors to learn the organization and musical tasks required of directors as they prepare ensembles for performance.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**MUS 312 Advanced Choral Composition 2 Credits**

Intensive, weeklong seminar/workshop for individual study with international faculty. Joint seminars and lab choir rehearsals on choral literature; rehearsals and premieres of student works. New works and repertoire presented in final concert conducted by faculty and participants.

**MUS 321 Conducting I 2 Credits**

Beginning study of conducting techniques, including score reading and preparation, analysis, conducting patterns and gestures. Prerequisites as noted below or consent of instructor.

**Prerequisites:** (MUS 083)

**Attribute/Distribution:** HU

**MUS 322 Conducting II 2 Credits**

Continuation of MUS 321. Prerequisites as noted below.

**Prerequisites:** (MUS 321)

**Attribute/Distribution:** HU

**MUS 331 Advanced Analysis 4 Credits**

In-depth analysis of music from the Western tradition. Compositions studied to include at least one orchestral piece, one piece with text (song cycle or opera) and one piece using serial procedures. Introduction to Schenkerian analysis.

**Attribute/Distribution:** HU

**MUS 336 Seminar in the History of Musical Style 3 Credits**

Study and analysis of the development of musical language and genre from the middle ages to the present. Prerequisites as noted below.

**Prerequisites:** MUS 083

**Can be taken Concurrently:** MUS 083

**Attribute/Distribution:** ND

**MUS 350 Senior Project 1-6 Credit**

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** ND

**MUS 353 Composition Seminar 3 Credits**

Seminar review of original compositions alternating with private lessons in composition. The seminar is intended for students doing either independent work in composition or senior projects.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**MUS 361 Music Internship 3 Credits****MUS 370 Recital 1-2 Credit**

Department permission. Repeatable for credit.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**MUS 389 Honors Project 1-8 Credit**

**Repeat Status:** Course may be repeated.

**MUS 412 Advanced Choral Composition 2 Credits**

Intensive, weeklong seminar/workshop for individual study with international faculty. Joint seminars and lab choir rehearsals on choral literature; rehearsals and premieres of student works. New works and repertoire presented in final concert conducted by faculty and participants.

**Philosophy**

Philosophy is born of discomfort. Whether it is the need to account for tragedies, the incongruities between our assumptions about the world and what experience and science reveal, being exposed to different ways of thinking, philosophy arises in those contexts in which serious questions emerge about the adequacy of our deepest assumptions.

Philosophy is concerned with foundational questions about the nature and extent of human knowledge (epistemology), about the nature of reality and the distinction between appearance and reality (metaphysics), about the nature, scope, and grounds of moral value (ethics), and about the nature and theoretical foundations of formal reasoning and valid inference (logic).

**Professors.** Mark H. Bickhard, PhD (University of Chicago); Robin S. Dillon, PhD (University of Pittsburgh); Steven L. Goldman, DSC (Boston University); Roslyn E. Weiss, MA (Baltimore Hebrew University)

**Associate Professors.** Gordon C. F. Bearn, PhD (Yale University); Michael Mendelson, PhD (University of California San Diego); Aladdin M. Yaqub, PhD (University of Wisconsin)

**Emeriti.** Robert F. Barnes, Jr., PhD (University of California Berkeley); Norman P. Melchert, PhD (University of Pennsylvania)

**THE MAJOR PROGRAM**

The major program in philosophy is designed to provide a broad exposure to the major areas of philosophy as well as a strong grounding in the history of the western philosophical tradition. The program emphasizes the close reading and critical evaluation of classic texts from ancient times to the present, and students can expect to develop sophisticated analytic and expository skills that will enable them to

engage in original, critical reflection on their own. The major program provides excellent preparation for graduate study in philosophy as well as a solid foundation for any career that places a premium upon clear, careful thinking, rigorous conceptual and analytical skills, and effective written and oral communication.

The major consists of a minimum of 40 credits in philosophy. These must include PHIL 292 Philosophical Methods (2 credits) for junior majors, the senior thesis sequence PHIL 390 (2 credits) and PHIL 391 (6 credits), and 16 credits of Disciplinary Area courses. At least 12 credits in addition to PHIL 292, PHIL 390, and PHIL 391 must be at the 200-level or above. Independent studies may be taken to satisfy major requirements.

**Major Requirements****Thesis and Methods**

PHIL 292	Philosophical Methods	4
PHIL 390	Senior Thesis	2
PHIL 391	Senior Thesis	4

**Disciplinary Areas****Logic**

Select one of the following:		4
PHIL 114	Symbolic Logic	
PHIL 115	Topics in Philosophical Logic	
PHIL 303	Mathematical Logic	

**Ethics**

Select one of the following:		4
PHIL 008	Ethics In Global Perspectives	
PHIL 105	Ethics	
PHIL 116	Bioethics	
PHIL 205	Contemporary Ethics	
PHIL 206	Figures/Themes in Ethics	

**History of Philosophy**

Select two of the following:		8
PHIL 131	Ancient Philosophy	
PHIL 132	Hellenistic Philosophy	
PHIL 133	Medieval Philosophy	
PHIL 135	Modern Philosophy	
PHIL 137	Nineteenth Century Philosophy	
PHIL 139	Contemporary Philosophy	
PHIL 231	Figures/Themes in Ancient Philosophy	
PHIL 232	Figures/Themes in Hellenistic Philosophy	
PHIL 233	Figures/Themes in Medieval Philosophy	
PHIL 235	Figures/Themes in Modern Philosophy	
PHIL 237	Figures/Themes in Nineteenth Century Philosophy	
PHIL 239	Figures/Themes in Contemporary Philosophy	

**Advanced Courses**

Select 12 credits of courses at the 200-level or above <sup>1</sup> 12

**Independent Studies**

Independent studies may be taken to satisfy major requirements. 2

**Total Credits** 40

<sup>1</sup> Disciplinary area courses can satisfy this requirement.

**Writing-Intensive Requirement**

Majors are strongly encouraged to fulfill their junior writing-intensive requirement by taking a WI-designated philosophy course.

**Senior Thesis**

The senior thesis is a year-long independent project during which philosophy majors, with the consent and under the guidance of a philosophy faculty advisor, investigate a topic of special interest to them. The topic may be historical or non-historical, pure or applied, disciplinary

or interdisciplinary; the only constraint is that the topic must be approved by the thesis advisor. Seniors take PHIL 390 in the fall, devoting their energies to refining the topic, working through the bulk of the essential literature, and producing a paper roughly 20 pages in length on the thesis topic. PHIL 391 is taken in the spring semester of the senior year and is focused on investigating the topic more intensively, expanding, revising, and refining the fall paper into a substantial senior thesis roughly 50 pages in length.

### Honors

Departmental honors in philosophy are awarded to graduating seniors who satisfy the following two criteria:

1. at the start of their final semester, their overall GPA is 3.25 or higher and their GPA in philosophy is 3.5 or higher, and
2. their senior thesis receives an A from the thesis advisor and then is judged by the whole department faculty to be well-researched, well-argued, well-organized, well-written, and to exhibit original philosophical thinking.

Majors planning to pursue graduate study in philosophy are strongly encouraged to strive for Honors and to include the following courses in their programs:

PHIL 105	Ethics	4
PHIL 114	Symbolic Logic	4
PHIL 131	Ancient Philosophy	4
PHIL 135	Modern Philosophy	4
And at least one of the following:		4
PHIL 220	Theory Of Knowledge	
PHIL 221	Metaphysics	
PHIL 250	Philosophy of Mind	
Total Credits		20

### The Minor Program

The minor in philosophy consists of a minimum of 16 credits:

At least one course at the 200-level or above	4
At least two courses taught by a member of the Philosophy Department	8
Independent studies may be taken to satisfy the minor requirements.	4
Total Credits	16

Minor programs are planned in conjunction with the departmental advisor who will help the student plan a program compatible with his or her interests. Minor programs may be, but do not have to be, focused in a particular area such as ethics or the history of philosophy or philosophy of mind.

### Courses

#### PHIL 001 The Examined Life: An Introduction To Philosophy 4 Credits

What makes a life meaningful, what makes it worth living? In pursuit of an answer to this question this course examines many of the basic questions of philosophy: ethical questions about justice and virtue, epistemological questions about the limits of human knowledge, metaphysical questions about what there is.

**Attribute/Distribution:** HU

#### PHIL 003 Global Religion, Global Ethics 4 Credits

Introduction to philosophical and religious modes of moral thinking, with attention given to ethical issues as they arise cross-culturally in and through religious traditions. The course will reference the United Nations Millennium Goals to consider family life and the role of women, social justice, the environment, and ethical ideals.

**Attribute/Distribution:** HU

#### PHIL 005 Contemporary Moral Problems 4 Credits

An examination of contemporary issues that raise questions about right and wrong, good and bad, both for individuals and for social policy, using the methods, theories, and concepts of moral philosophy.

#### PHIL 008 Ethics In Global Perspectives 4 Credits

Examination of the moral perspectives of a variety of different ethical outlooks, including Euro-American, Hindu, Buddhist, Confucian, African, and Islamic traditions, and of serious moral problems arising from globalization, including the increasing gap between the rich so-called First World nations and the poor so-called Third World nations, global environmental degradation, war and terrorism.

**Attribute/Distribution:** HU

#### PHIL 100 Introduction to Political Thought 4 Credits

A critical examination of political ideologies: Liberalism, Marxism, Fascism, and Islamism.

**Attribute/Distribution:** ND

#### PHIL 101 Ancient Political Heritage 4 Credits

Important Political thinkers from the pre-Socratics to early, modern political theorists like Machiavelli.

**Attribute/Distribution:** SS

#### PHIL 105 Ethics 4 Credits

Examination of right and wrong, good and bad, from classic sources such as Plato, Aristotle, Hume, Kant, Mill and Nietzsche.

**Attribute/Distribution:** HU

#### PHIL 114 Symbolic Logic 4 Credits

A first course in logical theory, introducing the notions of logical consequence and proof, as well as related concepts such as consistency and contingency. Formal systems taught may include: term logic, sentence logic, and predicate logic. (MA).

**Attribute/Distribution:** MA

#### PHIL 115 Topics in Philosophical Logic 4 Credits

Topics may include the many systems of non-classical logic, truth theory, the impact of incompleteness and undecidability results on philosophy, the foundational projects of various philosopher/mathematicians, or the work of an important figure in the history of philosophical logic. May be taken more than once for credit. Consent of instructor required.

**Attribute/Distribution:** HU

#### PHIL 116 Bioethics 4 Credits

Moral issues that arise in the context of health care and related biomedical fields in the United States today, examined in the light of the nature and foundation of moral rights and obligations. Topics include: confidentiality, informed consent, euthanasia, medical research and experimentation, genetics, and the distribution of health care.

**Attribute/Distribution:** HU

#### PHIL 117 Race And Philosophy 4 Credits

An introduction to the philosophy born of struggle against racism and white supremacy. We will read the work of philosophers, mostly European, who quietly made modern racism possible by inventing the category of race, but we will concentrate on the work of philosophers, mostly of African descent, who for 200 years have struggled to force a philosophical critique of the category of race and the practice of white supremacy.

**Attribute/Distribution:** HU

#### PHIL 118 Ethics in Practice 1-4 Credit

A variable content course focusing on ethical issues arising in a particular profession, such as law health, business, engineering, military. Variable credit. May be taken more than once.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

#### PHIL 120 Philosophy in Film 4 Credits

This seminar course will explore a variety of themes, genres, and movements within cinema from a philosophical perspective. Regular screenings of films from silent era to present. Content may vary depending upon instructor. Course may be repeated for credit if the content varies substantially.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**PHIL 121 Philosophy In Literature 4 Credits**

Exploration of philosophical themes through the study of literature and film. Authors may include: Homer, Euripides, Dante, Rimbaud, Sterne, George Eliot, Valery, Joyce, Melville, T.S. Eliot, Rilke, Proust, Musil, Stevens, Cummings, Camus, Sartre, Beckett, Morrison, Barthelme.

**Attribute/Distribution:** HU

**PHIL 122 Philosophy Of Law 4 Credits**

Analysis of the conceptual foundations of our legal system. Special attention devoted to the nature of law and legal obligation, liberty and privacy in constitutional litigation, justice and contractual obligation, theories of punishment in criminal law, and the nature and scope of responsibility in criminal law.

**Attribute/Distribution:** HU

**PHIL 123 Aesthetics 4 Credits**

Theories, classical and modern, of the nature of beauty and the aesthetic experience. Practical criticism of some works of art, and examination of analogies between arts, and between art and nature.

**Attribute/Distribution:** HU

**PHIL 124 Philosophy Of Religion 4 Credits**

Critical examination, from a philosophical perspective, of some fundamental problems of religion, the nature of religious experience and belief, reason and revelation, the existence and nature of God, the problem of evil, and religious truth.

**Attribute/Distribution:** HU

**PHIL 125 Social & Political Philosophy 4 Credits**

Examination of visions of good social life and values that should shape society so that people are able to live good lives together. Issues covered may include the nature of freedom, how the facts of gender, race, class, ethnic, and cultural differences should be taken into account in social and political relations, the limits of religious tolerance, war, world hunger.

**Attribute/Distribution:** HU

**PHIL 126 Professional Ethics 4 Credits**

An examination of the moral rules and action guides that govern various professions. Professions to be examined will include health (physician and nursing); legal; counseling and psychiatry; engineering; military; clergy; teaching. Attention will be given to modes of ethical reasoning and how those modes are practically applied in professional life and activity. Among issues to be discussed, will be the limits of confidentiality; employer authority; power relationships; obligations to the public; professional rights; sexual boundaries; whistle-blowing; safety and risk; computer ethics; weapons development; discrimination; professional review of ethical infractions. Course will include guest lectures and case studies.

**Attribute/Distribution:** HU

**PHIL 127 Existentialism 4 Credits**

Investigation of the historical development of existentialism from its origins in the 19th century (Kierkegaard, Nietzsche) through its marriage to phenomenology in the early 20th (Heidegger, Sartre, Merleau-Ponty), and out the other side as a vigorous dimension of much literary, psychological, and artistic work produced in the last 50 years.

**Attribute/Distribution:** HU

**PHIL 128 Philosophy Of Science 4 Credits**

Introduction to the structure and methods of scientific investigation. The nature of explanation, confirmation, and falsification. Scientific progress: What is it? Would it be suffocated by obedience to completely rational methods?

**Attribute/Distribution:** HU

**PHIL 129 Jewish Philosophy 4 Credits**

Consideration of how major Jewish thinkers from the first to 20th centuries confronted questions at the intersection of religion and philosophy: the existence and nature of God, free will, evil, divine providence, miracles, creation, revelation, and religious obligation.

**Attribute/Distribution:** HU

**PHIL 131 Ancient Philosophy 4 Credits**

Historical survey of selected texts and issues in the classical world, from the pre-Socratics through Aristotle, with emphasis on the origins of the western philosophical traditions in ethics, metaphysics, and epistemology.

**Attribute/Distribution:** HU

**PHIL 132 Hellenistic Philosophy 4 Credits**

Historical survey of selected texts and issues in post-Aristotelian Greek and Roman philosophy from the fourth century B.C. to the third century A.D. Areas of focus may include epicureanism, stoicism, academic and pyrrhonian scepticism, and neoplatonism.

**Attribute/Distribution:** HU

**PHIL 133 Medieval Philosophy 4 Credits**

Historical survey of selected texts and issues in western philosophy from the fourth to 14th centuries. Attention will be given to the relation between developments in medieval philosophy and major currents in ancient and modern thought. Figures may include Augustine, Eriugena, Anselm, Aquinas, Ockham, and Nicholas of Autrecourt.

**Attribute/Distribution:** HU

**PHIL 135 Modern Philosophy 4 Credits**

Historical survey of selected texts and issues in 17th and 18th century European philosophy with particular emphasis on developments in epistemology and metaphysics. Attention will be given to the relation of the "modern period" to developments in late medieval philosophy and the rise of the experimental sciences. Figures may include Descartes, Leibniz, Locke, Hume, and Kant.

**Attribute/Distribution:** HU

**PHIL 137 Nineteenth Century Philosophy 4 Credits**

Historical survey of selected texts and issues in 19th century philosophy. Areas of focus may include post-Kantian idealism; period-specific critiques of religion, politics, and morality; theories of history; the origins of utilitarianism, pragmatism, existentialism, and mathematical logic; etc. Figures may include Hegel, Marx, Kierkegaard, Mill, Peirce, Frege, Nietzsche, James, etc.

**Attribute/Distribution:** HU

**PHIL 139 Contemporary Philosophy 4 Credits**

Philosophical thought from the late 19th century to the present; pragmatism, linguistic analysis, existentialism, and Marxism. Truth and knowledge, values and moral judgment, meaning, the place of the individual in the physical world and society, and the impact of the scientific method upon all of these.

**Attribute/Distribution:** HU

**PHIL 140 Eastern Philosophy 4 Credits**

Survey of selected texts and issues in the eastern philosophical traditions. Attention will be given to the development and interrelations of these traditions as well as a comparison of western and eastern treatments of selected issues. Areas of focus may include Confucianism, Taoism, and Zen Buddhism.

**Attribute/Distribution:** HU

**PHIL 141 Medieval Islamic Philosophy 4 Credits**

The medieval era was the golden age of Islamic civilization. Science, mathematics, theology, philosophy, logic, jurisprudence, and many other disciplines flourished during that time. Islamic scientific and philosophical thoughts were greatly influenced by the Greek intellectual tradition, and in turn the Islamic intellectual tradition influenced European thoughts during the Middle Ages and beyond. The course is an introduction to medieval Islamic philosophy. There is no indigenous Islamic philosophy other than medieval Islamic philosophy. Reading selections include works by al-Kindi, al-Razi, al-Farabi, Ibn Sina (Avicenna), al-Ghazali, Ibn al-Fayl, and Ibn Rushd (Averroes). The goal is to attain a thorough understanding of the reading selections instead of covering a large number of treatises.

**Attribute/Distribution:** HU

**PHIL 145 Philosophy and Technology 4 Credits**

This course is an exploration of questions of metaphysics and morality in the digital age. Are new technologies changing our views of metaphysics (what's real) and morality (what's right)? Can classical and contemporary philosophical theories help us think more clearly and make better choices when faced with new technologies? To help answer these questions, students will read a variety of philosophical works that invite critical reflection on a broad array of topics at the intersection of philosophy and technology.

**Attribute/Distribution:** HU

**PHIL 205 Contemporary Ethics 4 Credits**

Examination of significant questions addressed by contemporary moral philosophers. Topics vary, but might include: What is a good person? Can a woman be good in the same way as a man? Is morality relative or absolute? Is morality all that important? Must have completed one HU-designated course in Philosophy at 100-level or higher. Consent of the instructor.

**Prerequisites:** PHIL 105

**Attribute/Distribution:** HU

**PHIL 206 Figures/Themes in Ethics 4 Credits**

This semester course will involve in-depth focus on a major figure in ethics (e.g., Plato, Aristotle, Hume, Kant, Mill, etc.) or on a theme such as relativism, free will, the intersection of religion and ethics, or war. Must have completed one HU-designated course in Philosophy at 100-level or higher. May be taken more than once for credit.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**PHIL 217 Figures/Themes in Race and Philosophy 4 Credits**

An investigation of a significant figure in the philosophy of race (e.g. David Walker, W.E.B. DuBois, Alain Locke, Marcus Garvey, Jean-Paul Sartre, Franz Fanon, Cornel West) and/or an investigation of a significant theme in the philosophy of race (Racial Exploitation, Colonialism, Negritude, Afrocentrism, Black Nationalism, African Philosophy, Black Athena). Content Varies. Must have completed one HU-designated course in Philosophy at 100-level or higher. May be taken more than once for credit.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**PHIL 220 Theory Of Knowledge 4 Credits**

Recent work in epistemology. Questions addressed include: If you can't know whether you are dreaming, how can you know you have two hands? Does knowledge require answers to all possible doubts or only all reasonable doubts? How should we determine the horizon of the reasonable—psychologically or philosophically? Must have completed one HU-designated course in Philosophy at 100-level or higher.

**Attribute/Distribution:** HU

**PHIL 221 Metaphysics 4 Credits**

A survey of contemporary literature in metaphysics. Topics may include: the nature of existence, universals and properties, identity and individuation, causation, necessity and possibility, reduction and emergence, and realism and antirealism. Must have completed one HU-designated course in Philosophy at 100-level or higher.

**Attribute/Distribution:** HU

**PHIL 223 Figures/Themes In Aesthetics 4 Credits**

An investigation of a significant figure in aesthetics (e.g., Burke, Kant, Hegel, Benjamin, Adorno, Goodman, Kivy, Derrida, Deleuze) and/or an investigation of a significant theme in aesthetics (e.g., sensuality, representation, politics, expressionism, cinematic gore, minimalism, architecture, postmodernism). Content varies. Must have completed one HU-designated course in Philosophy at 100-level or higher. May be taken more than once for credit.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**PHIL 224 Topics in the Philosophy of Religion 4 Credits**

Selected problems and issues in the philosophy of religion. Content varies. Must have completed one HU-designated course in Philosophy at 100-level or higher. May be taken more than once for credit.

**Attribute/Distribution:** HU

**PHIL 226 Feminism and Philosophy 4 Credits**

Analysis of the nature, sources, and consequences of the oppression and exploitation of women and justification of strategies for liberation. Topics include women's nature and human nature, sexism, femininity, sexuality, reproduction, mothering. Must have completed one HU designated course in philosophy, or one course in Women, Gender, and Sexuality Studies.

**Attribute/Distribution:** HU

**PHIL 228 Topics in the Philosophy of Science 4 Credits**

Themes in the natural, life and social sciences. May be repeated for credit as topic varies. Must have completed one 100-level HU-designated course or have consent of instructor.

**Repeat Status:** Course may be repeated.

**Prerequisites:** (PHIL 128)

**Attribute/Distribution:** HU

**PHIL 231 Figures/Themes in Ancient Philosophy 4 Credits**

This seminar course will involve indepth focus upon a major ancient thinker (e.g. Plato, Aristotle, Sextus Empiricus, Plotinus, etc.) or the classical treatment of a particular theme (e.g. "human nature," "the good life," ethical or political theory, etc.). Content varies. Must have completed one HU-designated course in Philosophy at 100-level or higher. May be taken more than once for credit.

**Repeat Status:** Course may be repeated.

**Prerequisites:** PHIL 105 or PHIL 116 or PHIL 117 or PHIL 121 or PHIL 122 or PHIL 123 or PHIL 124 or PHIL 125 or PHIL 127 or PHIL 128 or PHIL 129 or PHIL 131 or PHIL 132 or PHIL 133 or PHIL 134 or PHIL 135 or PHIL 139 or PHIL 140 or PHIL 141

**Attribute/Distribution:** HU

**PHIL 232 Figures/Themes in Hellenistic Philosophy 4 Credits**

This seminar course will involve an in-depth focus upon a major movement in Hellenistic Philosophy (roughly 4th century B.C.E. to the 2nd Century C.E.) such as Epicureanism, Stoicism, Ancient Scepticism, or Neoplatonism, or the Hellenistic treatment of a particular theme (e.g. freedom from anxiety, the nature of the Cosmos and our place within it, or human nature). Content varies. Must have completed one HU-designated course in Philosophy at 100-level or higher. May be taken more than once for credit.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**PHIL 233 Figures/Themes in Medieval Philosophy 4 Credits**

This seminar course will involve in-depth focus upon a major medieval thinker (e.g. Augustine, Boethius, Maimonides, Bonaventure, Dante, etc.) or the medieval treatment of a particular theme (e.g. the relation of "will" and "intellect," the "problem of universals," ethical or political theory, etc.). Content varies. Must have completed one HU-designated course in Philosophy at 100-level or higher. May be taken more than once for credit.

**Attribute/Distribution:** HU

**PHIL 235 Figures/Themes in Modern Philosophy 4 Credits**

This seminar course will involve in-depth focus upon a major 17th or 18th century thinker (e.g. Descartes, Leibniz, Berkeley, Kant, etc.) or the modern treatment of a particular theme (e.g. the nature of "ideas," the roles of experience, reason, and revelation, ethical or political theory, etc.). Content varies. Must have completed one HU-designated course in Philosophy at 100-level or higher. May be taken more than once for credit.

**Repeat Status:** Course may be repeated.

**Prerequisites:** PHIL 105 or PHIL 116 or PHIL 117 or PHIL 121 or PHIL 122 or PHIL 123 or PHIL 124 or PHIL 125 or PHIL 127 or PHIL 128 or PHIL 129 or PHIL 131 or PHIL 132 or PHIL 133 or PHIL 134 or PHIL 135 or PHIL 139 or PHIL 140 or PHIL 141

**Attribute/Distribution:** HU

**PHIL 237 Figures/Themes in Nineteenth Century Philosophy 4 Credits**

This seminar course will involve in-depth focus upon a major 19th century thinker (e.g. Hegel, Marx, Kierkegaard, Mill, Peirce, Frege, Nietzsche, James, etc.) or the 19th century treatment of a particular theme (e.g. the end of history, revolution, nihilism, authenticity, origins of mathematical logic, infinity, etc.). Content varies. Must have completed one HU-designated course in Philosophy at 100-level or higher. May be taken more than once for credit.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**PHIL 239 Figures/Themes in Contemporary Philosophy 4 Credits**

This seminar course will involve in-depth focus upon a major contemporary thinker (e.g. Russell, Whitehead, Husserl, Heidegger, Wittgenstein, Quine, Habermas, Rawls, Rorty, Derrida, Davidson, Foucault, Deleuze, Irigaray, etc.) or the contemporary treatment of a particular theme (e.g. logical positivism, naturalism, non-foundationalism, existential phenomenology, return to virtue, neopragmatism, hermeneutics, post-structuralism, postmodernism, neokantian political theory, the politics of identity, etc.). Content varies. Must have completed one HU-designated course in Philosophy at 100-level or higher. May be taken more than once for credit.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**PHIL 240 Figures/Themes in Eastern Philosophy 4 Credits**

This seminar course will involve in-depth focus upon a major figure in Eastern thought or upon the Eastern treatment of a particular theme or set of themes. Content varies. Must have completed one HU-designated course in Philosophy at 100-level or higher.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**PHIL 241 Critics Of Religion 4 Credits**

In recent years, with the resurgence of religion as a significant political force globally, the claims of religion have been subjected to renewed scrutiny and critique. A wide array of scientists, philosophers, and social critics (e.g., Richard Dawkins, Daniel Dennet, Sam Harris, Christopher Hitchens) have challenged religion's basic claims and provide alternative rational, scientifically grounded explanations. However, in many instances, these books fall short of the powerful critiques, previously formulated by philosophers such as Baruch Spinoza and Friedrich Nietzsche, or those of contemporary French philosophers Michel Foucault and Gilles Deleuze. In this seminar, we shall explore in-depth the critiques of religion contained in the writings of Spinoza, Nietzsche, Sigmund Freud, Foucault and Deleuze. Students will have an opportunity to examine one or more of the recent critiques of religion in light of the arguments of these philosophers.

**Attribute/Distribution:** HU

**PHIL 250 Philosophy of Mind 4 Credits**

An exploration of the mind-body problem. Are the body and mind distinct substances (dualism); or is there only body (materialism); or only mind (idealism)? Other views to be considered include behaviorism (the view that behavior can be explained without recourse to mental states), and the view that the mind is a complex computer. Must have completed one HU-designated course in Philosophy at 100-level or higher.

**Attribute/Distribution:** HU

**PHIL 260 Philosophy Of Language 4 Credits**

Analysis of the nature of the correspondence between the words we use and the world in which we live. Our unifying theme is the quest for an understanding of truth, conceived as a peculiar relation between language and reality. We examine such central notions as meaning and reference, as understood in historically influential philosophical theories of language. Must have completed one HU-designated course in Philosophy at 100-level or higher.

**Prerequisites:** PHIL 105 or PHIL 116 or PHIL 117 or PHIL 121 or PHIL 122 or PHIL 123 or PHIL 124 or PHIL 125 or PHIL 127 or PHIL 128 or PHIL 129 or PHIL 131 or PHIL 132 or PHIL 133 or PHIL 134 or PHIL 135 or PHIL 139 or PHIL 140 or PHIL 141

**Attribute/Distribution:** HU

**PHIL 265 Philosophy Of Mathematics 4 Credits**

A survey of the main philosophical views on the nature of mathematics and mathematical knowledge, including the classical debate between the logicist, formalist, and intuitionist schools, and the recent debate between realism and antirealism. Some of the material makes use of logical theory. Must have completed one HU-designated course in Philosophy at 100-level or higher.

**Attribute/Distribution:** HU

**PHIL 271 Independent Study 1-4 Credit**

Individual philosophical investigation of an author, book, or topic designed in collaboration with a philosophy professor. Tutorial meetings; substantial written work. Must have completed one HU-designated course in philosophy. May be repeated more than once for credit. Consent of faculty instructor required.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** ND

**PHIL 292 Philosophical Methods 4 Credits**

Methods of and approaches to philosophical research, reasoning, and writing, as preparation for senior thesis. Open only to junior philosophy majors. Department permission required.

**Attribute/Distribution:** HU

**PHIL 300 Apprentice Teaching 1-4 Credit**

**Attribute/Distribution:** ND

**PHIL 303 Mathematical Logic 3,4 Credits**

Detailed proofs for the basic mathematical results relating the syntax and semantics of first-order logic (predicate logic): the Soundness and Completeness (and Compactness) Theorems, followed by a brief exposition of the celebrated limitative results of Gödel, Turing, and Church on incompleteness and undecidability. The material is conceptually rigorous and mathematically mature; the necessary background is a certain degree of mathematical sophistication or a basic knowledge of symbolic logic. Consent of instructor required.

**Prerequisites:** (PHIL 114)

**Attribute/Distribution:** MA

**PHIL 304 Axiomatic Set Theory 3,4 Credits**

A development of set theory from axioms; relations and functions; ordinal and cardinal arithmetic; recursion theorems; axiom of choice; independence questions. Prerequisites as noted below or consent of department chair.

**Prerequisites:** MATH 301

**Attribute/Distribution:** MA

**PHIL 329 Computability Theory 3,4 Credits**

Course development of classical computability theory; enumeration, index and recursion theorems, various models of computation and Church's Thesis, uncomputability results, introduction to reducibilities and their degrees (in particular, Turing degrees, or degrees of uncomputability), computable operators and their fixed points.

**Attribute/Distribution:** MA

**PHIL 347 American Religious Thinkers 4 Credits**

An examination of the writings of key figures in the history of American religious thought (such as Edwards, Emerson, Bushnell, Peirce, James, Royce, Dewey and the Niebuhrs). Attention will be directed both to the historical reception of these writings and to their contemporary significance. Must have completed One HU-designated course in Philosophy at 100-level or higher.

**Attribute/Distribution:** HU

**PHIL 364 Issues In Contemporary Political Philosophy 3-4 Credits**

Selected topics in contemporary political philosophy, such as the Frankfurt school, existentialism, legitimation, authenticity, participatory democracy, and the alleged decline of political philosophy. May be repeated for credit with consent of the political science chair.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** SS

**PHIL 367 American Political Thought 3-4 Credits**

Critical examination of American political thought from the founding of the Republic to the present. Writings from Madison, Hamilton, and Jefferson to Emma Goldman, Mary Daly, Malcolm X, Henry Kariel, and others will be discussed.

**Attribute/Distribution:** SS



**PHIL 371 Advanced Independent Study 1-4 Credit**

Individual philosophical investigation of an author, book, or topic designed in collaboration with a philosophy professor. Tutorial meetings; substantial written work. Must have completed one HU designated philosophy course at 200-level or higher, and have consent of instructor. May be repeated more than once for credit.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** ND

**PHIL 389 Honors Project 1-8 Credit**

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** ND

**PHIL 390 Senior Thesis 2 Credits**

The first part of two semesters of intensive research and writing supervised by the philosophy faculty thesis advisor in anticipation of completing a senior thesis in philosophy. Individual tutorials; substantial written work. Senior standing as a philosophy major and permission of the philosophy faculty thesis advisor required.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** ND

**PHIL 391 Senior Thesis 4 Credits**

Continuation and completion of PHIL 390 under the guidance of the thesis advisor. Consent of thesis advisor required. Prerequisites as noted below.

**Repeat Status:** Course may be repeated.

**Prerequisites:** (PHIL 390)

**Attribute/Distribution:** ND

## Physics

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Physics students study the basic laws of mechanics, heat and thermodynamics, electricity and magnetism, optics, relativity, quantum mechanics, and elementary particles. Students also study applications of the basic theories to the description of bulk matter, including the mechanical, electric, magnetic, and thermal properties of solids, liquids, gases, and plasmas, and to the description of the structure of atoms and nuclei. In addition, students develop the laboratory skills and techniques of the experimental physicist, skills that can be applied in the experimental search for new knowledge or in applications of the known theories.

A majority of physics graduates go to graduate school in physics, often earning the Ph.D. degree. These graduates take university or college faculty positions, or work on research in a variety of university, government, or industrial laboratories. Some students choose employment immediately after the bachelor's degree. They use their many approved and free electives to supplement their science background with applied courses, such as engineering, to develop the skills needed for a position in a particular area.

Because of the fundamental role of physics in all natural sciences, students also use the physics major as an excellent preparation for graduate study in many other scientific areas, such as: optical engineering, applied mathematics, computer science, biophysics, molecular biology, astrophysics, geology and geophysics, materials science and engineering, meteorology, or physical oceanography. Attractive engineering areas with a high science content include optical communications, aeronautical engineering, nuclear engineering, including both fission and fusion devices; electrical engineering, including instrumentation, electronics and solid-state devices, electrical discharges and other plasma-related areas; and mechanical engineering and mechanics, including fluids and continuum mechanics. The broad scientific background developed in the physics curriculum is also an excellent background for professional schools, such as law (particularly patent law), medicine, and optometry.

Lehigh offers three undergraduate degrees in physics and two undergraduate degrees in astronomy or astrophysics. The three physics degrees are the bachelor of arts with a major in physics and the bachelor of science in physics in the College of Arts and Sciences, and the bachelor of engineering physics in the College of Engineering and Applied Science. The B.A. with a major in astronomy and the B.S. in astrophysics are in the College of Arts and Sciences and are described in the **Astronomy and Astrophysics** section of this catalog.

In addition, there are several five-year, dual-degree programs involving physics: The Arts-Engineering program (see the **Arts-Engineering** section of this catalog), the combination of the bachelor of science program in the College of Arts and Sciences with Electrical Engineering (described below), and the combination of **electrical engineering and engineering physics** (see the Electrical Engineering and Engineering Physics section of this catalog).

The bachelor of science curriculum in the College of Arts and Sciences requires somewhat more physics and mathematics than the bachelor of arts major, while the latter provides more free electives and three fewer hours for graduation. By making good use of the electives in these programs, either can prepare a student for graduate work in physics or the physical aspects of other sciences or engineering disciplines, or for technical careers requiring a basic knowledge of physics. The bachelor of arts curriculum is particularly useful for those planning careers in areas where some knowledge of physics is needed or useful, but is not the main subject, such as science writing, secondary school teaching, patent law, or medicine. The bachelor of science in engineering physics curriculum in the College of Engineering and Applied Science requires an engineering concentration in either solid state electronics or optical sciences, in addition to regular physics and mathematics courses. This four-year program prepares students to do engineering work in an overlap area between physics and engineering, which may be engineering in a forefront area in which it is desirable to have more physics knowledge than the typical engineer has, or may be experimental physics which either relies heavily on forefront engineering or in which the nature of the problem dictates that scientists and engineers will accomplish more working together rather than separately.

Requirements and recommended course sequences are described below for programs in the College of Arts and Sciences and in the P. C. Rossin College of Engineering and Applied Science. Note that no more than 6 credits of military science may be applied toward any degree program.

**Professors.** Ivan Biaggio, PhD (ETH Zurich); Gary G. DeLeo, PhD (University of Connecticut); Volkmar R. Dierolf, PhD (University of Utah); James D. Gunton, PhD (Stanford University); Albert Peet Hickman, PhD (Rice University); John P. Huennekens, PhD (University of Colorado Boulder); Alvin S. Kanofsky, PhD (University of Pennsylvania); Yong W. Kim, PhD (University of Michigan Ann Arbor); Arnold H. Kritz, PhD (Yale University); George Eadon McCluskey, Jr., PhD (University of Pennsylvania); H. Daniel Ou-Yang, PhD (University of California Los Angeles); Michael J. Stavola, PhD (University of Rochester); Jean Toulouse, PhD (Columbia University)

**Associate Professors.** Jerome C. Licini, PhD (Massachusetts Institute of Technology); Mary Virginia McSwain, PhD (Georgia State University); Vyacheslav Rotkin, PhD (Ioffe Institute); Dimitrios Vavylonis, PhD (Columbia University)

**Assistant Professor.** Joshua A. Pepper, PhD (Ohio State University)

**Emeriti.** Garold J Borse, PhD (University of Virginia); Robert T. Folk, PhD (Lehigh University); W. Beall Fowler, PhD (University of Rochester); Sheldon H. Radin, PhD (Yale University); Russell A. Shaffer, PhD (Johns Hopkins University)

### College of Arts and Sciences

#### Bachelor of Arts Program Requirements

PHY 010	General Physics I	4
or PHY 011	Introductory Physics I	
PHY 013	General Physics II	3-4
or PHY 021	Introductory Physics II	
PHY 012	Introductory Physics Laboratory I	1
PHY 022	Introductory Physics Laboratory II	1
PHY 031	Introduction to Quantum Mechanics	3
MATH 021	Calculus I	4
MATH 022	Calculus II	4
MATH 023	Calculus III	4
MATH 205	Linear Methods	3

CHM 030	Introduction to Chemical Principles	4
Select at least one of the following:		2-3
PHY 190	Electronics	
PHY 262	Advanced Physics Laboratory	
Select at least 6 of the following:		18
PHY 301	Modern Astrophysics I	
PHY 212	Electricity and Magnetism I	
PHY 213	Electricity and Magnetism II	
PHY 215	Classical Mechanics I	
PHY 332	High-Energy Astrophysics	
PHY 340	Thermal Physics	
PHY 342	Relativity and Cosmology	
PHY 348	Plasma Physics	
PHY 352	Modern Optics	
PHY 355	Nonlinear Optics	
PHY 362	Atomic and Molecular Structure	
PHY 363	Physics of Solids	
PHY 364	Nuclear and Elementary Particle Physics	
PHY 365	Physics Of Fluids	
PHY 369	Quantum Mechanics I	
PHY 380	Introduction to Computational Physics	
Total Credits		51-53

A total of 120 credits are required for the BA in Physics

#### Bachelor of Science Program Requirements

PHY 011	Introductory Physics I	4
or PHY 010	General Physics I	
PHY 021	Introductory Physics II	3-4
or PHY 013	General Physics II	
PHY 012	Introductory Physics Laboratory I	1
PHY 022	Introductory Physics Laboratory II	1
PHY 031	Introduction to Quantum Mechanics	3
MATH 021	Calculus I	4
MATH 022	Calculus II	4
MATH 023	Calculus III	4
MATH 205	Linear Methods	3
MATH 322	Methods of Applied Analysis I	3
CHM 030	Introduction to Chemical Principles	4
CSE 001	Breadth of Computing <sup>1</sup>	2
PHY 190	Electronics	3
PHY 262	Advanced Physics Laboratory	2
PHY 212	Electricity and Magnetism I	3
PHY 213	Electricity and Magnetism II	3
PHY 215	Classical Mechanics I	4
PHY 362	Atomic and Molecular Structure	3
PHY 364	Nuclear and Elementary Particle Physics	3
PHY 340	Thermal Physics	3
At least 17 credits of approved electives <sup>2</sup>		17
Total Credits		77-78

<sup>1</sup> Or an equivalent course in scientific computing.

<sup>2</sup> At least 17 credits of approved electives in physics, physical sciences or technical areas must be selected in consultation with the advisor. Included in this group must be three of the following courses: PHY 363, PHY 369, (PHY 352 or PHY 355), and (PHY 348 or PHY 365) and PHY 380. Students planning graduate work in physics are advised to include PHY 273 and PHY 369 among their electives.

A total of 123 credits are required for the BS in Physics

The recommended sequence of courses for the two physics degree programs are indicated below. General electives are not indicated,

but they should be selected in consultation with the advisor so that educational goals and total credit hour requirements are satisfied.

#### Physics Degree Programs

##### College of Arts & Sciences

##### Bachelor of Arts

##### First Year

Fall	CR Spring	CR
ENGL 001	3 ENGL 002	3
PHY 010 or 011	4 CHM 030	4
PHY 012	1 MATH 022	4
MATH 021	4 Dist. Req.	4
Col. Sem.	3-4	
<b>15-16</b>		<b>15</b>

##### Second Year

Fall	CR Spring	CR
PHY 013 or 021	3-4 PHY 031	3
PHY 022	1 PHY 190 (or elective)	3
MATH 023	4 MATH 205	3
Dist. Req.	8 Dist. Req.	4
<b>16-17</b>		<b>13</b>

##### Third Year

Fall	CR Spring	CR
Adv. PHY.	6 PHY 262 (or elective)	2-3
	Adv. PHY.	6
	Jr. Writing	3
<b>6</b>		<b>11-12</b>

##### Fourth Year

Fall	CR
Adv. PHY.	6
<b>6</b>	

Total Credits: 82-85

##### Bachelor of Science

##### First Year

Fall	CR Spring	CR
ENGL 001	3 ENGL 002	3
PHY 011 or 010	4 CHM 030	4
PHY 012	1 MATH 022	4
MATH 021	4 CSE 001 <sup>1</sup>	2
Col. Sem	3-4	
<b>15-16</b>		<b>13</b>

##### Second Year

Fall	CR Spring	CR
PHY 021 & PHY 022	5 PHY 031	3
MATH 023	4 PHY 190	3
Dist. Req.	8 MATH 205	3
	Dist. Req.	4
	Appr. Elec.	4
<b>17</b>		<b>17</b>

##### Third Year

Fall	CR Spring	CR
PHY 212	3 PHY 213	3
PHY 362	3 PHY 262	2
MATH 322	3 PHY 364	3
Jr. Writing	3 PHY 215	4
<b>12</b>		<b>12</b>

##### Fourth Year

Fall	CR Spring	CR
PHY 340	3 Appr. Elec	6

Appr. Elec	8 Dist.Req.	4
	<b>11</b>	<b>10</b>

Total Credits: 107-108

<sup>1</sup> Or an equivalent course in scientific computing.

**P.C. Rossin College of Engineering & Applied Sciences**

Both concentrations require 131 credit hours. The tables below indicate both course requirements and recommended enrollment sequences.

**Bachelor of Engineering Physics  
with a concentration in Solid State Electronics**

First Year		
Fall	CR Spring	CR
ENGL 001	3 ENGL 002	3
PHY 011 & PHY 012	5 CHM 030	4
MATH 021	4 MATH 022	4
ENGR 005	2 ENGR 010	2
	Elective	3
	<b>14</b>	<b>16</b>

Second Year		
Fall	CR Spring	CR
PHY 021 & PHY 022	5 PHY 031	3
MATH 023	4 PHY 190	3
ECO 001	4 MATH 205	3
ECE 081	4 MATH 208	3
	ECE 123	3
	<b>17</b>	<b>15</b>

Third Year		
Fall	CR Spring	CR
PHY 212	3 PHY 213	3
ECE 033	4 PHY 262	2
ECE 108	4 PHY 215	4
MATH 322	3 ECE 126	3
HSS	4 HSS	3
	Elective	3
	<b>18</b>	<b>18</b>

Fourth Year		
Fall	CR Spring	CR
PHY 340 or ME 104	3 HSS	6
PHY 363	3 SSE -Elec <sup>1</sup>	8
PHY 362	3 Electives	4
SSE -Elec	3	
Elective	4	
	<b>16</b>	<b>18</b>

Total Credits: 132

<sup>1</sup> The 11 credit hours of SSE (Solid State Engineering) electives must include ECE 257 or ECE 258 or PHY 273. Other advanced physics or engineering courses may be included among the SSE electives with the approval of the student's advisor.

**with a concentration in Optical Sciences**

First Year		
Fall	CR Spring	CR
ENGL 001	3 ENGL 002	3
PHY 011 & PHY 012	5 CHM 030	4
MATH 021	4 MATH 022	4
ENGR 005	2 ENGR 010	2
	Elective	3
	<b>14</b>	<b>16</b>

**Second Year**

Fall	CR Spring	CR
PHY 021 & PHY 022	5 PHY 031	3
MATH 023	4 PHY 190	3
ECO 001	4 MATH 205	3
ECE 081	4 MATH 208	3
	HSS	4
	<b>17</b>	<b>16</b>

**Third Year**

Fall	CR Spring	CR
PHY 212	3 PHY 213	3
PHY 362	3 PHY 262	2
ECE 108	4 PHY 215	4
MATH 322	3 OE -Elec	3
OE -Elec <sup>1</sup>	3 HSS	3
	Elective	3
	<b>16</b>	<b>18</b>

**Fourth Year**

Fall	CR Spring	CR
PHY 340 or ME 104	3 PHY 355	3
PHY 352	3 Electives	3
OE -Elec	6 OE -Elec	6
Electives	5 HSS	6
	<b>17</b>	<b>18</b>

Total Credits: 132

<sup>1</sup> The 18 credit hours of OE (Optical Engineering) electives must include ECE 257 or ECE 258 or PHY 273. Must include at least two of ECE 347, ECE 348, ECE 371, ECE 372. Other advanced physics or engineering courses may be included among the OE electives with the approval of the student's advisor.

**Combined B.S.(Physics)/B.S.(Electrical Engineering)**

The combined arts/engineering programs resulting in bachelors degrees in both physics and electrical engineering may be arranged so that either of the two degrees is completed within the first four years. The suggested curricula are:

**Physics-Elec. Engr (Physics first)**

First Year		
Fall	CR Spring	CR
ENGL 001	3 ENGL 002	3
PHY 011 & PHY 012	5 CHM 030	4
MATH 021	4 MATH 022	4
ENGR 005	2 ENGR 010	2
	<b>14</b>	<b>13</b>

**Second Year**

Fall	CR Spring	CR
PHY 021 & PHY 022	5 PHY 031	3
MATH 023	4 ECO 001	4
ECE 033	4 MATH 205	3
ECE 081	4 MATH 208	3
	ECE 182	1
	HSS	4
	<b>17</b>	<b>18</b>

**Third Year**

Fall	CR Spring	CR
PHY 212	3 PHY 213	3
PHY 362	3 PHY 262	2
ECE 108	4 PHY 364	3
MATH 322	3 PHY 215	4

Jr. Writing	3 ECE 121	2
	ECE 123	3
	<b>16</b>	<b>17</b>

**Fourth Year**

<b>Fall</b>	<b>CR Spring</b>	<b>CR</b>
PHY 340	3 ECE 126	3
PHY Appr. Elective	6 ECE 138	2
HSS	6 ECE 125	3
Elective	3 PHY Appr. Elective	5
	Dist. Req.	4
	<b>18</b>	<b>17</b>

**Fifth Year**

<b>Fall</b>	<b>CR Spring</b>	<b>CR</b>
ECE 257	3 ECE 136	3
MATH 231	3 ECE Appr Elective	9
ECE Appr Elective	3 Elective	3
Elective	5	
HSS	3	
	<b>17</b>	<b>15</b>

Total Credits: 162

**Elec. Engr-Physics (Electrical Engineering First)****First Year**

<b>Fall</b>	<b>CR Spring</b>	<b>CR</b>
ENGL 001	3 ENGL 002	3
PHY 011 & PHY 012	5 CHM 030	4
MATH 021	4 MATH 022	4
ENGR 005	2 ENGR 010	2
	<b>14</b>	<b>13</b>

**Second Year**

<b>Fall</b>	<b>CR Spring</b>	<b>CR</b>
PHY 021 & PHY 022	5 PHY 031	3
MATH 023	4 ECE 121	2
ECE 033	4 MATH 205	3
ECE 081	4 ECE 182	1
	ECE 123	3
	HSS	6
	<b>17</b>	<b>18</b>

**Third Year**

<b>Fall</b>	<b>CR Spring</b>	<b>CR</b>
PHY 212	3 PHY 213	3
ECE 108	4 ECE 126	3
MATH 208	3 ECE 138	2
MATH 231	3 ECE 136	3
Jr. Writing	3 ECE 125	3
	ECO 001	4
	<b>16</b>	<b>18</b>

**Fourth Year**

<b>Fall</b>	<b>CR Spring</b>	<b>CR</b>
PHY 362	3 PHY 364	3
ECE 257	3 PHY 215	4
ECE Appr. Elective	3 ECE 258	2
Elective	4 ECE Appr. Elective	6
HSS	4 HSS	2
	<b>17</b>	<b>17</b>

**Fifth Year**

<b>Fall</b>	<b>CR Spring</b>	<b>CR</b>
PHY 340	3 PHY 262	2
MATH 322	3 PHY Appr Elective	5

PHY Appr Elective	6 Electives	3
Electives	3 HSS	3
	Dist. Req	3
	<b>15</b>	<b>16</b>

Total Credits: 161

**Physics approved electives**

Select three of the following:	9
PHY 363	Physics of Solids
PHY 369	Quantum Mechanics I
PHY 352 or PHY 355	Modern Optics Nonlinear Optics
PHY 348 or PHY 365	Plasma Physics Physics Of Fluids
PHY 380	Introduction to Computational Physics
Total Credits	9

Total Credits 9

Students must satisfy both the HSS requirements of the College of Engineering and Applied Science and the distribution requirements, including the junior writing intensive requirement, of the College of Arts and Sciences. Courses appropriate for both may be counted in both categories.

Approved electives are subject to the approval of the student's advisor. Students planning graduate work in physics are advised to include PHY 273 and PHY 369 among their electives.

**Astronomy/Astrophysics Degree Programs**

(See the Astronomy section in this catalog.)

**Research opportunities**

A majority of physics, astronomy, and engineering physics majors take advantage of opportunities to participate in research under the direction of a faculty member. Research areas available to undergraduates are the same as those available to graduate students; they are described below under the heading For Graduate Students. Undergraduate student research is arranged informally as early as the sophomore (or, occasionally, freshman) year at the initiation of the student or formally as a senior research project. In addition, a number of students receive financial support to do research during the summer between their junior and senior years, either as Physics Department Summer Research Participants or as Sherman Fairchild Scholars.

**The use of electives**

The electives available in each of the physics and astronomy curricula provide the student with an opportunity to develop special interests and to prepare for graduate work in various allied areas. In particular, the many available upper-level physics, mathematics, and engineering courses can be used by students in consultation with their faculty advisors to structure programs with special emphasis in a variety of areas such as optical communications, solid-state electronics, or biophysics.

**Departmental Honors**

Students may earn departmental honors by satisfying the following requirements:

- Grade point average of at least 3.50 in physics courses.
- Complete 6 credits of PHY 273 (research), or summer REU project, submit a written report, and give an oral presentation open to faculty and students.
- Complete three courses from the list:
 

• Select one of the following:	3	
PHY 332	High-Energy Astrophysics	
PHY 342	Relativity and Cosmology	
ASTR 350	Topics in Astrophysics	
PHY 348	Plasma Physics	3
PHY 363	Physics of Solids	3
PHY 352 or PHY 355	Modern Optics Nonlinear Optics	3

PHY 369	Quantum Mechanics I	3
PHY 380	Introduction to Computational Physics	3
Any 400 level Physics course		

For students majoring in astronomy or astrophysics, see the **Astronomy and Astrophysics** section of this catalog.

#### Five-Year combined bachelor/master's programs

Five-Year programs that lead to successive bachelor and master's degrees are available. These programs satisfy all of the requirements of one of the five bachelor's degrees in physics (B.A., B.S., B.S.E.P.) and astronomy/astrophysics (B.A., B.S.), plus the requirements of the M.S. in physics in the final year. Depending upon the undergraduate degree received, one summer in residence may be required. Interested students should contact the associate chair of physics no later than the spring semester of their junior year for further detail.

#### The minor program

The minor in physics consists of 15 credits of physics courses, excluding PHY 005 and PHY 007. No more than one physics course required in a student's major program may be included in the minor program. The minor program must be designed in consultation with the physics department chair.

#### For Graduate Students

The department of physics has concentrated its research activities within several fields of physics, with the result that a number of projects are available in each area. Current departmental research activities include the following:

**Condensed matter physics.** Areas of interest include the optical and electronic properties of defects in semiconductors and insulators, quantum phenomena in semiconductor devices, collective dynamics of disordered solids, structural phase transitions in ferroelectrics and superconducting crystals, theory of quantum charge transport in nanotubes and single molecule systems, physics of nano devices.

**Atomic and molecular physics.** Research topics include atomic and molecular spectroscopy and collision processes. Recent work has addressed velocity-changing collisions, diffusion, energy-pooling collisions, charge exchange, fine structure mixing, light-induced drift and radiation trapping.

**Nonlinear optics and photonics.** Research topics include nonlinear light-matter interaction that enable the control of light with light, four-wave mixing, phase conjugation, resonant Brillouin scattering, ferroelectric domain patterning for quasi phase matching, waveguides, photonic crystals, holey and other specialty fibers, and the application of photonics to biological systems.

**Plasma physics.** Computational studies of magnetically confined toroidal plasmas address anomalous thermal and particle transport, large scale instabilities, and radiofrequency heating. Laboratory studies address collisional and collisionless phenomena of supercritical laser-produced plasmas.

**Statistical physics.** Investigation is underway of nonequilibrium fluctuations in gases, chaotic transitions and  $1/f$  dynamics, light-scattering spectroscopy, colloidal suspensions, the nonlinear dynamics of granular particles, and pattern formation in nonequilibrium dissipative systems, including the kinetics of phase transitions and spatiotemporal chaos.

**Soft condensed matter and biological physics.** Current research topics include both the experimental and theoretical studies of complex fluids including biological polymers, colloids, and biological cells and tissues. Laser tweezers, Raman scattering, photoluminescence and advanced 3-D optical imaging techniques are integrated for investigating the structures and dynamical properties of these systems. Theoretical studies focus on the kinetics of phase transitions, including the crystallization of globular and membrane proteins and also the modeling of interactions of proteins and nanotubes.

**Complex fluids.** Polymers in aqueous solutions, colloidal suspensions, and surfactant solutions are investigated using techniques such as "laser tweezers," video-enhanced microscopy, and laser light scattering. Areas of interest include the structures of polymers at liquid-solid interfaces

and microrheology of confined macromolecules. Recent work addresses systems of biological significance.

**Computational physics.** Several of the above areas involve the use of state-of-the-art computers to address large-scale computational problems. Areas of interest include atom-atom collisions, simulations of tokamak plasmas, the statistical behavior of ensembles of many particles, the calculation of electronic wave functions for molecules and solids, and the multi-scale modeling of nano-bio systems.

Candidates for advanced degrees normally will have completed, before beginning their graduate studies, the requirements for a bachelor's degree with a major in physics, including advanced mathematics beyond differential and integral calculus. Students lacking the equivalent of this preparation will make up deficiencies in addition to taking the specified work for the degree sought.

At least eight semester hours of general college physics using calculus are required for admission to all 200- and 300-level courses. Additional prerequisites for individual courses are noted in the course descriptions. Admission to 400-level courses generally is predicated on satisfactory completion of corresponding courses in the 200- and 300-level groups or their equivalent.

#### Facilities for Research

Research facilities are housed in the Sherman Fairchild Center for the Physical Sciences, containing Lewis Laboratory, the Sherman Fairchild Laboratory for Solid State Studies, and a large connecting research wing. Well-equipped laboratory facilities are available for experimental investigations in research areas at the frontiers of physics. Instruments used for experimental studies include a wide variety of laser systems ranging from femtosecond and picosecond pulsed lasers to stabilized single-mode cw Ti-sapphire and dye lasers. There is also a Fourier-transform spectrometer, cryogenic equipment that achieves temperatures as low as 0.05K and magnetic fields up to 9 Tesla, a facility for luminescence microscopy, and a laser-tweezers system for studies of complex fluids. A 3MeV van de Graaff accelerator is used to study radiation-produced defects in solids. The Fairchild Laboratory also contains a processing laboratory where advanced Si devices can be fabricated and studied. All laboratories are well furnished with electronic instrumentation for data acquisition and analysis.

Several professors are members of the interdisciplinary Center for Optical Technologies that offers a wide range of state-of-the-art facilities including a fiber drawing tower, waveguide and fiber characterization labs, and a new epitaxy facility for the growth of III-V semiconductor structures and devices. Extensive up-to-date computer facilities are available on campus and in the department. All computing resources can be accessed directly from graduate student and faculty offices through a high speed backbone. Researchers have access to the national Research Internet (Internet 2) via a 155 Mbps gateway.

#### Courses

##### PHY 005 Concepts In Physics 4 Credits

Fundamental discoveries and concepts of physics and their relevance to current issues and modern technology. For students not intending to major in science or engineering. Lectures, demonstrations, group activities, and laboratories using modern instrumentation and computers. This is a non-calculus course; no previous background in physics is assumed. Three class meetings and one laboratory period per week.

**Attribute/Distribution:** NS

##### PHY 007 Introduction to Astronomy 3 Credits

Introduction to planetary, stellar, galactic, and extragalactic astronomy. An examination of the surface characteristics, atmospheres, and motions of planets and other bodies in our solar system. Properties of the sun, stars, and galaxies, including the birth and death of stars, stellar explosions, and the formation of stellar remnants such as white dwarfs, neutron stars, pulsars, and black holes. Quasars, cosmology, and the evolution of the universe. May not be taken by students who have previously completed ASTR/PHY 105, 301, or 302.

**Attribute/Distribution:** NS

**PHY 008 Introduction to Astronomy Laboratory 1 Credit**

Laboratory to accompany PHY 7 (ASTR 7). Must be enrolled concurrently in PHY 007 (ASTR 007).

**Prerequisites:** PHY 007 or ASTR 007

**Can be taken Concurrently:** PHY 007, ASTR 007

**Attribute/Distribution:** NS

**PHY 009 Introductory Physics I Completion 1-2 Credit**

For students who have Advanced Placement or transfer credit for 2 or 3 credits of PHY 11. The student will be scheduled for the appropriate part of PHY 11 to complete the missing material. The subject matter and credit hours will be determined by the Physics Department for each student. Students with AP Physics C credit for mechanics will take the thermodynamics and kinetic theory part of PHY 11 for one credit. Consent of department required.

**Prerequisites:** MATH 021 or MATH 031 or MATH 051 or MATH 076 or MATH 075

**Can be taken Concurrently:** MATH 021, MATH 031, MATH 051, MATH 076, MATH 075

**Attribute/Distribution:** NS

**PHY 010 General Physics I 4 Credits**

Statics, dynamics, conservation laws, thermodynamics, kinetic theory of gases, fluids. Primarily for architecture, biological science, earth and environmental science students.

**Prerequisites:** MATH 021 or MATH 031 or MATH 051 or MATH 076 or MATH 075

**Can be taken Concurrently:** MATH 021, MATH 031, MATH 051, MATH 076, MATH 075

**Attribute/Distribution:** NS

**PHY 011 Introductory Physics I 4 Credits**

Kinematics, frames of reference, laws of motion in Newtonian theory and in special relativity, conservation laws, as applied to the mechanics of mass points; temperature, heat and the laws of thermodynamics; kinetic theory of gases. Two lectures and two recitations per week.

**Prerequisites:** MATH 021 or MATH 031 or MATH 051 or MATH 076 or MATH 075

**Can be taken Concurrently:** MATH 021, MATH 031, MATH 051, MATH 076, MATH 075

**Attribute/Distribution:** NS

**PHY 012 Introductory Physics Laboratory I 1 Credit**

A laboratory course taken concurrently with PHY 10 or 11. Experiments in mechanics, heat, and DC electrical circuits. One three-hour laboratory period per week.

**Prerequisites:** PHY 010 or PHY 011 or PHY 090

**Can be taken Concurrently:** PHY 010, PHY 011, PHY 090

**Attribute/Distribution:** NS

**PHY 013 General Physics II 3 Credits**

A continuation of PHY 10, primarily for biological science and earth and environmental science students. Electrostatics, electromagnetism, light, sound, atomic physics, nuclear physics, and radioactivity.

**Prerequisites:** (PHY 010 or PHY 011 or PHY 090) and (MATH 021 or MATH 031 or MATH 051)

**Can be taken Concurrently:** MATH 021, MATH 031, MATH 051

**Attribute/Distribution:** NS

**PHY 019 Introductory Physics II Completion 1-2 Credit**

For students who have Advanced Placement or transfer credit for 2 or 3 credits of PHY 21. The student will be scheduled for the appropriate part of PHY 21 to complete the missing material. The subject matter and credit hours will be determined by the Physics Department for each student. Students with AP Physics C credit for electricity and magnetism will take the optics and modern physics part of PHY 21 for one credit. Consent of instructor required.

**Prerequisites:** (PHY 010 or PHY 011) and (MATH 023 or MATH 032 or MATH 052)

**Can be taken Concurrently:** MATH 023, MATH 032, MATH 052

**Attribute/Distribution:** NS

**PHY 021 Introductory Physics II 4 Credits**

A continuation of PHY 11. Electrostatics and magnetostatics; DC circuits; Maxwell's equations; waves; physical and geometrical optics; introduction to modern physics. Two lectures and two recitations per week.

**Prerequisites:** (PHY 010 or PHY 011 or PHY 090) and (MATH 023 or MATH 032 or MATH 052)

**Can be taken Concurrently:** MATH 023, MATH 032, MATH 052

**Attribute/Distribution:** NS

**PHY 022 Introductory Physics Laboratory II 1 Credit**

A laboratory course to be taken concurrently with PHY 13 or 21. One three-hour laboratory period per week.

**Prerequisites:** (PHY 012) and (PHY 021 or PHY 013)

**Can be taken Concurrently:** PHY 021, PHY 013

**Attribute/Distribution:** NS

**PHY 031 Introduction to Quantum Mechanics 3 Credits**

Experimental basis and historical development of quantum mechanics; the Schrodinger equation; one-dimensional problems; angular momentum and the hydrogen atom; many-electron systems; spectra; selected applications. Three lectures per week.

**Prerequisites:** (PHY 013 or PHY 021) and MATH 205

**Can be taken Concurrently:** MATH 205

**Attribute/Distribution:** NS

**PHY 091 Measurement and Transducers 1 Credit**

Computer-assisted laboratory course, dealing with physical phenomena in mechanics, electricity and magnetism, optics, spectroscopy and thermodynamics. Measurement strategies are developed and transducers devised. Computer simulation, analysis software, digital data acquisition.

**Prerequisites:** (PHY 021 and PHY 022)

**Attribute/Distribution:** NS

**PHY 105 Planetary Astronomy 4 Credits**

Structure and dynamics of planetary interiors, surfaces, and atmospheres. Models for the formation of the solar system and planetary evolution. Internal structure, surface topology, and composition of planets and other bodies in our solar system. Comparative study of planetary atmospheres. Organic materials in the solar system. Properties of the interplanetary medium, including dust and meteoroids. Orbital dynamics. Extrasolar planetary systems.

**Attribute/Distribution:** NS

**PHY 110 Methods of Observational Astronomy 1 Credit**

Techniques of astronomical observation, data reduction, and analysis. Photometry, spectroscopy, CCD imaging, and interferometry. Computational analysis. Examination of ground-based and spacecraft instrumentation, and data transmission, reduction, and analysis.

**Attribute/Distribution:** NS

**PHY 190 Electronics 3 Credits**

DC and AC circuits, diodes, transistors, operational amplifiers, oscillators, and digital circuitry. Two laboratories and one recitation per week.

**Prerequisites:** (PHY 013 or PHY 021) and PHY 022

**Attribute/Distribution:** NS

**PHY 212 Electricity and Magnetism I 3 Credits**

Electrostatics, magnetostatics, and electromagnetic induction.

**Prerequisites:** (PHY 021 or PHY 013) and MATH 205

**Can be taken Concurrently:** MATH 205

**Attribute/Distribution:** NS

**PHY 213 Electricity and Magnetism II 3 Credits**

Maxwell's equations, Poynting's theorem, potentials, the wave equation, waves in vacuum and in materials, transmission and reflection at boundaries, guided waves, dispersion, electromagnetic field of moving charges, radiation, Lorentz invariance and other symmetries of Maxwell's equations.

**Prerequisites:** PHY 212

**Attribute/Distribution:** NS

**PHY 215 Classical Mechanics I 4 Credits**

Kinematics and dynamics of point masses with various force laws; conservation laws; systems of particles; rotating coordinate systems; rigid body motions; topics from Lagrange's and Hamilton's formulations of mechanics; continuum mechanics.

**Prerequisites:** (PHY 021 or PHY 013) and MATH 205

**Can be taken Concurrently:** MATH 205

**Attribute/Distribution:** NS

**PHY 262 Advanced Physics Laboratory 2 Credits**

Laboratory practice, including machine shop, vacuum systems, and computer interfacing. Experiment selected from geometrical optics, interference and diffraction, spectroscopy, lasers, fiber optics, and quantum phenomena.

**Prerequisites:** (PHY 013 or PHY 021) and PHY 022

**Attribute/Distribution:** NS

**PHY 272 Special Topics In Physics 1-4 Credit**

Selected topics not sufficiently covered in other courses.

**Repeat Status:** Course may be repeated.

**PHY 273 Research 2-3 Credits**

Participation in current research projects being carried out within the department. Intended for seniors majoring in the field.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** NS

**PHY 281 Basic Physics I 3 Credits**

A course designed especially for secondary-school teachers in the master teacher program. Presupposing a background of two semesters of college mathematics through differential and integral calculus and of two semesters of college physics, the principles of physics are presented with emphasis on their fundamental nature rather than on their applications. Open only to secondary-school teachers and those planning to undertake teaching of secondary-school physics.

**Attribute/Distribution:** NS

**PHY 282 Basic Physics II 3 Credits**

Continuation of PHY 281.

**Prerequisites:** PHY 010 or PHY 011 or PHY 090 or PHY 281

**Attribute/Distribution:** NS

**PHY 300 Apprentice Teaching 1-4 Credit****PHY 301 Modern Astrophysics I 4 Credits**

Physics of stellar atmospheres and interiors, and the formation, evolution, and death of stars. Variable stars. The evolution of binary star systems. Novae, supernovae, white dwarfs, neutron stars, pulsars, and black holes. Stellar spectra, chemical compositions, and thermodynamic processes. Thermonuclear reactions. Interstellar medium.

**Prerequisites:** (PHY 010 or PHY 011 or PHY 090) and (PHY 013 or PHY 021) and (MATH 022 or MATH 032 or MATH 052)

**Attribute/Distribution:** NS

**PHY 302 Modern Astrophysics II 4 Credits**

The Milky Way Galaxy, galactic morphology, and evolutionary processes. Active galaxies and quasars. Observed properties of the universe. Relativistic cosmology, and the origin, evolution and fate of the universe. Elements of General Relativity and associated phenomena.

**Prerequisites:** (PHY 010 or PHY 011 or PHY 090) and (PHY 013 or PHY 021) and (MATH 022 or MATH 032 or MATH 052)

**Attribute/Distribution:** NS

**PHY 321 Biomolecular & Cellular Mechanics 3 Credits**

Mechanics and physics of the components of the cell, ranging in length scale from fundamental biomolecules to the entire cell. The course covers the mechanics of proteins and other biopolymers in 1D, 2D, and 3D structures, cell membrane structure and dynamics, and the mechanics of the whole cell.

**Prerequisites:** MATH 205 and MATH 231 and PHY 022 and (PHY 013 or PHY 021)

**Attribute/Distribution:** NS

**PHY 331 Integrated Bioelectronics/Biophotonics Laboratory 2 Credits**

Experiments in design and analysis of bioelectronics circuits, micropatterning of biological cells, micromanipulation of biological cells using electric fields, analysis of pacemakers, instrumentation and computer interfaces, ultrasound, optic, laser tweezers and advanced imaging and optical microscopy techniques for biological applications.

**Prerequisites:** (PHY 013 or PHY 021) and PHY 022 and (PHY 190 or ECE 081)

**Attribute/Distribution:** NS

**PHY 332 High-Energy Astrophysics 3 Credits**

Observation and theory of X-ray and gamma-ray sources, quasars, pulsars, radio galaxies, neutron stars, black holes. Results from ultraviolet, X-ray and gamma-ray satellites. Generally offered in the spring of odd-numbered years.

**Prerequisites:** PHY 021 and (MATH 023 or MATH 033)

**Can be taken Concurrently:** MATH 023, MATH 033

**Attribute/Distribution:** NS

**PHY 340 Thermal Physics 3 Credits**

Basic principles of thermodynamics, kinetic theory, and statistical mechanics, with emphasis on applications to classical and quantum mechanical physical systems.

**Prerequisites:** (PHY 013 or PHY 021) and (MATH 023 or MATH 032 or MATH 052)

**Attribute/Distribution:** NS

**PHY 342 Relativity and Cosmology 3 Credits**

Special and general relativity. Schwarzschild and Kerr black holes. Super massive stars. Relativistic theories of the origin and evolution of the universe. Generally offered in the spring of even-numbered years.

**Prerequisites:** PHY 021 and (MATH 023 or MATH 033)

**Can be taken Concurrently:** MATH 023, MATH 033

**Attribute/Distribution:** NS

**PHY 348 Plasma Physics 3 Credits**

Single particle behavior in electric and magnetic fields, plasmas as fluids, waves in plasmas, transport properties, kinetic theory of plasmas, controlled thermonuclear fusion devices. Must have senior standing or consent of the department chair.

**Prerequisites:** PHY 021 and MATH 205

**Attribute/Distribution:** NS

**PHY 352 Modern Optics 3 Credits**

Paraxial optics, wave and vectorial theory of light, coherence and interference, diffraction, crystal optics, and lasers.

**Prerequisites:** MATH 205 and (PHY 212 or ECE 202)

**Attribute/Distribution:** NS

**PHY 355 Nonlinear Optics 3 Credits**

This course will introduce the fundamental principles of nonlinear optics. Topics include nonlinear interaction of optical radiation with matter, multi-photon interactions, electro-optics, self and cross phase modulation, and the nonlinear optical susceptibilities that describe all these effects in the mainframe of electromagnetic theory.

**Prerequisites:** PHY 031 and (PHY 213 or ECE 203)

**Can be taken Concurrently:** PHY 213, ECE 203

**Attribute/Distribution:** NS

**PHY 362 Atomic and Molecular Structure 3 Credits**

Review of quantum mechanical treatment of one-electron atoms, electron spin and fine structure, multi-electron atoms, Pauli principle, Zeeman and Stark effects, hyperfine structure, structure and spectra of simple molecules.

**Prerequisites:** PHY 031 or CHM 341

**Attribute/Distribution:** NS

**PHY 363 Physics of Solids 3 Credits**

Introduction to the theory of solids with particular reference to the physics of metals and semiconductors.

**Prerequisites:** (PHY 031 or MAT 316 or CHM 341) and PHY 340

**Can be taken Concurrently:** PHY 340

**Attribute/Distribution:** NS

**PHY 364 Nuclear and Elementary Particle Physics 3 Credits**

Models, properties, and classification of nuclei and elementary particles; nuclear and elementary particle reactions and decays; radiation and particle detectors; accelerators; applications. Prerequisites as noted below.

**Prerequisites:** PHY 031 and MATH 205

**Attribute/Distribution:** NS

**PHY 365 Physics Of Fluids 3 Credits**

Concepts of fluid dynamics; continuum and molecular approaches; waves, shocks and nozzle flows; nature of turbulence; experimental methods of study.

**Prerequisites:** (PHY 212 or ECE 202) and (PHY 340 or ME 104)

**Can be taken Concurrently:** PHY 212, ECE 202, PHY 340, ME 104

**Attribute/Distribution:** NS

**PHY 369 Quantum Mechanics I 3 Credits**

Principles of quantum mechanics: Schroedinger, Heisenberg, and Dirac formulations. Applications to simple problems.

**Prerequisites:** PHY 031 and MATH 205 and PHY 215

**Can be taken Concurrently:** PHY 215

**Attribute/Distribution:** NS

**PHY 372 Special Topics In Physics 1-3 Credit**

Selected topics not sufficiently covered in other courses.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** NS

**PHY 380 Introduction to Computational Physics 3 Credits**

Numerical solution of physics and engineering problems using computational techniques. Topics include linear and nonlinear equations, interpolation, eigenvalues, ordinary differential equations, partial differential equations, statistical analysis of data, Monte Carlo, and molecular dynamics methods.

**Prerequisites:** MATH 205

**Can be taken Concurrently:** MATH 205

**Attribute/Distribution:** NS

**PHY 389 Honors Project 1-8 Credit**

**Repeat Status:** Course may be repeated.

**PHY 411 Survey Nuclear Particles and Elementary Particle Physics 3 Credits**

Intended for non-specialists. Fundamentals and modern advanced topics in nuclear and elementary particle physics. Topics include: nuclear force, structure of nuclei, nuclear models and reactions, scattering, elementary particle classification, SU(3), quarks, gluons, quark flavor and color, leptons, gauge theories, GUT, the big bang.

**Prerequisites:** PHY 369

**PHY 420 Mechanics 3 Credits**

Includes the variational methods of classical mechanics, methods of Hamilton and Lagrange, canonical transformations, Hamilton-Jacobi Theory.

**PHY 421 Electricity & Magnetism I 3 Credits**

Electrostatics, magnetostatics, Maxwell's equations, dynamics of charged particles, multipole fields.

**PHY 422 Electricity & Magnetism II 3 Credits**

Electrodynamics, electromagnetic radiation, physical optics, electrostatics in anisotropic media. Special theory of relativity.

**Prerequisites:** (PHY 421)

**PHY 424 Quantum Mechanics II 3 Credits**

General principles of quantum theory; approximation methods; spectra; symmetry laws; theory of scattering.

**Prerequisites:** PHY 369

**PHY 425 Quantum Mechanics III 3 Credits**

A continuation of Phys 424. Relativistic quantum theory of the electron; theory of radiation.

**Prerequisites:** PHY 422

**PHY 428 Methods of Mathematical Physics I 3 Credits**

Analytical and numerical methods of solving the ordinary and partial differential equations that occur in physics and engineering. Includes treatments of complex variables, special functions, product solutions and integral transforms.

**PHY 429 Methods of Mathematical Physics II 3 Credits**

Continuation of Physics 428 to include the use of integral equations. Green's functions, group theory, and more on numerical methods.

**Prerequisites:** PHY 428

**PHY 431 Theory Of Solids 3 Credits**

Advanced topics in the theory of the electronic structure of solids. Many-electron theory. Theory of transport phenomena. Magnetic properties, optical properties. Superconductivity. Point imperfections.

**Prerequisites:** PHY 363 and PHY 424

**PHY 442 Statistical Mechanics 3 Credits**

General principles of statistical mechanics with application to thermodynamics and the equilibrium properties of matter.

**Prerequisites:** PHY 340 and PHY 369

**PHY 443 Nonequilibrium Statistical Mechanics 3 Credits**

A continuation of PHY 442. Applications of kinetic theory and statistical mechanics to nonequilibrium processes; nonequilibrium thermodynamics.

**Prerequisites:** PHY 422

**PHY 446 Atomic and Molecular Physics 3 Credits**

Advanced topics in the experimental and theoretical study of atomic and molecular structure. Topics include fine and hyperfine structure, Zeeman effect, interaction of light with matter, multi-electron atoms, molecular spectroscopy, spectral line broadening atom-atom and electron-atom collisions and modern experimental techniques.

**Prerequisites:** PHY 424

**PHY 455 Physics of Nonlinear Phenomena 3 Credits**

Basic concepts, theoretical methods of analysis and experimental development in nonlinear phenomena and chaos. Topics include nonlinear dynamics, including period-multiplying routes to chaos and strange attractors, fractal geometry and devil's staircase. Examples of both dissipative and conservative systems will be drawn from fluid flows, plasmas, nonlinear optics, mechanics and waves in disordered media. Must have graduate standing in science or engineering, or consent of the chairman of the department.

**PHY 462 Theories of Elementary Particle Interactions 3 Credits**

Relativistic quantum theory with applications to the strong, electromagnetic and weak interactions of elementary particles.

**Prerequisites:** PHY 425

**PHY 467 Nuclear Theory 3 Credits**

Theory of low-energy nuclear phenomena within the framework of non-relativistic quantum mechanics.

**PHY 471 Continuum Mechanics 3 Credits**

An introduction to the continuum theories of the mechanics of solids and fluids. This includes a discussion of the mechanical and thermodynamical bases of the subject, as well as the use of invariance principles in formulating constitutive equations. Applications of theories to specific problems are given.

**PHY 472 Special Topics In Physics 1-3 Credit**

Selected topics not sufficiently covered in other courses.

**Repeat Status:** Course may be repeated.

**PHY 474 Seminar In Modern Physics 3 Credits**

Discussion of important advances in experimental physics. May be repeated for credit when a different topic is offered.

**Repeat Status:** Course may be repeated.

**PHY 475 Seminar In Modern Physics 3 Credits**

Discussion of important advances in theoretical physics. May be repeated for credit when a different topic is offered.

**Repeat Status:** Course may be repeated.



**PHY 482 Applied Optics 3 Credits**

Review of ray and wave optics with extension to inhomogeneous media, polarized optical waves, crystal optics, beam optics in free space (Gaussian and other types of beams) and transmission through various optical elements, guided wave propagation in planar waveguides and fibers (modal analysis), incidence of chromatic and polarization mode dispersion, guided propagation of pulses, nonlinear effects in waveguides (solitons), periodic interactions in waveguides, acousto-optic and electro-optics.

**Prerequisites:** PHY 352

**PHY 490 Thesis 1-6 Credit****PHY 491 Research 3 Credits**

Research problems in experimental or theoretical physics.

**PHY 492 Research 3 Credits**

Continuation of PHY 491.

**Repeat Status:** Course may be repeated.

**PHY 499 Dissertation 1-15 Credit**

**Repeat Status:** Course may be repeated.

**Political Science*****Richard K. Matthews, Ph.D NEH Distinguished Professor and Chair***

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<http://cas.lehigh.edu/pols>

The major in political science is designed to promote understanding of political ideas, institutions and processes and to develop skills in analyzing and evaluating political problems.

A balanced program within the discipline, one that exposes the student to various areas of inquiry in political institutions and political processes as well as in the comparative and philosophical perspectives of political analysis, has been the way in which the goals of the major program generally have been achieved. While the major program outlined below will prove adequate for most student needs, it may be that some special factors such as late transfer or unusual interests and/or abilities the outlined program does not accommodate some students. In that case the students may, in consultation with their advisers, develop a major program that in their judgment will more adequately fulfill those needs.

The faculty adviser to the student majoring in political science is designated by the department. The adviser consults with the student and approves the major program. The adviser attempts to help the student relate courses offered by the department to the student's educational goals. The adviser also may act as a resource for the student, and may suggest courses in other disciplines, language courses, and courses in research techniques that may be of benefit.

A variety of experiential opportunities are available to undergraduates majoring in political science. The department, for example, offers a Community Politics Internship every semester that includes opportunities for internship placements in either local government, private agencies or law offices. Students are also encouraged to apply for off-campus internship opportunities, e.g., American University's Washington Semester Program and The Philadelphia Center's Internship in Philadelphia.

Completion of the political science major is considered suitable training for the undergraduate who wishes to go on to law school, to become a social science teacher, or to work as a governmental official, party or civic leader, public affairs commentator, or staff member of a government research bureau. In addition, the business sector continues to provide opportunities in areas such as banking, insurance, and marketing for bachelor of arts graduates with training in the social sciences. Graduate study is advisable for students contemplating certain careers: college teaching, research, or public management, for example.

**Professors.** Richard K. Matthews, PhD (University of Toronto); Edward P. Morgan, PhD (Brandeis University); Laura K Olson, PhD (University of Colorado Boulder)

**Associate Professors.** Frank L. Davis, PhD (North Carolina State University); Vera L. Fennell, PhD (University of Chicago); Brenea Holland, PhD (University of Chicago); Janet M. Laible, PhD (Yale University); Brian K Pinaire, PhD (Rutgers University); Albert H. Wurth, Jr., PhD (University of North Carolina Chapel Hill)

**Assistant Professors.** Saladin M. Ambar, PhD (Rutgers University); Nandini Deo, PhD (Yale University); Holona L. Ochs, PhD (University of Kansas)

**Professor Of Practice.** Mark Orrs, MA (Columbia University)

**Emeriti.** Dave Curtis Amidon, Jr., MA (The Pennsylvania State University); Donald D. Barry, PhD (Syracuse University); Howard R. Whitcomb, PhD (Suny College Albany); W. Ross Yates, PhD (Yale University)

The three core courses are required. Individual exceptions may be made, for good reasons, by the major adviser with the approval of the department chair.

**Major Requirements**

POLS 001	American Political System	4
POLS 003	Comparative Politics	4

Select one of the following:

POLS 100	Introduction to Political Thought	
POLS 101	Ancient Political Heritage	
POLS 102	Modern Political Heritage	

**Electives**

Select seven of the following with at least two courses from each of the two fields listed below: <sup>1</sup> 28

American Politics, Public Law and Interdisciplinary		
POLS 103	Introduction to Public Administration	
POLS 104	Political Sociology	
POLS 107	The Politics of the Environment	
POLS 108	Global Citizenship and its Discontents	
POLS 109	Introduction to Public Policy	
POLS 115	Technology As Politics	
POLS 179	Politics of Women	
POLS 205	The Political Development of American Race Relations	
POLS 230	Social Movements and Legacies of the 1960s	
POLS 232	The Vietnam War in Politics, Media, and Memory	
POLS 240	Law and Order. The Politics of Crime and Punishment	
POLS 274	Political Parties and Elections	
POLS 282	First Ladies and the Changing Role of Women	
POLS 302	Comparative State Politics	
POLS 306	Public Policy Process	
POLS 307	The Politics of Mental Health Policy	
POLS 309	Nonprofit Administration	
POLS 310	Social Entrepreneurship: How to Change the World	
POLS 317	The American Presidency	
POLS 326	Organizing For Democracy	
POLS 328	U.S. Politics and the Environment	
POLS 329	Propaganda, Media, and American Politics	
POLS 331	Community Politics Internship	
POLS 333	Social Psychology of Politics	
POLS 348	Land Use, Growth Management, and the Politics of Sprawl	
POLS 351	Constitutional Law and Politics	
POLS 352	Civil Rights and Civil Liberties	

POLS 354	U.S. Health Care Politics	
POLS 358	Interest Groups, Factions, and Coalitions in American Politics	
POLS 359	U.S. Congress	
POLS 360	Public Administration	
POLS 368	Political Economy	
POLS 373	Globalization and Social Well-Being	
POLS 375	Seminar: Green Polity	
POLS 376	Seminar: National Social Policy	
POLS 378	Honors Thesis In Political Science	
POLS 379	Honors Thesis In Political Science	
Political Theory and Comparative Politics		
POLS 100	Introduction to Political Thought	
POLS 101	Ancient Political Heritage	
POLS 102	Modern Political Heritage	
POLS 105	Environmental Policy and Planning	
POLS 106	Environmental Values and Ethics	
POLS 125	International Political Economy	
POLS 133	Lehigh in Martinique: Globalization and Local Identity	
POLS 201	Democracy and Dictatorship in South Asia	
POLS 301	Current Political Controversies	
POLS 321	Research In Political Science	
POLS 323	Politics Of The European Union	
POLS 324	Politics Of Western Europe	
POLS 325	Nationalism in Comparative Perspective	
POLS 335	Latin American Political Systems	
POLS 336	U.S. Foreign Policy and Latin America	
POLS 337	Religion and Politics in Latin America	
POLS 338	Markets, Justice, And Law	
POLS 339	The Rise of the State in Modern East Asia	
POLS 342	Gender and Third World Development	
POLS 343	Global Politics of Race: Asia and Africa	
POLS 350	Religion and Politics in Comparative Perspective	
POLS 355	Environmental Justice and the Law	
POLS 356	Seminar: Political Philosophy	
POLS 357	Politics Of Authenticity	
POLS 364	Issues In Contemporary Political Philosophy	
POLS 367	American Political Thought	
POLS 370	Seminar: The Citizen versus the Administrative State	
Total Credits		36

<sup>1</sup> One of the electives may, with the consent of the department, be in a cognate field.

#### Political Science Minor

It takes **five (5) courses to complete the political science minor**. Beginning the 3rd week of the semester, a student can declare the minor. In order to declare, however, a student must have already taken, or be in the process of taking, one of POLS "core" courses (POLS 001, POLS 003 or POLS 100) AND any two other POLS courses (either "core" or elective options).

POLS 001	American Political System	4
POLS 003	Comparative Politics	4
POLS 100	Introduction to Political Thought	4
Select any two other POLS courses (either "core" or elective options).		8
Total Credits		20

#### Public Administration Minor

The minor consists of:

POLS 001, POLS 103 plus four other courses chosen in consultation with the advisor for a minimum of twenty-four credits. 24

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Total Credits 24

#### Political Science Honors

Students must have at least a 3.2 cumulative grade point average, and a 3.3 major grade point average, in order to proceed with departmental honors. Students with honors must complete ten courses in the major, including an independent study focusing on the honors thesis.

#### Master of Arts in Politics and Policy

##### Political Science

For Graduate Students the department offers a graduate program leading to the Master of Arts degree. The applicant for admission is required to demonstrate adequate undergraduate preparation.

The Master of Arts in politics and policy is a 30 credit hour program that can be accomplished in 12 months by fulltime students. Students interested in enrolling on a part-time basis will be given consideration, but the expectation is that most students will complete the program in a year. Students must take ten classes with a minimum of seven classes at the 400 level. The normal path would be at least two 400-level courses each semester and two over the summer. Students must take Introduction to Politics and Policy, one methodology course, and one course with a normative component. With the approval of the department DGS, students may take graduate level courses outside of the Department of Political Science.

##### Community Fellows Program

Students interested in state or local public service or nonprofit work may also elect to apply to the Community Fellows program in which the student works for 15 hours per week for a local non-profit organization on a project related to community (re)development. For more information on the Community Fellows program, please see the program website [www.lehigh.edu/communityfellows](http://www.lehigh.edu/communityfellows).

Graduate students will be required to write a major paper (one semester) or a Master's thesis (two semesters) that will be defended before a panel of faculty members. Those participating in the Community Fellows program will be required to write a paper summarizing and analyzing their community fellows experience.

The Master of Arts program is intended for high-achieving students with a social science and liberal arts background who have a keen interest in the study of politics and/or are interested in the Community Fellows program and related experiential learning opportunities. The Master of Arts prepares students for further study in political science, public policy, or the law as well as careers in business, public service, or nonprofit organizations.

##### Courses

##### POLS 001 American Political System 4 Credits

Constitutional principles; organization and operation of the national government; and dynamics of power within the U.S. political system.

**Attribute/Distribution:** SS

##### POLS 003 Comparative Politics 4 Credits

The political systems of foreign countries; approaches to the study of comparative politics.

**Attribute/Distribution:** SS

##### POLS 100 Introduction to Political Thought 4 Credits

A critical examination of political ideologies: Liberalism, Marxism, Fascism, and Islamism.

**Attribute/Distribution:** ND

##### POLS 101 Ancient Political Heritage 4 Credits

Important political thinkers from the pre-Socratics to early, modern political theorists like Machiavelli.

**Attribute/Distribution:** SS

**POLS 102 Modern Political Heritage 4 Credits**

Begins where POLS 101 ends: from early, modern theorists (e.g., Hobbes) up to contemporary thinkers (e.g., Marcuse).

**Attribute/Distribution:** SS

**POLS 103 Introduction to Public Administration 4 Credits**

This course presents the intellectual history of the study of public administration in a manner that is intended to inform career choices for those who might consider public service and provide a broad introduction to the field of public administration. Students will gain a comprehensive perspective on the public administration discipline by exploring the pervasive puzzles, ethical dilemmas, and the critical issues in governance to date.

**Attribute/Distribution:** SS

**POLS 104 Political Sociology 4 Credits**

An introduction to political sociology through an examination of the major sociological questions concerning power, politics, and the state. Covers historical questions concerning state formation, nationalism, social movements, globalization, political culture and participation, and civil society. Includes examples such as racism, welfare reform, campaign financing, coal mining in Appalachia, revolution in Latin America, and the rise of the Nazi party in Germany, and the place of the United States in a global society.

**Attribute/Distribution:** SS

**POLS 105 Environmental Policy and Planning 4 Credits**

Analysis of the framework that has been established to protect the environment and promote sustainable growth. Focus on the roles of the different branches of the U.S. government and the relative responsibilities of state and local governments within this framework. Consideration of the political nature of environmental issues and the social forces influencing environmental protection in different areas of domestic environmental policy, such as climate change, toxic waste disposal, and natural resources conservation.

**Attribute/Distribution:** SS

**POLS 106 Environmental Values and Ethics 4 Credits**

An introduction to the ethical perspectives and values that shape human relationships to the natural environment in contemporary society. What are the moral implications of these relationships for justice and human collective action? Given these implications, what policy responses to environmental problems are morally or politically justifiable? In answering these questions, the course explores ethical ideas developed in different schools of environmental thought, such as deep ecology and ecofeminism, in addition to ideas that emerge from social movements, such as environmental justice and bioregionalism.

**Attribute/Distribution:** SS

**POLS 107 The Politics of the Environment 4 Credits**

A survey of the major environmental, resource, energy and population problems of modern society, focusing on the United States. The politics of man's relationship with nature, the political problems of ecological scarcity and public goods, and the response of the American political system to environmental issues.

**Attribute/Distribution:** SS

**POLS 108 Global Citizenship and its Discontents 4 Credits**

The purpose of the course is to consider the nature-and desirability-of citizenship, both as an ideal and as applied (if possible) in the global context. What exactly does it mean to be a "citizen?" Does citizenship require particular actions, thoughts, or values? What are the legal, political, and moral obligations of this designation? What exactly do you owe to your neighbor, or to someone on the other side of the world? Readings range from Socrates to the Manifesto of the Unabomber. (SS/GC).

**Attribute/Distribution:** SS

**POLS 109 Introduction to Public Policy 4 Credits**

Introduces students to the basic theories, principles, institutions, and processes of public policy in the U.S. The objectives are to provide students with an understanding of how social problems are defined, how potential solutions to those problems move through the policy process, and gain an empirical perspective on the consequences, as well as insight regarding the normative dimensions of policy making. Students will develop knowledge of the framework for understanding policy and engage in critical thinking regarding the nature of policy.

**Attribute/Distribution:** SS

**POLS 115 Technology As Politics 4 Credits**

Relationship of technology and technological change with politics and public policy. Review of theories of political significance of technology, including technological determinism, technology assessment, technological progress and appropriate technology. Specific issues in technology with emphasis on U.S.

**Attribute/Distribution:** ND

**POLS 125 International Political Economy 4 Credits**

Principles governing the interaction between the economic and political components of international phenomena. Political causes and consequences of trade and investment. Foreign economic policy in its relationship to domestic economic policy and other aspects of foreign policy. Determinants of foreign economic policy. Prerequisites as noted below.

**Prerequisites:** (ECO 001 or ECO 011 or ECO 012) and IR 010

**Attribute/Distribution:** SS

**POLS 133 Lehigh in Martinique: Globalization and Local Identity 3,4 Credits**

History, culture, and politics of the French Caribbean island of Martinique, from its position as a key site of the 18th century Atlantic World economy to becoming an official French department and outpost of the European Union. Interdisciplinary perspectives on the complex nature of social identity, historical memory and impact of globalization. No French is required. Offered during winter inter-term through Lehigh Study Abroad.

**Attribute/Distribution:** HU

**POLS 179 Politics of Women 4 Credits**

Selected social and political issues relating to the role of women in American society. Focuses on such questions as economic equality, poverty, and work roles, the older woman, gender gap, political leadership, reproduction technology, and sexual violence.

**Attribute/Distribution:** SS

**POLS 201 Democracy and Dictatorship in South Asia 4 Credits**

Theories of democracy and democratization explored in the South Asian context. Relationship of democracy to economic development and identity considered. How do historical legacies of colonialism and conflict shape contemporary outcomes.

**Attribute/Distribution:** SS

**POLS 205 The Political Development of American Race Relations 4 Credits**

This course examines the distinctive role race has played in shaping the political history of the United States.

**Attribute/Distribution:** SS

**POLS 230 Social Movements and Legacies of the 1960s 4 Credits**

The lessons and legacies of 1960s social and political movements. Students examine civil rights, black power movements, the New Left, campus protests, the Vietnam war and antiwar movement, the counterculture, women's and ecology movements and assess their connection to democracy, today's world and their own lives.

**Attribute/Distribution:** SS

**POLS 232 The Vietnam War in Politics, Media, and Memory 4 Credits**

Examines the meaning of the American war in Vietnam as interpreted and disputed in American politics, the mass media, and private and public memory. Reviews the political history and context of the war, personal experiences and critical perspectives on the war, and characterizations of the war in mainstream news media and popular film.

**Attribute/Distribution:** SS

**POLS 240 Law and Order. The Politics of Crime and Punishment 4 Credits**

This course explores the legal and political consequences of various theories of crime, punishment and social control in the United States. Topics include policing, racial profiling, trial court proceedings and the administration of justice, growing incarceration rates and the prison industry, capital punishment, the jury system, and the nature of legal obligation.

**Attribute/Distribution:** ND

**POLS 274 Political Parties and Elections 4 Credits**

Study of the organization, functions and behavior of political parties in the United States. Includes voting behavior, campaigns and elections, polling, interest groups, public opinion and the role of the media.

**Attribute/Distribution:** SS

**POLS 282 First Ladies and the Changing Role of Women 4 Credits**

The role of presidential wives since Martha Washington first held the position will be examined with particular attention focused on the decades since 1932, beginning with Eleanor Roosevelt.

**Attribute/Distribution:** SS

**POLS 300 Apprentice Teaching 1-4 Credit**

**Repeat Status:** Course may be repeated.

**POLS 301 Current Political Controversies 4 Credits**

Selected topical policy issues and alternative approaches to understanding them. Includes the major domestic questions facing the U.S. Emphasis is on debating the current issues of the day.

**Attribute/Distribution:** SS

**POLS 302 Comparative State Politics 4 Credits**

Analysis of major questions relating to the role of the states in the American federal system and their relationship with the national government.

**Attribute/Distribution:** SS

**POLS 306 Public Policy Process 3-4 Credits**

Power relations and their impacts on selected public policy issues, specifically taxation, housing, environment, poverty, energy, the military, and health.

**Attribute/Distribution:** SS

**POLS 307 The Politics of Mental Health Policy 4 Credits**

What is normal behavior, and how do we come to understand mental illness? How do the resulting policies, to address mental health, impact society? This course is designed to facilitate thoughtful discourse on the various ways in which society regulates access to opportunities, facilitates integration or alienation, and constructs the social world.

**Attribute/Distribution:** SS

**POLS 309 Nonprofit Administration 4 Credits**

This course will address key questions in nonprofit sector research, policy, and management and familiarize students with factors that tend to make the nonprofit sector distinct. Students will gain an understanding of the scope and character of nonprofit activity in the U.S. and abroad. We will explore current debates in nonprofit policy and evaluate critical challenges facing the organization and management of nonprofits.

**Attribute/Distribution:** SS

**POLS 310 Social Entrepreneurship: How to Change the World 4 Credits**

The marketplace does not always have to be harsh. Social entrepreneurship uses market-based approaches to address needs and solve problems in our society. Students in this seminar-style course will learn how to identify community problems, convince the community that it is a problem worth solving, design the response, and implement it. Hands-on projects. Must have at least junior standing or consent of the minor director.

**Attribute/Distribution:** SS

**POLS 317 The American Presidency 3-4 Credits**

Role of the executive in the American political process. Includes an analysis of the historical development, selection process, and scope of executive power. Emphasizes domestic and foreign policy initiatives of selected presidents from FDR to today. Prerequisites as noted below.

**Prerequisites:** (POLS 001)

**Attribute/Distribution:** SS

**POLS 321 Research In Political Science 4 Credits**

Models in the explanation of political phenomena, appropriateness of measurement techniques; construction of research designs; rationale and application of statistical analyses; individual projects involving the construction and testing of models employing a major social science data set. Consent of instructor required.

**Attribute/Distribution:** ND

**POLS 323 Politics Of The European Union 4 Credits**

The institutions and policy-making processes of the European Union. Topics include the creation of the single market and the euro, environmental and agricultural policy, regional development and the policy challenges of eastward enlargement. Prerequisites as noted below.

**Prerequisites:** POLS 003 or IR 010

**Attribute/Distribution:** SS

**POLS 324 Politics Of Western Europe 3,4 Credits**

Comparative discussion of systems of government in Western Europe and of major policy questions facing these states in the post-war era. Topics include the evolution of social welfare systems, the impact of economic crises and globalization on Western European political economy, and immigration and identity politics. Prerequisites as noted below.

**Prerequisites:** POLS 003

**Attribute/Distribution:** SS

**POLS 325 Nationalism in Comparative Perspective 3,4 Credits**

Examination of major theoretical and policy debates in contemporary studies of nationalism. Focus on the emergence and endurance of nationalist movements in the modern era. Discussion of efforts to evaluate the legitimacy of nationalist claims and to resolve nationalist conflict. Prerequisites as noted below.

**Prerequisites:** POLS 003

**Attribute/Distribution:** SS

**POLS 326 Organizing For Democracy 3-4 Credits**

Seminar on the theory and practice of community and political organizing and their relationship with democracy and power in the United States, complementing semester-long student field placements with community groups and local organizations. Student teams help enhance the political voice of under-resourced community groups through organization-building, outreach, and policy input at the local level. Consent of instructor required.

**Attribute/Distribution:** ND

**POLS 328 U.S. Politics and the Environment 4 Credits**

An examination of contemporary American politics and policy dealing with environmental issues. Current controversies in the legislative and regulatory areas will be covered to examine environmental issues and the political process. Significant portions of the course readings will be taken from government publications.

**Attribute/Distribution:** SS

**POLS 329 Propaganda, Media, and American Politics 3-4 Credits**

The role of propaganda and mass media in sustaining hegemony in the United States. Emphasis on television, advertising and mass culture, public relations, news media, and political propaganda pertaining to U.S. foreign and domestic policy. Students compare critical counter-hegemonic theories to political speeches, documents, news reports, and media encounters that shape much of American political life.

**Attribute/Distribution:** SS

**POLS 331 Community Politics Internship 4 Credits**

Integrated fieldwork and academic study. Seminar, research paper, and journal; internship with government and social service agencies, political groups, elected officials, and law offices. May be repeated for credit. Consent of instructor required.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** ND

**POLS 333 Social Psychology of Politics 4 Credits**

Political behavior viewed from a psychological and social psychological perspective.

**Prerequisites:** (ANTH 001 or SSP 001 or PSYC 001)

**Attribute/Distribution:** SS

**POLS 335 Latin American Political Systems 4 Credits**

Democratic, authoritarian and revolutionary paths to contemporary political issues. Political, economic and social implications of contemporary "democratic" regimes and neo-liberal economic policies. Discussion groups and student presentations on prospects for democratic peace and prosperity in the future. Prerequisites as noted below.

**Prerequisites:** (POLS 003)

**Attribute/Distribution:** ND

**POLS 336 U.S. Foreign Policy and Latin America 3-4 Credits**

U.S. historical relationship with Central America, Caribbean and South America with emphasis on economic and military dominance. Contemporary issues such as U.S. invasions of Panama and Grenada, U.S. Cuban relations, the militarization of the "drug war," counter-insurgency. Written analysis of competing U.S. interests across time and regions. Prerequisites as noted below.

**Prerequisites:** (POLS 003)

**Attribute/Distribution:** ND

**POLS 337 Religion and Politics in Latin America 4 Credits**

Indigenous and "imported" religious structures, the prominent role of the Catholic Church in Latin America, and the recent explosion of Protestant/ Pentecostal churches. Emphasis on the intersection of religious belief and power (i.e., gender, local politics, national development, etc.). Short papers integrate material with students' knowledge of religious/political phenomena. Discussion groups analyze philosophical foundations of belief. Prerequisites as noted below.

**Prerequisites:** (POLS 003 and POLS 336)

**Attribute/Distribution:** ND

**POLS 338 Markets, Justice, And Law 3,4 Credits**

The exploration of the various ways in which markets shape cultural, social, ethical, and political practices in contemporary society. Normative justification for market as an institutional arrangement that is neutral between different views of "the good". Ethical critique of this normative justification and implications of the critique for law and policy.

**Attribute/Distribution:** SS

**POLS 339 The Rise of the State in Modern East Asia 4 Credits**

An examination of the role of Asian nationalism in the construction of the modern state form in Asia.

**Attribute/Distribution:** SS

**POLS 342 Gender and Third World Development 3-4 Credits**

Focus on gender implications of contemporary strategies for Third World economic growth, neo-liberalism. How do economic theories affect 'real people?' How do economic theories affect men vs. women? What is the role of people who want to 'help?' Some background in economic theories and/or Third World politics desired, but not required. Prerequisites as noted below.

**Prerequisites:** POLS 001 or WGSS 001

**Attribute/Distribution:** SS

**POLS 343 Global Politics of Race: Asia and Africa 4 Credits**

An examination of the concept of "race" and its impact on domestic and international politics.

**Attribute/Distribution:** SS

**POLS 348 Land Use, Growth Management, and the Politics of Sprawl 3-4 Credits**

An intro to the issues of Land Use Planning, Community, Growth Mgmt, & Sprawl. Will examine the history of urban development in America, from the earliest settlements to the auto suburbs. Also explore such planning & development factors as comprehensive plans, zoning, & the influence of infrastructure on development. Concludes with an assessment of the revival of city centers, alternatives to sprawl, & comparisons to development patterns in other countries.

**Attribute/Distribution:** SS

**POLS 350 Religion and Politics in Comparative Perspective 4 Credits**

This research seminar attempts to identify the conditions under which religious parties arise and become influential, how religion influences popular understandings of secular politics and the extent to which religion is a necessary feature of modern public discourse. These topics are explored through country specific cases from around the world.

**Attribute/Distribution:** SS

**POLS 351 Constitutional Law and Politics 4 Credits**

Exploration of the process of legal reasoning, the place of the United States Supreme Court in the American political system, the multiple influences on judicial decision-making, and various interpretive debates over the meaning of the U.S. Constitution. Following this introduction to the interplay of law and politics, the focus turns to particular domains within the canon of constitutional law, including cases pertaining to the Supreme Court's jurisdiction and capacity; the separation of powers between the three branches of government; federalism (federal-state-local relations); the "takings" clause; election law; the powers of Congress; "police powers" at the state level; and, foreign affairs and constitutional crises. POLS 001 is strongly recommended.

**Attribute/Distribution:** ND

**POLS 352 Civil Rights and Civil Liberties 3-4 Credits**

A continuation of themes, issues, and debates of the previous semester (POLS 351). This course addresses the major cases and controversies within several legal domains, including the freedoms of and from religion; freedom of speech; freedom of association; freedom of the press; the right to bear arms; the rights of criminal defendants and suspects; the right to privacy; capital punishment; and, the equal protection of the law. Prerequisites as noted below.

**Prerequisites:** POLS 351

**Attribute/Distribution:** ND

**POLS 354 U.S. Health Care Politics 4 Credits**

Health care programs, policies, and their impact on American society. Topics include approaches to health care; public sector plans (Medicare and Medicaid); managed care; the employer-sponsored system; medically uninsured; vested interests and lobbyists; movements for national health care; and options for change.

**Attribute/Distribution:** SS

**POLS 355 Environmental Justice and the Law 4 Credits**

This course explores the various ways in which environmental law and policy can have discriminatory effects. It examines the rise and evolution of environmental justice movement, and the impact of environmental justice claims on administrative rule making at state and federal level. Reviewing the history of case law concerning environmental justice suits filed under the 1964 Civil Rights Act, it also examines the future of environmental justice in environmental law and policy. Prerequisites as noted below.

**Prerequisites:** POLS 105 or ES 105

**Attribute/Distribution:** SS

**POLS 356 Seminar: Political Philosophy 3-4 Credits**

Critical examination of several of the "great books" and/or "great ideas" in political thought. Students will help select the material for critical discussion.

**Attribute/Distribution:** SS

**POLS 357 Politics Of Authenticity 4 Credits**

Works in political philosophy, psychoanalytic theory, literature, and film that discuss knowing and being one's self will be critically discussed. If you feel a life of "quiet desperation" is inevitable, this course is for you.

**Attribute/Distribution:** SS

**POLS 358 Interest Groups, Factions, and Coalitions in American Politics 4 Credits**

The rise of interest group power. Social, economic, and political reasons for groups' increasing influence. Value of different group resources and influence in particular national policy arenas. Types of more, and less, powerful interests, and the implications of this distribution of power for American politics.

**Attribute/Distribution:** SS

**POLS 359 U.S.Congress 3-4 Credits**

Elections for the House and Senate and their significance for the way in which Congress functions. The formal structure of party leadership and committees, House and Senate organizational and functional differences, and informal and formal power of legislation and oversight. Congressional relations with the president, bureaucracy, and Supreme Court. Prerequisites as noted below.

**Prerequisites:** POLS 001

**Attribute/Distribution:** SS

**POLS 360 Public Administration 3-4 Credits**

The nature of administration; problems of organization and management; public personnel policies; budgeting and budgetary system; forms of administrative responsibility.

**Attribute/Distribution:** ND

**POLS 364 Issues In Contemporary Political Philosophy 3-4 Credits**

Selected topics in contemporary political philosophy, such as the Frankfurt school, existentialism, legitimation, authenticity, participatory democracy, and the alleged decline of political philosophy. May be repeated for credit with the consent of instructor.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** SS

**POLS 367 American Political Thought 3-4 Credits**

A critical examination of American political thought from the founding of the Republic to the present. Writings from Madison, Hamilton, and Jefferson to Emma Goldman, Mary Daly, Malcolm X, Henry Kariel, and others will be discussed.

**Attribute/Distribution:** SS

**POLS 368 Political Economy 3-4 Credits**

Relationship of democratic politics to government and market, and significance of economic power in the American polity. Economic rationale for the place of the market and economic institutions in polity. Emphasis on information in comparison of economic approaches to public policy and organization (public goods, market failure, and collective action) with traditional political science approaches (group mobilization and conflict, non-decisions and symbolic action).

**Attribute/Distribution:** SS

**POLS 370 Seminar: The Citizen versus the Administrative State 4 Credits**

Administrative power and policy. Constitutional and judicial control of administration. Remedies against improper administrative acts. Major emphasis will be on the United States, with some attention given to analogous issues in other countries.

**Attribute/Distribution:** SS

**POLS 373 Globalization and Social Well-Being 4 Credits**

This course examines how the various dimensions of globalization impact people by exploring factors that reflect and affect quality of life. Students will gain an understanding of the complexities resulting from the growing interconnectedness and interdependencies of global relations. The course is intended to get people thinking creatively about opportunities for connections that preserve human dignity.

**Attribute/Distribution:** SS

**POLS 375 Seminar: Green Polity 4 Credits**

Development of guidelines and applications for public policy and political action directed toward environmental sustainability and political feasibility. Focus on problem-solving and policy design, connecting sustainable environmental goals with workable and responsive institutional designs.

**Attribute/Distribution:** SS

**POLS 376 Seminar: National Social Policy 3-4 Credits**

A readings/research seminar on current social policy questions. Course analyzes, from alternatives political perspectives, such issues as Social Security, Medicare, health care, welfare reform, income inequality, and taxation. Students research a specific social issue of their choice. Class discussion on individual research and common readings.

**Attribute/Distribution:** SS

**POLS 378 Honors Thesis In Political Science 1-4 Credit**

Opportunity for undergraduate majors in Political Science to pursue an extended project for senior honors. Department permission required.

**Attribute/Distribution:** ND

**POLS 379 Honors Thesis In Political Science 4 Credits**

Continuation of POLS 378. Prerequisites as noted below. Consent of department required.

**Prerequisites:** POLS 378

**Attribute/Distribution:** ND

**POLS 381 Special Topics 1-4 Credit**

A seminar on a topic of special interest in a particular political institution, process, or policy. Consent of department chair required.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** ND

**POLS 382 Special Topics 1-4 Credit**

A seminar on a topic of special interest in a particular political institution, process, or policy. Consent of department chair required.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** ND

**POLS 401 Introduction to Politics and Policy 3 Credits**

Structured around a generative theme, such as inequality and justice, or community and the environment, each faculty member will discuss this issue from the perspective of his/her specialty.

**POLS 402 Methods Of Policy Analysis 3 Credits**

Approaches or models used to analyze public policy. Assumptions underlying each model and critiques of each; may include a number of the following approaches: institutional, process, rational, group, incremental, and/or elite.

**POLS 403 Creativity, Ideas, and Methods in Political Science 3 Credits**

Explores the challenges and creative possibilities of turning 'research interests' into doable research projects – such as research papers, MA theses, or doctoral dissertations. Discusses the domains of qualitative methodology and how social scientists seek to understand, represent, and analyze the social world. Topics: the politics of interpretation, observation, and quantification in social research, and critiques of assumptions about power and causality.

**POLS 404 Environmental Valuation: Policy Design/Legal Analysis 3 Credits**

Review of the "contingent valuation method" for pricing environmental resources. Assessment of the empirical and normative strengths and weakness of this method. Evaluation of the recent turn to "deliberative" methods of resource valuation. Consideration of empirical and normative problems and common problems that challenge resource valuation.

**POLS 407 The Politics of Mental Health Policy 3 Credits**

What is normal behavior, and how do we come to understand mental illness? How do the resulting policies, to address mental health, impact society? This course is designed to facilitate thoughtful discourse on the various ways in which society regulates access to opportunities, facilitates integration or alienation, and constructs the social world.

**POLS 408 American Politics Core 3 Credits**

A survey of American politics utilizing readings reflecting a variety of methodological approaches and theoretical perspectives. Readings include but are not limited to works widely regarded as "classics" in American political science.

**POLS 409 Nonprofit Administration 3 Credits**

This course will address key questions in nonprofit sector research, policy, and management and familiarize students with factors that tend to make the nonprofit sector distinct. Students will gain an understanding of the scope and character of nonprofit activity in the U.S. and abroad. We will explore current debates in nonprofit policy and evaluate critical challenges facing the organization and management of nonprofits.

**POLS 413 Modern Political Philosophy 3 Credits**

A study of selected modern political philosophers and their continuing effect on politics and political philosophy.

**POLS 415 State and Local Government 3 Credits**

Comparative state government, urban politics, intergovernmental relations, regional and local government.

**POLS 416 American Environmental Policy 3 Credits**

Formation, implementation and impact of environmental policies in the U.S. An examination of the scope of environmental problems, the development of environment as an issue, the role of interest groups and public opinion, the policy-making process, and the various approaches to implementing environmental policy. Special attention to current issues and administrative approaches and to the distinctive character of environmental protection as a political issue.

**POLS 421 Research Methods 3 Credits**

Models in the explanation of political phenomena, appropriateness of measurement techniques; construction of research designs; rationale and application of statistical analyses; individual projects involving the construction and testing of models employing a major social science data set.

**POLS 423 Politics Of The European Union 3 Credits**

The institutions and policy-making processes of the EU. Topics include the creation of the single market and the euro, environmental and agricultural policy, regional development and the policy challenges of eastward enlargement.

**POLS 425 Nationalism in Comparative Perspective 3 Credits**

Examination of major theoretical and policy debates in contemporary studies of nationalism. Focus on the emergence and endurance of nationalist movements in the modern era. Discussion of efforts to evaluate the legitimacy of nationalist claims and to resolve nationalist conflict.

**POLS 426 Organizing For Democracy 3 Credits**

Seminar on the theory and practice of community and political organizing and their relationship with democracy and power in the United States, complementing semester-long student field placements with community groups and local organizations. Student teams help enhance the political voice of under-resourced community groups through organization-building, outreach, and policy input at the local level. Consent of instructor required.

**POLS 427 American Democracy: Decline or Revival? 3 Credits**

Theories of democracy, analysis of its decline, and possible scenarios for a revived democratic culture. Research projects on topics of personal interest; class participation in hands-on project in local democracy-building.

**POLS 428 Media & Democracy 3 Credits**

General & theoretical considerations about democracy, the political economy of the mass media, and analysis of ways in which the media influence political discourse in the United States and globalized media culture. Hands-on analysis of media samples: news coverage, political advertising, public relations advertising, and interactive learning on how group might utilize the media to express its voice effectively.

**POLS 429 Propaganda, Media & American Politics 3 Credits**

The role of propaganda and mass media in sustaining hegemony in the United States. Emphasis on television, advertising and mass culture, public relations, news media, and political propaganda pertaining to U.S. foreign and domestic policy. Students compare critical, counter-hegemonic theories to political speeches, documents, news reports, and media encounters that shape much of American political life.

**POLS 430 Social Movements & Legacies of 1960s 3 Credits**

The lessons and legacies of 1960s social and political movements. Students examine civil rights, black power movements, the New Left, campus protests, the Vietnam war and antiwar movement, the counterculture, women's and ecology movements and assess their connection to democracy, today's world, and their own lives.

**POLS 431 Public Management 3 Credits**

The study of bureaucracy and problems of public and nonprofit organization and management; executive leadership; personnel management systems and regulatory administration.

**POLS 433 The Politics Of Health Care 3 Credits**

Examines the politics of American health care and its impact on society. Issues ranging from the role of the private sector to government-supported programs; focus on ways to restructure the system, based on alternatives in selected nations.

**POLS 435 Power, Persuasion and the American Presidency 3 Credits**

Examination of selected modern presidents, from FDR to the current occupant of the White House, and their effectiveness as communicators and policy makers.

**POLS 438 Markets, Justice, And Law 3 Credits**

The exploration of the various ways in which markets shape cultural, social, ethical, and political practices in contemporary society. Normative justification for market as an institutional arrangement that is neutral between different views of "the good". Ethical critique of this normative justification and implications of the critique for law and policy.

**POLS 439 The Rise of the State in Modern East Asia 3 Credits**

An examination of the role of Asian nationalism in the construction of the modern state form in Asia.

**POLS 443 Global Politics of Race: Asia and Africa 3 Credits**

An examination of the concept of "race" and its impact on domestic and international politics.

**POLS 448 Land Use, Growth Management, and the Politics of Sprawl 3 Credits**

An intro to the issues of Land Use Planning, Community, Growth Mgmt, & Sprawl. Will examine the history of urban development in America, from the earliest settlements to the auto suburbs. Also explore such planning & development factors as comprehensive plans, zoning, & the influence of infrastructure on development. Concludes with an assessment of the revival of city centers, alternatives to sprawl, & comparisons to development patterns in other countries.

**POLS 450 Religion and Politics in Comparative Perspective 3 Credits**

This research seminar attempts to identify the conditions under which religious parties arise and become influential, how religion influences popular understandings of secular politics and the extent to which religion is a necessary feature of modern public discourse. These topics are explored through country specific cases from around the world.

**POLS 451 Comparative Politics Core 3 Credits**

Discussion of major recent works in comparative politics that exemplify on-going substantive debates and methodological problems in the field. Topics: state-building and the construction of social order, institutions, political economy, democracy, development, and political mobilization.

**POLS 452 Civil Rights and Civil Liberties 3 Credits**

A continuation of themes, issues, and debates of the previous semester (POLS 351). This course addresses the major cases and controversies within several legal domains, including the freedoms of and from religion; freedom of speech; freedom of association; freedom of the press; the right to bear arms; the rights of criminal defendants and suspects; the right to privacy; capital punishment; and, the equal protection of the law.

**POLS 453 Seminar: Media, Propaganda and Democracy 3 Credits**

Research seminar on theoretical and applied issues related to democracy vs. political hegemony, as affected by propaganda, the mass media, popular culture, and the capitalist economy. Students will pursue individual research topics linked to common class readings. Weekly paper presentations and critical responses.

**POLS 454 The State in Asia 3 Credits**

Examination of state-directed political, economic and social development in and among Asian states, with an addition focus on the relationships between the domestic policies of various Asian states and relations with non-Asian states.

**POLS 455 Environmental Justice & The Law 3 Credits**

This course explores the various ways in which environmental law and policy can have discriminatory effects. It examines the rise and evolution of environmental justice movement, and the impact of environmental justice claims on administrative rule making at state and federal level. Reviewing the history of case law concerning environmental justice suits filed under the 1964 Civil Rights Act, it also examines the future of environmental justice in environmental law and policy.

**Attribute/Distribution:** SS

**POLS 456 Seminar: Political Philosophy 3 Credits**

Critical examination of several of the “great books” and/or “great ideas” in political thought.

**POLS 457 Politics Of Authenticity 3 Credits**

Works in political philosophy, psychoanalytic theory, literature, and film that discuss knowing and being one’s self will be critically discussed. If you feel a life of “quiet desperation” is inevitable, this course is for you.

**POLS 462 Seminar: American Political Thought 3 Credits**

Focus on a narrow topic or theorist in the field, e.g., the work of Jefferson, Madison, Hamilton, or Tocqueville. Students will be required to write a major paper and present it to the class.

**POLS 464 Community Fellowship I 3 Credits**

15 hours/week in regional agency on specific project relating to regional redevelopment with regularly scheduled contact hours with the faculty advisor.

**POLS 465 Community Fellowship II 3 Credits**

15 hours/week in regional agency on specific project relating to regional redevelopment with regularly scheduled contact hours with the faculty advisor.

**POLS 467 Legal Problems 3 Credits**

This course involves an examination of the role of legal rules, agents, institutions, and values in our society. Primary emphasis will be given to the American legal system, though we will evaluate U.S. principles and politics through a comparative lens as well.

**POLS 468 Political Economy 3 Credits**

Relationship of democratic politics to government and market, and significance of economic power in the American polity. Economic rationale for the place of the market and economic institutions in polity. Emphasis on information in comparison of economic approaches to public policy and organization (public goods, market failure and collective action) with traditional political science approaches (group mobilization and conflict, non-decisions and symbolic actions).

**POLS 473 Globalization and Social Well-Being 3 Credits**

This course examines how the various dimensions of globalization impact people by exploring factors that reflect and affect quality of life. Students will gain an understanding of the complexities resulting from the growing interconnectedness and interdependencies of global relations. The course is intended to get people thinking creatively about opportunities for connections that preserve human dignity.

**POLS 475 Seminar: Green Polity 3-4 Credits**

Development of guidelines and applications for public policy and political action directed toward environmental sustainability and political feasibility. Focus on problem-solving and policy design, connecting sustainable environmental goals with workable and responsive institutional designs.

**POLS 477 Advanced Computer Applications 3 Credits**

Uses of computers in social sciences, including data collection, management, analysis, presentation, and decision-making; includes weekly lab.

**POLS 481 Special Topics 1-3 Credit**

Individual inquiry into some problem of government. Reading, field work, and other appropriate techniques of investigation. Conferences and reports. May be repeated for credit.

**Repeat Status:** Course may be repeated.

**POLS 482 Special Topics 1-3 Credit**

Continuation of POLS 481.

**Repeat Status:** Course may be repeated.

**POLS 490 Thesis 1-6 Credit****Psychology**

The Psychology Department offers B.A. and B.S. undergraduate degrees, undergraduate minors in general psychology and clinical psychology, and M.Sc. and Ph.D. graduate degrees.

Psychology is the science of mind, brain, and behavior. Undergraduate study in Psychology provides:

- A knowledge base about how people think, feel, and act as individuals and in groups, from infancy to old age
- An understanding of how psychological principles can be applied in everyday life to improve the human condition
- Working knowledge of empirical research methods for psychology and ethical issues in research and application
- An appreciation of individual, sociocultural, and international diversity
- Familiarity with the relationship of psychological processes to brain processes
- Critical thinking, communication, and teamwork skills

Psychology majors pursue careers in many areas such as: business including marketing and industrial/organizational psychology; education; medicine/health; mental and behavioral health professions including clinical, counseling, and sports psychology; law; human services; and basic and applied research positions. The knowledge and skills provided by a degree in Psychology are valuable to all such careers.

For more information, please visit our website: <http://psychology.cas2.lehigh.edu/>

**Professors.** Diane T. Hyland, PhD (Syracuse University); Barbara C. Malt, PhD (Stanford University); Gordon B. Moskowitz, PhD (New York University); Ageliki Nicolopoulou, PhD (University of California Berkeley)

**Associate Professors.** Catherine M. Arrington, PhD (Michigan State University); Susan E Barrett, PhD (Brown University); Michael J. Gill, DSC (University Texas Austin); Deborah Laible, PhD (University of Nebraska-Lincoln); Pdraig G O’Searghda, PhD (University of Toronto)

**Assistant Professors.** Amanda C. Brandone, PhD (University of Michigan Ann Arbor); Christopher T. Burke, PhD (New York University); Almut Hupbach, PhD (Universitat Trier); Jessecacae Marsh, PhD (Yale University); Dominic J. Packer, PhD (University of Toronto)

**Emeriti.** William Newman, PhD (Stanford University); George K. Shortess, PhD (Brown University)

**B.A. Major Program in Psychology**

The Bachelor of Arts in psychology is a social science major requiring 11 courses (approximately 44 credit hours) in psychology as described below. The B.A. requires three core courses, four 100-level breadth courses, and four 300-level seminars. Students must also fulfill college and university degree requirements. This flexible program permits development of one or more minors in other fields or the undertaking of a double major. Transfer credits and study abroad course work may be applied toward the major; however, students must take a minimum of two 100-level breadth courses, three 300-level seminars, and PSYC 210 at Lehigh to complete a psychology major from Lehigh.

**Required Core Courses**

12

PSYC 001	Introduction to Psychology
PSYC 110	Statistical Analysis of Behavioral Data
PSYC 210	Experimental Research Methods and Laboratory

**Breadth Courses**

16

Four 100-level courses, with a minimum of one from each of the following three areas, are required of all majors. <sup>1</sup>

**Cognition and Cognitive Neuroscience**

PSYC/COGS 117	Cognitive Psychology
PSYC/COGS 176	Mind and Brain

**Developmental**

PSYC 107	Child Development
PSYC/SSP 109	Adulthood and Aging

**Social and Personality**

PSYC/SSP 121	Social Psychology
PSYC/SSP 153	Personality

**Seminars**

16



Four 300-level seminars are required of all B.A. students. Seminars need to span at least two areas. (See list of seminars per area in Psychology Concentrations section below).<sup>2</sup>

Total Credits 44

- The fourth 100-level breadth course must be selected from any of the above courses or PSYC 138.
- Students can **not** use PSYC 300, PSYC 310, PSYC 391, PSYC 392, PSYC 393 or PSYC 394 to fulfill this requirement. All other 300-level psychology courses can be used to fulfill this requirement.

#### Optional Concentration

Students in the B.A. program may choose to complete an optional concentration. Concentrations are available in four areas: Cognition and Cognitive Neuroscience; Developmental; Social and Personality; and Clinical and Behavioral Health. Completion of a concentration involves selecting specific 100-level breadth courses and 300-level seminars within the concentration. See listings of individual concentration courses below.

#### Recommended Electives

The B.A. program in psychology is a flexible preparation for a number of fields. With suitable selection of additional courses, students can prepare themselves for graduate study in any subfield of psychology or for careers in areas for which psychology is a desirable and relevant major such as neuroscience, law, social work, marketing, management, and education.

Depending on the specific subfield of interest, many courses in other departments within CAS, and in other Colleges, may be relevant. Examples include Biological Sciences (especially the Behavioral Neuroscience program), Philosophy, Sociology and Anthropology, Marketing, Economics, Management, Education, and in the interdisciplinary programs of Cognitive Science; Women, Gender, and Sexuality Studies; Health, Medicine, and Society; Global Studies; and Africana Studies.

For graduate programs in psychology, neuroscience, and related fields, additional coursework in research and statistics is desirable, as is engagement in supervised research and participation in the honors program.

Preparation for programs in health-related areas such as nursing, medicine, and dentistry will include additional coursework in biology, chemistry, and physics. Students should consult with the appropriate pre-professional advisors to determine specific requirements.

Students interested in applying psychology to fields such as law, marketing, social work, management, or education should consult with faculty in those areas to discuss relevant courses.

#### B.S. Major Program in Psychology

The Bachelor of Science in psychology is a highly structured and comprehensive behavioral science major requiring 12 courses (approximately 48 credit hours) in psychology and 10 collateral courses (approximately 35-40 credit hours) as described below. Students must also fulfill college and university degree requirements. Students pursuing a wide-range of post-graduate plans may find this program fits their needs and interests. One difference between the B.S. in psychology and other B.S. programs is that the collateral requirements for the B.S. in psychology allow for a level of breadth that is not always possible in B.S. programs. The collateral courses for the B.S. in psychology span three areas (Mathematics and Computer Science; Natural Science; and Social and Cognitive Science). Hence, students with wide-ranging interests may find that they can pursue their varied interests while fulfilling the collateral requirements for this B.S. program. For students considering graduate programs in psychology, neuroscience, and related fields, additional coursework in research and statistics is desirable, as is engagement in supervised research and participation in the honors program.

Students in the B.S. program must complete a concentration in Cognition and Cognitive Neuroscience; Developmental; Social and Personality; or Clinical and Behavioral Health. Progression through the program is best served through early commitment. Students who do not declare their majors early may find it difficult to complete the B.S. major program. Transfer credits and study abroad course work may be

applied toward the major; however, students must take a minimum of two 100-level breadth courses, three 300-level seminars, and PSYC 210 at Lehigh to earn a psychology major from Lehigh.

#### Requirements for the B.S. in Psychology

##### Collateral Requirements

For students in the B.S. program, collateral courses can be used to fulfill the college distribution requirements in mathematics, natural science, and social science. To fulfill natural science college distribution requirements, at least one course must include the associated lab.

Please consult the course listings for information on prerequisites.

#### Mathematics and Computer Science 7-8

Select two of the following:

MATH 012	Basic Statistics
MATH 043	Survey of Linear Algebra
Any of the calculus courses or above	
CSE 001 & CSE 002	Breadth of Computing and Fundamentals of Programming
Any CSE course 12 or above	

#### Natural Science 14-16

Select at least one of the following:

BIOS 008	Drugs and Behavior
BIOS 010	Bioscience in the 21st Century
BIOS 041	Biology Core I: Cellular and Molecular
EES 025	The Environment and Living Systems
EES 028	Conservation and Biodiversity
EES 031	Introduction to Environmental and Organismal Biology

Select three of the following:

Any BIOS course 010 or above	
Any CHM course 030 or above	
Any PHY course 010 or above	
EES courses 25, 28, or 31	

#### Social and Cognitive Science 7-8

Select two of the following:

Any Anthropology (ANTH), Sociology and Anthropology (SOAN), Sociology/Social Psychology (SSP). <sup>1</sup>	
Any area studies (Asian, Africana, etc.); Global Studies (GS); Health, Medicine, and Society (HMS); Science, Technology, and Society (STS); and Women, Gender, and Sexuality Studies (WGSS). <sup>1,2</sup>	

#### Additional Coursework 7-8

Select any two additional courses from the above lists.<sup>3</sup>

Total Credits 35-40

- Courses may not be cross-listed with Psychology.
- Courses must have a SS designation.
- Students are strongly encouraged to discuss their interests and career goals with their advisor before selecting courses.

#### Psychology Requirements

##### Required Core Courses 12

PSYC 001	Introduction to Psychology
PSYC 110	Statistical Analysis of Behavioral Data
PSYC 210	Experimental Research Methods and Laboratory

##### Breadth Courses 16

Four 100-level courses, with a minimum of one from each of the following three areas, are required of all majors.<sup>1</sup>

<b>Cognition and Cognitive Neuroscience</b>	
PSYC/COGS 117	Cognitive Psychology
PSYC/COGS 176	Mind and Brain
<b>Developmental</b>	
PSYC 107	Child Development

PSYC/SSP 109 Adulthood and Aging

**Social and Personality**

PSYC/SSP 121 Social Psychology

PSYC/SSP 153 Personality

**Seminars 20**

Five 300-level seminars are required of all B.S. students. Seminars need to span at least two areas. (See list of seminars per area in Psychology Concentrations section below.)<sup>2</sup>

Total Credits 48

<sup>1</sup> The fourth 100-level breadth course is determined by the concentration being pursued.

<sup>2</sup> Students can **not** use PSYC 300, PSYC 310, PSYC 391, PSYC 392, PSYC 393, PSYC 394 or to fulfill this requirement. All other 300-level psychology courses can be used to fulfill this requirement.

**Psychology Concentrations**

Concentrations are available in four areas: Cognition and Cognitive Neuroscience; Developmental; Social and Personality; and Clinical and Behavioral Health. Students in the B.A. major program may choose to complete a concentration. Students in the B.S. major program are required to complete a concentration. Completion of a concentration involves selecting two specific 100-level breadth courses and three 300-level seminars within the concentration area.

**Cognition and Cognitive Neuroscience Concentration**

Specified 100-level breadth courses, take both:

PSYC 117 Cognitive Psychology

PSYC 176 Mind and Brain

300-level seminars, choose three:

PSYC 304 Memory Development from Infancy to Old Age

PSYC 307 Higher Order Cognition

PSYC 320 Psychology of Language

PSYC 328 Educational Psychology

PSYC 344 Health Care Reasoning and Decision-Making

PSYC 351 Children's Thinking

PSYC 358 Inside the Infant Mind

PSYC 362 Cognition in Practice & Policy

PSYC 369 Memory Under Construction

PSYC 377 Attention and Attentional Failures

**Developmental Concentration**

Specified 100-level breadth courses, take both:

PSYC 107 Child Development

PSYC 109 Adulthood and Aging

300-level seminars, choose three:

PSYC 304 Memory Development from Infancy to Old Age

PSYC 318 Seminar in Gender and Psychology

PSYC 323 The Child In Family and Society

PSYC 328 Educational Psychology

PSYC 351 Children's Thinking

PSYC 358 Inside the Infant Mind

PSYC 363 Personality and Social Development in Childhood

PSYC 364 Children and Narratives

PSYC 365 Human Development in Cross-Cultural Perspective

PSYC 368 Children, Psychology, and the Law

PSYC 378 Emotional Development

PSYC 383 Attachment Theory & Research: The Study of Close Relationships Across the Lifespan

PSYC 386 Child and Adolescent Health Psychology

**Social and Personality Concentration**

Specified 100-level breadth courses, take both:

PSYC 121 Social Psychology

PSYC 153 Personality

300-level seminars, choose three:

PSYC 302 Stress and Coping

PSYC 311 The Psychology of Stereotyping, Prejudice, and Discrimination

PSYC 313 Person Perception

PSYC 314 Social Cognition

PSYC 318 Seminar in Gender and Psychology

PSYC 323 The Child In Family and Society

PSYC 332 The Psychology of Human Goodness

PSYC 341 Social Psychology and Social Issues

PSYC 363 Personality and Social Development in Childhood

PSYC 364 Children and Narratives

PSYC 365 Human Development in Cross-Cultural Perspective

PSYC 378 Emotional Development

PSYC 383 Attachment Theory & Research: The Study of Close Relationships Across the Lifespan

PSYC 384 Self and Identity

**Clinical and Behavioral Health Concentration**

Specified 100-level breadth courses, take both:

PSYC 138 Abnormal Psychology

PSYC 153 Personality

300-level seminars, choose three:

PSYC 302 Stress and Coping

PSYC 327 Health Psychology

PSYC 334 The Psychology of Body Image and Eating Disorders

PSYC 338 Phenomenology and Theory of Childhood Disorders

PSYC 344 Health Care Reasoning and Decision-Making

PSYC 354 Psychological Assessment

PSYC 367 Clinical Psychology

PSYC 378 Emotional Development

PSYC 380 Sports Psychology

PSYC 386 Child and Adolescent Health Psychology

**Department Honors in Psychology**

Students in either the B.A. or B.S. degree programs may undertake a program that leads to graduation with department honors. The honors program permits majors of unusual academic ability and interest to explore topics in greater depth than the curricula normally allow. Under faculty supervision, a student normally spends the first semester of the senior year enrolled in PSYC 391 doing library research, learning the appropriate methodology, and preparing a written proposal and oral presentation. In the second semester, while the student is enrolled in PSYC 392, the proposal is implemented, culminating in a written honors thesis and oral presentation.

In the junior year, students may apply for the honors program with the department Honors Program Director. To be eligible to participate in the honors program, a student must maintain overall and major GPAs of 3.5.

**Minor Programs****General Psychology**

The general psychology minor consists of a minimum of four courses in psychology beyond the introductory course (PSYC 001). Students should declare this minor in the Psychology Department office.

**Clinical Psychology**

The clinical psychology minor consists of the following courses beyond the introductory course (PSYC 001):

<b>Required Courses</b>		12
PSYC 138	Abnormal Psychology	
PSYC 153	Personality	
PSYC 367	Clinical Psychology	
<b>Elective Courses</b>		8
Select two of the following:		
PSYC 302	Stress and Coping	
PSYC 327	Health Psychology	
PSYC 328	Educational Psychology	
PSYC 354	Psychological Assessment	
<b>Total Credits</b>		<b>20</b>

The clinical minor is available to Psychology majors as well as to students from other majors. To complete the clinical minor, students must be prepared to register for at least one summer session since some courses (PSYC 367, PSYC 354) are most frequently offered in the summer, and other courses have limited enrollment during the academic year. Only one course may be used to jointly fulfill the requirements of a major program and minor program.

**For Graduate Students**

The Department of Psychology offers a distinctive, research-intensive graduate program centered on Human Cognition and Development with specializations in cognitive, developmental and social psychology. The department accepts mainly Ph.D. students, who obtain a master's degree in the process of working for the doctorate. However, well-qualified students may also be accepted for a Master of Science degree. Students are trained primarily for positions at universities, and in basic or applied research settings. For more information visit: <http://psychology.cas2.lehigh.edu/content/welcome-graduate-program-psychology>.

In addition we offer two non-degree Certificate Programs in collaboration with other departments and programs.

The Graduate Certificate in Stereotypes, Prejudice, Discrimination, and Intergroup Relations is administered by the Psychology Department. Information is available via: <http://psychology.cas2.lehigh.edu/content/stereotypes-prejudice-discrimination-and-intergroup-relations-graduate-certificate>.

The Graduate Certificate in Cognitive Science is administered by the Cognitive Science Program. Information is available at: <http://psychology.cas2.lehigh.edu/content/cognitive-science-graduate-certificate>.

**Requirements for a Ph.D. in the Department of Psychology Research**

All graduate students are expected to be involved in research throughout their graduate careers. There are also several formal research requirements of the program.

**First-Year Apprenticeship**

First-year students are expected to choose an advisor and begin to work on research projects as early as possible. An oral report of the student's research activities is made to the department. Students will submit a draft Master's Thesis Proposal by June 1 of the first year of the Ph.D. program.

**Master's Thesis**

A master's thesis (usually empirical or data-based) is required. An oral presentation of the thesis is made to the department. Students entering with a master's degree may instead conduct an equivalent non-degree Pre-dissertation Project.

**Third-Year independent scholarly activity**

Third year students will work toward formulation of their dissertation proposal by completing a literature review or writing a small grant proposal. By the end of the third year of the Ph.D. program, students will choose a dissertation committee, and meet to report on their research activities.

**Doctoral Dissertation**

This is an original piece of scholarly work usually involving empirical research, although original theoretical or historical research is possible with faculty approval.

**Course work**

For the Ph.D., the minimum course requirements include:

- Three core courses covering cognitive psychology (PSYC 403), developmental psychology (PSYC 402), and social cognition (PSYC406);
- Two courses in statistics and research methodology (PSYC 421 and PSYC 422);
- At least three graduate seminars (PSYC 430 and above);
- Two elective courses, approved by the advisor;
- A professional development seminar (PSYC 409)

**Teaching**

Students are encouraged to participate in teaching as appropriate for their training throughout their graduate years. Normally, students begin as teaching assistants and progress to teaching independently.

**General Examination**

A general examination is required for all doctoral candidates and will be completed at the end of the second year of the Ph.D. program. Readings and questions for the exam will be compiled by faculty in the student's specialization area.

**Requirements for a Master of Science in the Department of Psychology Research**

Master of Science students will complete the First-Year Apprenticeship and Master's Thesis requirements as described in the Ph.D. section above.

**Coursework**

For the M.Sc., the minimum course requirements include:

- Two core courses covering cognitive psychology (PSYC 403), developmental psychology (PSYC 402), or social cognition (PSYC 406);
- Two courses on statistics and research methodology (PSYC 421, and PSYC 422 or approved equivalent);
- Two elective courses, approved by the advisor;
- A professional development seminar (PSYC 409)

**Evaluation**

Graduate students are evaluated on their performance in coursework, research and scholarship, teaching assistantship assignments, and the general examination. The faculty provides each student with an annual written evaluation of their progress in the graduate program.

**Financial Support**

Support for Ph.D. students is available in the form of teaching and research assistantships, fellowships and scholarships.

**How To Apply**

Information about admission and financial aid can be obtained from the Department of Psychology or found at: <https://psychology.cas2.lehigh.edu/node/67>. While a strong undergraduate background in psychology is desirable, promising students with majors other than psychology are encouraged to apply. Completed application forms, plus transcripts, letters of recommendation, and a report of scores on the Graduate Record Exam and advanced tests in psychology should be submitted no later than January 1 of the year of admission. New students are normally accepted for entrance into the program only for the fall semester.

**Courses****PSYC 001 Introduction to Psychology 4 Credits**

Psychology as a science of behavior. Natural science aspects such as learning, sensation-perception, and physiological bases; and social science aspects such as human development, intelligence, and personality. Methodologies appropriate to these areas, and related societal problems.

**Attribute/Distribution:** SS

**PSYC 107 Child Development 4 Credits**

Survey of theories and research concerning perceptual, cognitive, social, and personality development through infancy and childhood. Prerequisites as noted below. May not be taken pass/fail. Open to Freshman with departmental permission.

**Prerequisites:** PSYC 001 or SSP 001

**Attribute/Distribution:** SS

**PSYC 109 Adulthood and Aging 4 Credits**

Social science approaches to the latter two-thirds of life. Cognitive and personality development; attitudes toward aging; social behavior of older adults; widowhood; retirement. Prerequisites as noted below. May not be taken pass/fail. Open to Freshman with departmental permission.

**Prerequisites:** PSYC 001 or SSP 001

**Attribute/Distribution:** SS

**PSYC 110 Statistical Analysis of Behavioral Data 4 Credits**

Principles of experimental design and statistical analysis: characteristics of data and data collection; descriptive statistics; hypothesis testing theory and practice; correlation, chi-square, t-test, analysis of variance. Three hours lecture and one hour computer lab. Department permission required. Open to Freshman with departmental permission.

**Attribute/Distribution:** ND

**PSYC 115 Religion and Psychology 4 Credits**

A study of the origins, development and consequences of religion from a psychological perspective. Attention will be given to classic and contemporary sources, with a focus on major psychoanalytic theorists of religion (Freud, Jung, Erikson); psychological analyses of religious experience (e.g., Wm. James, Victor Frankl); and the diverse culture and religious forms that structure the connection between religion and psychology (e.g., Buddhist psychology, Japanese Morita therapy). Course examines the role of religion as a powerful meaning system that can affect the lives of individuals in terms of motivations, beliefs, emotions and behaviors, and can influence their interactions on both interpersonal and intergroup levels.

**PSYC 117 Cognitive Psychology 4 Credits**

The architecture and dynamics of the human mind: How we acquire knowledge through perception, represent and activate it in memory, and use it to communicate, make decisions, solve problems, and reason creatively. May not be taken pass/fail. Prerequisites as noted below.

**Prerequisites:** PSYC 001 or COGS 007

**Attribute/Distribution:** SS

**PSYC 121 Social Psychology 4 Credits**

Theories, methods of investigation, and results of research on the way social and psychological processes interact in human behavioral settings. Topics include analysis of self and relationships, dynamics of small groups, attitudes and persuasion, prejudice, prosocial and antisocial behavior. Prerequisites as noted below. Open to Freshman with departmental permission.

**Prerequisites:** ANTH 001 or SSP 001 or PSYC 001

**Attribute/Distribution:** SS

**PSYC 138 Abnormal Psychology 4 Credits**

Examines research and theory on the patterns, causes, and treatment of various forms of abnormal behavior. Prerequisites as noted below.

**Prerequisites:** PSYC 001

**Attribute/Distribution:** SS

**PSYC 140 Introduction to Linguistics 4 Credits**

Relationship between language and mind; formal properties of language; language and society; how languages change over time. No pass/fail option.

**Attribute/Distribution:** SS

**PSYC 153 Personality 4 Credits**

Examination of the major theoretical frameworks psychologists use to understand human thought, feeling, and behavior. Whereas these frameworks each emphasize very different concepts (e.g., the unconscious mind vs. culture vs. neurotransmitters), they are united in their effort to answer the question: Why does a given individual think, feel, or behave as she does? Prerequisites as noted below.

**Prerequisites:** PSYC 001 or SSP 001

**Attribute/Distribution:** SS

**PSYC 160 Independent Study 1-3 Credit**

Readings on topics selected in consultation with a staff member. May be repeated for credit. Consent of faculty sponsor required. Prerequisites as noted below.

**Repeat Status:** Course may be repeated.

**Prerequisites:** PSYC 001

**Attribute/Distribution:** SS

**PSYC 161 Supervised Research 1-3 Credit**

Apprenticeship in ongoing faculty research program. Literature review, experimental design, data collection and analysis, and professional writing under faculty supervision. May be repeated for a maximum of 9 credits. Consent of faculty sponsor required. Prerequisites as noted below.

**Repeat Status:** Course may be repeated.

**Prerequisites:** PSYC 001 or COGS 007

**Attribute/Distribution:** SS

**PSYC 162 Psychological Field Work 1-3 Credit**

Work-study practice including supervised experience in one of several local agencies. Development of familiarity with the operations of the agency and working with individual patients or students. Must have completed two additional psychology courses. Consent of instructor required. Prerequisites as noted below.

**Repeat Status:** Course may be repeated.

**Prerequisites:** PSYC 001

**Attribute/Distribution:** SS

**PSYC 176 Mind and Brain 4 Credits**

Perception and cognitive neuroscience as the link between mental processes and their biological bases. Visual and auditory perception; the control of action; neuropsychological syndromes of perception, language, memory and thought; neural network (connectionist) models of mental processes. Prerequisites as noted below. May not be taken pass/fail.

**Prerequisites:** PSYC 001 or COGS 007

**Attribute/Distribution:** NS

**PSYC 210 Experimental Research Methods and Laboratory 4 Credits**

Designing, conducting, and reporting psychological experiments. Laboratory exercises, report writing, and a group research project. Consent of department required. Prerequisites as noted below.

**Prerequisites:** PSYC 001 and PSYC 110

**Attribute/Distribution:** ND

**PSYC 300 Apprentice Teaching 1-4 Credit**

**PSYC 301 Industrial Psychology 4 Credits**  
Psychological concepts and methods applied to business and industrial settings. Personnel selection, placement and training, leadership, work motivation, job satisfaction and consumer behavior.

**Prerequisites:** PSYC 001

**Attribute/Distribution:** SS

**PSYC 302 Stress and Coping 4 Credits**

How does stress affect the psychological system, and what psychological mechanisms are in place to help people overcome environmental stressors? This seminar examines classic and contemporary theories and research on stress, coping, and social support. Prerequisites as noted below.

**Prerequisites:** PSYC 121 or SSP 121 or PSYC 153 or SSP 153

**Attribute/Distribution:** SS

**PSYC 304 Memory Development from Infancy to Old Age 4 Credits**

Memory development throughout the lifespan. We will discuss methods invented to study memory in preverbal infants, and the amazing memory capacities they have revealed. We will explore memory components that develop during early and middle childhood, look at memory in adults, and consider the normal and pathological decline of memory in older age, and possible ways of slowing aging processes down. Prerequisites as noted below or consent of instructor.

**Prerequisites:** PSYC 117 or COGS 117 or PSYC 176 or COGS 176 or COGS 007

**Attribute/Distribution:** SS

**PSYC 307 Higher Order Cognition 4 Credits**

In depth exploration of selected areas of higher level cognition such as thinking and reasoning, metacognition, expertise, executive processes, language and thought. Prerequisites as noted below or consent of instructor.

**Prerequisites:** PSYC 117 or PSYC 176 or COGS 007

**Attribute/Distribution:** SS

**PSYC 310 Advanced Research Methods in Psychology 4 Credits**

Experimental and nonexperimental research design; Sampling and selection from populations; Data exploration; Quantitative and qualitative measurement and analysis; Computer-based data collection; and other specialized topics. Prerequisites as noted below.

**Prerequisites:** PSYC 210

**Attribute/Distribution:** ND

**PSYC 311 The Psychology of Stereotyping, Prejudice, and Discrimination 4 Credits**

We will start by examining the basic cognitive processes that make stereotyping a functional aspect of everyday cognition, and then we will turn toward examining emotional, motivational, and personality differences that affect one's level of prejudice. Finally, we will study the role of social forces in transmitting prejudice (parents, schools, religion, media) and the impact of societal prejudice (discrimination) on those who are the targets of prejudice. The changing face through the decades of how stereotypes, prejudice, and discrimination are measured, expressed, and understood is the focus of the course. Prerequisites as noted below.

**Prerequisites:** PSYC 153 or SSP 153 or PSYC 121 or SSP 121

**Attribute/Distribution:** SS

**PSYC 313 Person Perception 4 Credits**

Psychological processes involved in forming impressions of others. Survey of the factors that influence the way in which we think about the people who make up our social environment and of the laboratory methods with which experimental social psychology investigates person perception. The emphasis is on demonstrating the joint impact of the behaviors performed by others and the biases/expectancies that we bring into the social setting. Prerequisites as noted below.

**Prerequisites:** PSYC 153 or SSP 153 or PSYC 121 or SSP 121

**Attribute/Distribution:** SS

**PSYC 314 Social Cognition 4 Credits**

Examines the cognitive processes through which people make sense of social groups, individual others, themselves, and the world. Topics include judgment and decision making, attitudes and persuasion, ordinary personology, stereotyping and prejudice, and the self. Prerequisites as noted below.

**Prerequisites:** PSYC 121 or SSP 121

**Attribute/Distribution:** SS

**PSYC 315 History of Modern Psychology 4 Credits**

Origin and development of major theories within perception, cognition, biological, clinical, personality, developmental, learning. 19th and 20th century thought to provide an overview of psychology as a discipline. Must have completed two 300-level PSYC courses.

**Attribute/Distribution:** SS

**PSYC 317 Psychology of Emotion 4 Credits**

A selective overview of the scientific study of emotion. Topics will include: historical and modern theories of emotion, physiological and neuropsychological aspects of emotions, evidence that facial expressions of emotion may be universal among humans, and the role of emotion in cognition. Prerequisites as noted below or consent of instructor.

**Prerequisites:** PSYC 110

**Attribute/Distribution:** SS

**PSYC 318 Seminar in Gender and Psychology 4 Credits**

Gender as shaped by psychological and social psychological processes. Socialization, communication and power, gender stereotypes, methodological issues in sex differences research. Consent of department required. Prerequisites as noted below or consent of instructor.

**Prerequisites:** PSYC 210

**Can be taken Concurrently:** PSYC 210

**Attribute/Distribution:** SS

**PSYC 320 Psychology of Language 4 Credits**

Psychological processes involved in language comprehension, production, and use. Topics include the relation of language to thought; word meaning; speech perception; language acquisition; sign language; language in society. Prerequisites as noted below or consent of instructor.

**Prerequisites:** PSYC 117 or PSYC 176 or COGS 007

**Attribute/Distribution:** SS

**PSYC 321 Language Development 4 Credits**

Descriptive and theoretical accounts of the development of language. Primary focus is on the development of spoken language in infancy and early childhood. Involves observation of children at various stages of language development. Prerequisites as noted below.

**Prerequisites:** PSYC 107 or PSYC 117

**Attribute/Distribution:** SS

**PSYC 323 The Child In Family and Society 4 Credits**

Influences such as marital discord, family violence, poverty and prejudice on the development of the child from birth through adolescence. Prerequisites as noted below.

**Prerequisites:** ANTH 001 or SSP 001

**Attribute/Distribution:** SS

**PSYC 325 Theories in Social Psychology 4 Credits**

This course will compare the contributions and limitations of major theoretical perspectives on social behavior, and examine the nature of theory-construction and theory-testing in psychology generally. We will discuss broad theories of social behavior (Behaviorism, Gestalt, Psychodynamics, Symbolic Interactionism), as well as more specific theories of social phenomena, such as social perception, self-perception, and social influence. Prerequisites as noted below or consent of instructor.

**Prerequisites:** PSYC 121 or SSP 121

**Attribute/Distribution:** SS

**PSYC 327 Health Psychology 4 Credits**

An overview of the topic of health psychology. The course presupposes a preventative intervention approach to the problem of assisting healthy individuals to understand the relationship between behavior and health, and to engage those behaviors that promote health. This course will be underpinned with basic science and research on health psychology, but will include an application focus.

**Prerequisites:** PSYC 001

**Attribute/Distribution:** SS

**PSYC 328 Educational Psychology 4 Credits**

Overview of historical, contemporary, and emerging issues in the field of educational psychology. Implications of various social, cognitive and behavioral educational-psychological theories for teaching and learning in the classroom. Prerequisites as noted below or consent of instructor.

**Prerequisites:** PSYC 107 or PSYC 117

**Attribute/Distribution:** SS

**PSYC 332 The Psychology of Human Goodness 4 Credits**

We begin with the Big Questions: Are human beings intrinsically good? How potent is our intrinsic capacity for goodness? What does it mean to be "good" or "moral"? How can we answer these questions? Next, we examine a variety of motives, capacities, and emotions that can promote our "good" behavior. Some examples include empathy, compassion (and other moral emotions), the justice motive, the norm enforcement motive, moral intuitions, social bonds, and perhaps even our general capacity for reason. Prerequisites as noted below.

**Prerequisites:** PSYC 121 or SSP 121

**Attribute/Distribution:** SS

**PSYC 333 Social Psychology of Politics 4 Credits**

Political behavior viewed from a psychological and social psychological perspective. Prerequisites as noted below or consent of department required.

**Prerequisites:** ANTH 001 or SSP 001 or PSYC 001

**Attribute/Distribution:** SS

**PSYC 334 The Psychology of Body Image and Eating Disorders 4 Credits**

The course addresses the psychosocial aspects of the development of healthy and unhealthy body image and eating disorders. The roles of personality traits/individual factors, family and interpersonal functioning, and cultural factors will be examined, as will the impact of representations of body image in mass media. Public health and psychological interventions for prevention and treatment will be explored. Personal accounts/memoirs, clinical case presentations, and documentary and dramatic films will be incorporated in the presentation of topics.

**Attribute/Distribution:** SS

**PSYC 335 Animal Behavior 3 Credits**

Discussion of the behavior of invertebrates and vertebrates and analysis of the physiological mechanisms responsible for behavioral actions, and adaptive value of specific behavior patterns. Prerequisites as noted below.

**Prerequisites:** BIOS 120

**Attribute/Distribution:** NS

**PSYC 338 Phenomenology and Theory of Childhood Disorders 4 Credits**

The nature, classification, and treatment of childhood disorders.

Prerequisites as noted below.

**Prerequisites:** PSYC 107

**Attribute/Distribution:** SS

**PSYC 341 Social Psychology and Social Issues 4 Credits**

This course examines the methods, concepts, and research findings associated with the effort to apply social psychology to the understanding and amelioration of social problems. Special attention will be paid to the topic of human conflict.

**Attribute/Distribution:** SS

**PSYC 342 Motivation 4 Credits**

This seminar emphasizes theory and research on motivational approaches to social psychology. We will focus on the ways in which goals, motives, and needs guide behavior. We will explore such key issues as the nature of achievement, wellbeing, self-regulation and self-control; emotions, values, and belief-protection as sources of social action; and the role of motivated cognition in understanding the self and others. Prerequisites as noted below.

**Prerequisites:** (PSYC 153 or SSP 153) or (PSYC 121 or SSP 121)

**Attribute/Distribution:** SS

**PSYC 344 Health Care Reasoning and Decision-Making 4 Credits**

Health care professionals diagnose physical and mental illnesses and create treatment plans to improve their patients' health. How do these professionals make decisions related to these important issues? We will explore the literature on how medical and mental health professionals reason and make decisions about health care issues. Topics to be covered include diagnosis, treatment decisions, access to care, and how these reasoning processes are swayed. Consideration will be given to patient decision-making as well. Prerequisites as noted below or consent of instructor.

**Prerequisites:** PSYC 117 or PSYC 176 or COGS 007

**Attribute/Distribution:** SS

**PSYC 351 Children's Thinking 4 Credits**

This course examines the development of children's thinking from infancy through adolescence. We will discuss current research and theories on the content of children's knowledge and how mental abilities develop. We will also consider the implications of research on children's thinking for real-world questions about parenting, education, and policy-making. Topics include memory, concepts, social cognition, language, reading, mathematics, and individual and cultural differences. Prerequisites as noted below.

**Prerequisites:** PSYC 107 or PSYC 117 or COGS 007

**Attribute/Distribution:** SS

**PSYC 354 Psychological Assessment 4 Credits**

Basic concepts in the construction, selection, administration, scoring, and interpretation of assessment procedures commonly used in psychology. Selection and evaluation of assessment procedures. Supervised experience administering, scoring, and interpreting assessment procedures. Prerequisites as noted below.

**Prerequisites:** PSYC 110

**Attribute/Distribution:** SS

**PSYC 356 Seminar In Personality Psychology 4 Credits**

Topics in personality psychology: the self, personality consistency, motivation, psychological adjustment. Prerequisites as noted below or consent of instructor.

**Prerequisites:** PSYC 153 or SSP 153

**Attribute/Distribution:** SS

**PSYC 358 Inside the Infant Mind 4 Credits**

How do babies understand and learn about the world? This course explores the origin and development of human knowledge by venturing inside the infant mind. Topics include current research and theory on infants' understanding of objects, number, language, and people. Research examining thinking in non-human primates is also considered to shed light on what aspects of knowledge are and are not uniquely human. Prerequisites as noted below or consent of instructor.

**Prerequisites:** PSYC 107 or PSYC 117 or COGS 007

**Attribute/Distribution:** SS

**PSYC 359 Seminar on Psychological Issues in the Legal System 4 Credits**

Contributions of psychological research to understanding the legal system. Social science data on juries, eyewitnesses, mental illness, and the death penalty will be discussed. Conflicts between psychological and legal approaches will be highlighted.

**Attribute/Distribution:** SS

**PSYC 361 Personality and Social Development in Adulthood 4 Credits**

Theories and current research. Prerequisites as noted below or consent of instructor.

**Repeat Status:** Course may be repeated.

**Prerequisites:** SSP 109 or PSYC 109

**Attribute/Distribution:** SS

**PSYC 362 Cognition in Practice & Policy 4 Credits**

Taking the study of cognition from principle to practice, this course examines how basic research and theory informs understanding of human performance in real-world settings. Topics will be chosen from domains such as automobile safety, environmental and medical decision-making, human-technology interaction, spatial navigation, and breakdown of cognition under fatigue and alcohol. Public policy implications will be considered. Prerequisites as noted below or consent of instructor.

**Prerequisites:** PSYC 117 or COGS 007

**Attribute/Distribution:** SS

**PSYC 363 Personality and Social Development in Childhood 4 Credits**

Issues related to social development (e.g., attachment, social competence), social contexts (e.g., family, day care), and personality development (e.g., sex roles, aggression, temperament) from infancy through adolescence. Prerequisites as noted below or consent of instructor.

**Prerequisites:** PSYC 107

**Attribute/Distribution:** SS

**PSYC 364 Children and Narratives 4 Credits**

Examines the complex role of narratives-told to and by children, and enacted by children in play-in children's experience and development. Compares and seeks to integrate different approaches in psychology and other disciplines. In the process, we will also be addressing three basic questions: what is narrative, how is it significant, and how should we study it? Prerequisites as noted below.

**Prerequisites:** PSYC 107

**Attribute/Distribution:** SS

**PSYC 365 Human Development in Cross-Cultural Perspective 4 Credits**

The formation of mind and personality is shaped in profound ways by the sociocultural contexts within which individuals develop. This course introduces students to basic theoretical and methodological issues and explores important examples of cross-cultural variation and diversity, using comparisons between different societies and between different subcultures within American society. Topics include cognition, language, personality, moral development, socio-emotional development, identity, attachment, and socialization. Materials drawn from anthropology, sociology and education in addition to psychology. Prerequisites as noted below or consent of instructor.

**Prerequisites:** PSYC 109 or PSYC 107 or PSYC 121 or SSP 121 or ANTH 001

**Attribute/Distribution:** SS

**PSYC 366 Seminar In Cognitive Aging 4 Credits**

Information processing by older adults: perception, attention, memory, speech and text processing and comprehension. The course will also examine the effects on cognitive processing of such diseases as Alzheimer's and Parkinson's. Prerequisites as noted below.

**Prerequisites:** PSYC 109

**Attribute/Distribution:** SS

**PSYC 367 Clinical Psychology 4 Credits**

The science and profession of helping people overcome psychological problems. Theories of human personality and abnormality in relation to techniques for assessing and treating psychosocial problems and in the light of empirical evidence of validity and effectiveness. Professional issues are also covered. Prerequisites as noted below or consent of instructor.

**Prerequisites:** (PSYC 153 or SSP 153) and (PSYC 305)

**Attribute/Distribution:** SS

**PSYC 368 Children, Psychology, and the Law 4 Credits**

Covers psychological research on child witnesses, child victims, juvenile crime, children's rights and decision-making capabilities, divorce and custody. Implications of psychological research for social policy and legal reform will be discussed. Prerequisites as noted below.

**Prerequisites:** PSYC 107

**Attribute/Distribution:** SS

**PSYC 369 Memory Under Construction 4 Credits**

Investigation of the constructive nature of human memory through hands-on exercises, reading and discussion. Includes exploration of personal memories, a memory expanding project, and a final project. Coverage includes autobiographical memory, expert memory, and memory disorders. Prerequisites as noted below or consent of instructor.

**Prerequisites:** PSYC 117 or PSYC 176 or COGS 007

**Attribute/Distribution:** SS

**PSYC 377 Attention and Attentional Failures 4 Credits**

Attention allows us to function in complex environments where there is more information than we could possibly process all at once and failures of attention can have drastic consequences. Experimental and neuropsychological evidence will be surveyed for topics including basic attentional phenomena, the role of attention in everyday tasks, and the impact of attentional failures from mind wandering to neuropsychological deficits like ADHD. Prerequisites as noted below.

**Prerequisites:** PSYC 117 or PSYC 176 or COGS 007 or COGS 117 or COGS 176

**Attribute/Distribution:** SS

**PSYC 378 Emotional Development 4 Credits**

The course will cover selected topics in emotional development from infancy through adulthood. Topics will include: infant attachment (learning to love), romantic attachment (being in love), emotion regulation, sympathy/empathy, anger/aggression, temperament, etc. We will also discuss the ways in which significant relationships with peers and parents shape children's emotional development. Prerequisites as noted below.

**Prerequisites:** PSYC 107

**PSYC 380 Sports Psychology 4 Credits**

Theory, research and application comprise this focal area of psychology. The course will allow students to explore the theory and research giving rise to individual, team, and peak performance assessment and interventions. Topics will include assessment, affect modulation, imagery, cognitive formulation, and psychodynamic development. Prerequisites as noted below.

**Prerequisites:** PSYC 110 or PSYC 153 or SSP 153

**PSYC 381 Special Topics In Psychology 4 Credits**

Topics vary from semester to semester. Topics are presented at an advanced level. Previous course work in psychology and consent of faculty sponsor is required. May be repeated for credit.

**Repeat Status:** Course may be repeated.

**PSYC 382 Endocrinology of Behavior 3 Credits**

Hormonal effects upon animal and human behavior. Emphasis on neuroendocrinology of steroid hormone involvement in reproductive behaviors. Prerequisites as noted below.

**Prerequisites:** BIOS 120

**Attribute/Distribution:** NS

**PSYC 383 Attachment Theory & Research: The Study of Close Relationships Across the Lifespan 4 Credits**

This course will examine the influence of close relationships across the lifespan on personality development. We will examine the influence of parents, peers, siblings, and romantic relationships using traditional attachment theory. In addition, we will also explore how attachment quality is measured and the clinical applications of attachment theory. Prerequisites as noted below.

**Prerequisites:** PSYC 107

**Attribute/Distribution:** SS

**PSYC 384 Self and Identity 4 Credits**

We will examine different types of identity (e.g., personal, relational, collective) and the cognitive processes that allow for a multifaceted yet unified sense of self. We will study how self-related motives (e.g., enhancement, consistency, distinctiveness) influence self-knowledge, self-regulation, and mental health. Finally, we will explore the origins of self from evolutionary, neuroscientific, and cultural perspectives. Prerequisites as noted below.

**Prerequisites:** PSYC 121 or SSP 121 or PSYC 153 or SSP 153

**Attribute/Distribution:** SS

**PSYC 386 Child and Adolescent Health Psychology 4 Credits**

Focuses on developmental research and theory related to health and wellness issues in children and adolescents. Topics include children's understanding of biology and disease, disease management, medical consent, education and policy efforts to promote children's health. Prerequisites as noted below or consent of instructor.

**Prerequisites:** PSYC 107

**Attribute/Distribution:** SS

**PSYC 389 Honors Project 1-8 Credit**

**Repeat Status:** Course may be repeated.

**PSYC 391 Thesis 4 Credits**

Written report: Literature review and design of project in selected area of psychology. Only open to students in the honors program. Consent of Honors Program Coordinator required. Prerequisites as noted below.

**Prerequisites:** PSYC 210

**Attribute/Distribution:** ND

**PSYC 392 Thesis 3 Credits**

Execution of project designed in PSYC 391. Final report and oral presentation. Only open to students in the honors program. Consent of Honors Program Coordinator required. Prerequisites as noted below.

**Prerequisites:** (PSYC 391)

**Attribute/Distribution:** ND

**PSYC 393 Independent Research 1-3 Credit**

Individual research projects designed and executed in collaboration with faculty sponsor. Regular meetings with sponsor to give progress reports and receive feedback. Student reads relevant literature and writes report in APA format. May be repeated for a maximum of 6 credits. Prerequisites as noted below. Consent of faculty sponsor required.

**Repeat Status:** Course may be repeated.

**Prerequisites:** PSYC 210 or PSYC 161

**Attribute/Distribution:** ND

**PSYC 394 Senior Research Project 3 Credits**

Literature review, design and execution of project in selected area of psychology. Intended for senior majors in psychology. May be repeated for up to 6 credits. Consent of faculty sponsor required.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** ND

**PSYC 402 Developmental Psychology 3 Credits**

Survey of theories and research concerning perceptual, cognitive, social, and personality development through infancy and childhood. Must have graduate standing or consent of instructor.

**PSYC 403 Cognitive Psychology 3 Credits**

Survey of theories and research in cognitive psychology. Must have graduate standing or consent of instructor.

**PSYC 404 Behavioral Neuroscience 3 Credits**

Theoretical and empirical issues in biopsychology. Must have graduate standing or consent of instructor.

**PSYC 406 Social Cognition 3 Credits**

Theory and research on cognitive processes in personality and social functioning. The self, personality consistency and change, causal attributions, social judgment, goals and self-regulation, and mood and emotion. Topics may vary. Must have graduate standing or consent of instructor.

**PSYC 409 Professional Seminar I 1 Credit**

For students entering the Ph.D. program: Acculturation to graduate school and the Psychology Ph.D. program in particular; professional issues of relevance to individuals at the outset of a research career in psychology. Department permission required.

**PSYC 410 Professional Seminar II 1 Credit**

For students nearing graduation: Professional issues of special relevance to Psychology Ph.D. students preparing for academic or nonacademic postdoctoral employment. Department permission required.

**PSYC 412 First Year Research Project 1-3 Credit**

Research project or paper to be completed by June of the first year of the Ph.D. program under the direction of a faculty advisor. May be repeated in second semester of program.

**Repeat Status:** Course may be repeated.

**PSYC 421 Statistical Analysis of Psychological Data I 3 Credits**

First of a two-semester sequence covering essential issues in statistical analysis as practiced by psychologists. Topics include data description, probability, z and t-tests, general linear model, simple correlation/regression, univariate analysis of variance, chi-square. Emphasis on connecting research designs to appropriate statistical tests, data interpretation, and implementation in statistical packages. Department permission required.

**PSYC 422 Statistical Analysis of Psychological Data II 3 Credits**

Second course of the two-semester statistics sequence. Topics include advanced analysis of variance designs, analysis of covariance, multivariate analysis, multiple regression, and analysis of categorical data. Emphasis on connecting research designs to appropriate statistical tests, data interpretation, and implementation in statistical packages. Consent of department required. Prerequisites as noted below or consent of instructor.

**Prerequisites:** PSYC 421

**PSYC 423 Foundations of Cognitive Science 3 Credits**

Survey of fundamental theory and methodologies from artificial intelligence, linguistics, cognitive psychology, philosophy, and neuroscience, as well as salient research problems such as knowledge acquisition and representation, natural language processing, skill acquisition, perception and action, and the philosophical question of intentionality.

**PSYC 433 Cognitive Neuroscience Techniques 3 Credits**

This glimpse into the toolkit of modern cognitive neuroscience will provide an overview of a range of techniques from psychopharmacology and single cell recording, to human neuroimaging and neuropsychology. The course introduces different techniques with a focus on issues of temporal and spatial resolution of different methods, the costs and benefits of various techniques, and the appropriateness of techniques for different types of research questions. Students will develop the skills to be knowledgeable consumers of the modern literatures in psychology and related fields that are increasingly incorporating a range of neuroscience methods.

**Prerequisites:** PSYC 403

**PSYC 443 Seminar In Language Acquisition 3 Credits**

Special topics in language acquisition. Content will vary each time the seminar is offered. Prerequisites as noted below or consent of instructor.

**Prerequisites:** PSYC 402 or PSYC 403

**PSYC 446 Developmental Theories and Special Populations 3 Credits**

Traditional developmental theories focus on normative development. Children with disabilities have a unique set of experiences that pose special challenges for these theories. In the developmental literature, children with disabilities have sometimes been the focus of studies because they provide a "tests case" for specific theoretical predictions. In this course, we will consider some of these theoretical issues and the insights that have been gained by focusing on special populations. Prerequisites as noted below or consent of instructor.

**Prerequisites:** PSYC 402

**PSYC 448 Seminar in Psychology of Language 3 Credits**

Topics in language comprehension and production. Content will vary from year to year. Prerequisites as noted below or consent of instructor.

**Prerequisites:** PSYC 403

**PSYC 450 Special Topics in Mathematical Models and Statistics 3 Credits**

Selected topics in the application of mathematics to psychological research. May be repeated for credit.

**Repeat Status:** Course may be repeated.

**PSYC 460 Special Study 1-9 Credit**

Study of some special topic not covered in the regular course offerings. May be repeated for credit.

**Repeat Status:** Course may be repeated.



**PSYC 461 Research Seminar 1-9 Credit**

Original research designed and executed in collaboration with the faculty. May be repeated for credit.

**Repeat Status:** Course may be repeated.

**PSYC 462 Stereotypes, Prejudice, Discrimination 3 Credits**

An in-depth survey of the social psychological literature on stereotypes, prejudice, and discrimination. Topics will include: Origin of stereotypes, mental representation of stereotypes, cognitive and behavioral consequences of stereotypes, inevitability of stereotyping, nature of prejudice in contemporary American society, context-specificity of discriminatory behavior, and theories of intergroup conflict reduction. Prerequisites as noted below or consent of instructor.

**Prerequisites:** PSYC 406

**PSYC 464 Naive Realism in Social Judgement 3 Credits**

This seminar examines the variety of unconscious influences that impact on social judgment, with a focus on the cognitive processing mechanisms through which influence is exerted. These influences include contributions to judgment from attitudes, goals, accessible constructs, mindsets, stereotypes, expectancies, heuristics, and theories about social objects. Prerequisites as noted below or consent of instructor.

**Prerequisites:** PSYC 402

**PSYC 466 Prosocial Cognition, Emotion, and Behavior 3 Credits**

In this course we will examine such phenomena as compassion, caregiving, sympathy, justice motivation, and helping. We will begin with an examination of human nature: Is prosociality fundamental to human nature? Subsequently, we will examine how prosociality can be nurtured by particular developmental experiences. Finally, we will examine the literature on the nature of prosociality in adulthood: What cognitive capacities support prosociality? What situational factors promote prosociality? What emotional qualities promote prosociality? What belief systems are linked to prosociality?.

**Prerequisites:** PSYC 406

**PSYC 476 Seminar In Cognition 3 Credits**

Selected topics in human information processing, including such areas as attention, memory, language and comprehension, and decision-making. Area of emphasis will vary from year to year. Prerequisites as noted below or consent of instructor.

**Prerequisites:** PSYC 403

**PSYC 478 Ontological Psychology 3 Credits**

Principles and constraints for the modeling of psychological phenomena: Representation, perception, memory, knowing, emotions, consciousness, language, and rationality.

**PSYC 480 Seminar in Cognitive Development 3 Credits**

Selected topics in cognitive development in infancy and childhood, including such areas as conceptual development, memory development, the development of reasoning abilities, and language acquisition.

Emphasis will vary from year to year. Prerequisites as noted below or consent of instructor.

**Prerequisites:** PSYC 402

**PSYC 481 Selected Topics in Social and Personality Development 3 Credits**

Topics include emotional and sex-role development, peer relations, and social competence. Emphasis will vary from year to year. Prerequisites as noted below or consent of instructor.

**Prerequisites:** PSYC 402

**PSYC 482 Seminar In Adult Development 3 Credits**

Application of lifespan developmental theory and methodology to personality, social, and cognitive development in adulthood. Prerequisites as noted below or consent of instructor.

**Prerequisites:** PSYC 402

**PSYC 483 Seminar In Cultural Psychology 3 Credits**

Major theoretical approaches and empirical debates in cultural psychology, with a focus on the interplay of individual and sociocultural elements in the formation of mind, the emergence of the self, and the definition and reproduction of culture. Prerequisites as noted below or consent of instructor.

**Prerequisites:** PSYC 402

**PSYC 484 Psychology of Gender 3 Credits**

Major theoretical approaches and empirical debates in the psychology of gender, with a focus on the interplay of nature and nurture in producing gender similarities, gender differences and gender variation in personality, social behaviors, cognitive abilities, achievement, sexuality, and mental health. Methodological issues in gender research. Consent of instructor required.

**PSYC 490 Thesis Research 1-6 Credit**

Master's Thesis or Pre-dissertation Project research directed by committee.

**PSYC 495 Narrative & Psychology 3 Credits**

This course explores the increasing significance of narrative analysis in psychology by delineating the conceptual foundations of a narrative perspective and considering arguments for narrative as an integrative paradigm in psychological research. Particular emphasis will be on the constitutive role of narrative in cognitive and socio-emotional development, the formation of identity, moral understanding, and other domains. Some specific topics will be narrative development, autobiographical memory, self-narrative, identity development, narratives of conflict, and the role of narrative in socialization and education.

**PSYC 499 Dissertation Research 1-15 Credit**

Ph.D. dissertation research directed by dissertation committee.

**Religion Studies****Department Home Page**

The religion studies department is committed to the academic investigation of religion as an intrinsic and vital dimension of human culture. The scholarly study of religion is an integral facet of a liberal arts education. The student of religion is engaged in the critical and interpretive task of understanding patterns of religious thought and behavior as aspects of the human cultural experience.

Religion studies is interdisciplinary in that it draws upon humanistic and social scientific modes of inquiry. These include historical, philosophical, sociological, anthropological, and psychological perspectives. Religion studies is a cross-cultural, comparative discipline concerned with the character and significance of the major religious traditions of the world. The student of religion confronts ethical problems and basic issues of value and meaning raised by modern multicultural and technological society.

**Professors.** Dena S Davis, JD (University of Virginia); Norman J. Girardot, PhD (University of Chicago); Kenneth L. Kraft, PhD (Princeton University); Michael L. Raposa, PhD (University of Pennsylvania); Lloyd H Steffen, PhD (Brown University); Lenore E. Chava Weissler, PhD (University of Pennsylvania); Benjamin G. Wright, III, PhD (University of Pennsylvania)

**Associate Professors.** Martin Thomas Kavka, PhD (Rice University); Robert Thomas Rozehnal, PhD (Duke University)

**Assistant Professors.** Khurram Hussain, PhD (Yale University); Monica R. Miller, PhD (Chicago Theological Seminary)

**Emeriti.** Alice L. Eckardt, MA (Lehigh University); Barbara Frankel, PhD (Princeton University); Laurence J. Silberstein, PhD (Brandeis University)

**Major in Religion Studies**

The major in religion studies consists of 32 credit hours of coursework (eight courses). Requirements include:

- In consultation with a major advisor from the departmental faculty, students will devise a balanced plan of study responsive to individual needs and interests. The curriculum for each major will demonstrate exposure to a diversity of approaches to the interdisciplinary, trans-cultural field of religion studies.
- At least four courses at the 100 level or above.
- REL 374 Seminar for Majors

The department recommends that in consultation with a major advisor, students concentrate in one of the major religious traditions, or in a comparative or thematic approach to the study of religion. The

concentration should include at least four courses. Language study appropriate to the concentration is also desirable.

Students are particularly encouraged to consider a joint or double major with another major field from any of the three colleges at the university.

#### **Departmental Honors**

Religion studies majors are admitted to honors by invitation of the departmental faculty toward the end of the student's junior year. To be eligible, a student must have attained at least a 3.25 average in his or her major program by the end of the junior year. Upon admittance to honors, the student will work out a special program of studies for the senior year with the major advisor, culminating in the writing of a senior essay.

#### **Minor in Religion Studies**

The minor in religion studies consists of a total of 16 credits. The specific courses to be taken by each student are to be decided upon jointly by the student and the departmental advisor. Ordinarily, the student will be expected to take one introductory course unless specifically exempted by the department chair.

#### **Courses**

##### **REL 001 Sacred Scriptures in Religious Traditions 4 Credits**

An encounter with the different sacred books of the world's major religions. Both the books and differing attitudes in these traditions towards sacred books are examined. Books investigated include the Bhagavad Gita, the Analects of Confucius, the Qur'an and the Jewish and Christian Bibles.

**Attribute/Distribution:** HU

##### **REL 002 Death In Religious Traditions 4 Credits**

Introduces students to the study of religion through an exploration of what different religious traditions have to say about the great mystery that we all face, death. Because we all must die, all religions must deal with the challenge and sense of crisis provoked by the deaths of those close to us, of innocent victims of disaster, disease, and crime, and our own imminent deaths. Death thus provides an excellent point of comparison among the various religious traditions.

**Attribute/Distribution:** HU

##### **REL 003 Global Religion, Global Ethics 4 Credits**

Introduction to philosophical and religious modes of moral thinking, with attention given to ethical issues as they arise cross-culturally in and through religious traditions. The course will reference the United Nations Millennium Goals to consider family life and the role of women, social justice, the environment, and ethical ideals. Particular focus varies but may include one or more of the following: abortion and reproductive health, the death penalty, religiously motivated violence, and problems of personal disorder (heavy drinking, anorexia, vengeance). A Global Citizenship course.

**Attribute/Distribution:** HU

##### **REL 004 How To Study Religion 4 Credits**

How do sociologists, psychologists and philosophers answer such questions as: Why and how do religions arise? Why and how do people develop beliefs in God? Where do religious scriptures come from? Why do people ascribe authority to religious traditions? Why has religious faith declined in modern society?.

**Attribute/Distribution:** HU

##### **REL 005 Spiritual Exercises in Religious Traditions 4 Credits**

Explores a variety of religious disciplines developed in various traditions, ranging from the practice of yoga and the martial arts to various forms of prayer, meditation, and asceticism.

**Attribute/Distribution:** HU

##### **REL 006 Religion and Ecological Crisis 4 Credits**

Past and present responses to nature in world religions. Contemporary topics include the animal rights debate, ecofeminism, and the development of environmental ethics. Is "the end of nature" at hand? Why is the environment a religious issue?.

**Attribute/Distribution:** HU

##### **REL 008 Prehistoric Religion, Art, and Technology 4 Credits**

Origins and early development of religions, with focus on interactions of religion, art, and technology in the Paleolithic and Neolithic periods. Special attention to the emergence of patriarchal social forms and the figure of the goddess. Interdisciplinary methods with a consideration of feminine theories of cultural development.

**Attribute/Distribution:** HU

##### **REL 009 Spiritual Journeys 4 Credits**

A comparative survey of spiritual traveling—from overland pilgrimages to inward journeys in search of truth. Through autobiographies, diaries, poetry and films, students encounter the experiences of seekers from diverse religious traditions, including Hinduism, Buddhism, Christianity and Islam.

**Attribute/Distribution:** HU

##### **REL 012 Introduction to Asian Religions 4 Credits**

This course explores the principal religions of Asia, including Hinduism, Buddhism, Daoism, Confucianism, and Shinto. What is each tradition's view of human potential? How is ultimate reality depicted and experienced? What do home altars, boisterous festivals, and silent meditation halls have in common? Several primary texts are read in translation.

**Attribute/Distribution:** HU

##### **REL 014 Virtual" Religion 4 Credits**

The contemporary world is replete with social phenomena that resemble religious thought and practice – sports fandom, trekkies, nationalistic rituals, online gaming, military camaraderie and codes, environmental activism, etc. In this course we will explore and discuss many of these "virtually" religious phenomena through the lens of the study of religion.

**Attribute/Distribution:** HU

##### **REL 060 Religions of South Asia 4 Credits**

A thematic introduction to the foundational religious traditions of South Asia: Hinduism, Jainism, Buddhism, Sikhism and Islam. Students explore the social and spiritual dimensions of these religious worlds through scripture, ritual practices, narrative and teaching traditions, music and art.

**Attribute/Distribution:** HU

##### **REL 064 Religions of China 4 Credits**

History and meaning of the major forms of Chinese religion- especially Confucianism and Neo-Confucianism, Taoist mysticism, Buddhism (Ch'an/Zen), and popular religion.

**Attribute/Distribution:** HU

##### **REL 065 Religions of Japan 4 Credits**

A survey of Japan's diverse religious heritage and its impact on contemporary culture. Japanese approaches to the self, the world, and the sacred are considered in comparative perspective. Topics covered include: Shinto, Buddhism, Zen, Confucianism, the way of the warrior, folklore, and postwar movements.

**Attribute/Distribution:** HU

##### **REL 067 Japanese Civilization 4 Credits**

This course explores the history and culture of Japan from the sixth century to the nineteenth century. How did Japan develop its distinct sense of itself? What aspects of Japanese culture have gained recognition on an international scale? Special consideration is given to the rise of the warrior class, the flowering of religious expression, and the dynamics of family life. (H/S).

**Attribute/Distribution:** HU

##### **REL 073 The Jewish Tradition 4 Credits**

Judaism is both a textual tradition and a lived religion. Students read basic Jewish texts—Bible, Talmud, Midrash—and study the ways Jews sanctify the life cycle through rites of passage, and the round of the year through the festival cycle.

**Attribute/Distribution:** HU

##### **REL 075 The Christian Tradition 4 Credits**

Introduction to the Christian tradition from its early variety and subsequent classical definition in the church councils up to the enlightenment. Special emphasis will be placed on the multiform interpretations of the Christian message.

**Attribute/Distribution:** HU

**REL 076 Reading the Bible in the Contemporary World 4 Credits**

Reading passages from the Bible with an eye toward distinguishing and understanding different sorts of questions that can be asked of them and various perspectives that can be adopted when reading them. What are these stories about? What do they mean, when, and to whom?.

**Attribute/Distribution:** HU

**REL 077 The Islamic Tradition 4 Credits**

A thematic introduction to Islamic history, doctrine and practice.

Topics include: Qur'an; prophecy and sacred history; ritual practices; community life; legal interpretation; art and aesthetics; mysticism; politics and polemics.

**Attribute/Distribution:** HU

**REL 099 Special Topics 1-4 Credit**

**Repeat Status:** Course may be repeated.

**REL 111 Jewish Scriptures/Old Testament 4 Credits**

The religious expression of the Hebrews, Israelites, and Jews as found in the Jewish Scriptures (Tanakh/Christian Old Testament). Near Eastern context of Hebrew religion, the Patriarchs, the Exodus, the monarchy, prophecy, Exile and Return. Emphasis on historical, literary, critical problems, and newer socio-historical methods.

**Attribute/Distribution:** HU

**REL 112 The Beginnings of Judaism and Jewish Origins: Jewish Diversity in the Greco-Roman World 4 Credits**

The variety of approaches to Judaism in the period following the Babylonian exile through the second century C.E. The literature studied will include Apocrypha, Pseudepigrapha, and the Dead Sea Scrolls.

**Attribute/Distribution:** HU

**REL 114 Christian Origins: New Testament and the Beginnings of Christianity 4 Credits**

Early Christianity from its beginnings until the end of the second century. Coverage includes the Jewish and Hellenistic matrices of Christianity, traditions about the life of Jesus and his significance, and the variety of belief and practice of early Christians. Emphasis on encountering primary texts.

**Attribute/Distribution:** HU

**REL 115 Religion And Psychology 4 Credits**

A study of the origins, development and consequences of religion from a psychological perspective. Attention will be given to classic and contemporary sources, with a focus on major psychoanalytic theorists of religion (Freud, Jung, Erikson); psychological analyses of religious experience (e.g., Wm. James, Victor Frankl); and the diverse cultural and religious forms that structure the connection between religion and psychology (e.g., Buddhist psychology, Japanese Morita therapy).

Course examines the role of religion as a powerful meaning system that can affect the lives of individuals in terms of motivations, beliefs, emotions and behaviors, and can influence their interactions on both interpersonal and intergroup levels.

**Attribute/Distribution:** HU

**REL 116 Bioethics 4 Credits**

Moral issues that arise in the context of health care and related biomedical fields in the United States today, examined in the light of the nature and foundation of moral rights and obligations. Topics include: confidentiality, informed consent, euthanasia, medical research and experimentation, genetics, and the distribution of health care.

**Attribute/Distribution:** HU

**REL 118 Ethics in Practice 1-4 Credit**

A variable content course focusing on ethical issues arising in a particular profession, such as law, health, business, engineering, military. Variable credit. May be taken more than once.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**REL 120 Newish Jewish: New Forms of Judaism in North America 4 Credits**

The new millennium has seen the emergence of new forms of Judaism and of Jewishness in North America: Jewish hip hop music, graphic novels, zines, performance arts, blogs, earth-based spirituality, and ecological activism. The course will examine the roots of these phenomena in Jewish traditions and texts and in American popular culture, and explore the uses of hybridity and pastiche in the forms of Jewish identity they create.

**Attribute/Distribution:** HU

**REL 121 Sources for the Life of Jesus: the Jewish and Christian Context 4 Credits**

Ancient sources that claim to provide information about Jesus of Nazareth. Approaches taken to Jesus' life and career; early Christian interpretations of the significance of Jesus; methodology in assessing evidence for the historical Jesus and his message.

**Attribute/Distribution:** HU

**REL 124 Philosophy Of Religion 4 Credits**

A critical look, from a philosophical perspective, at some fundamental problems of religion: The nature of religious experience and belief, reason and revelation, the existence and nature of God, the problem of evil, and religious truth.

**Attribute/Distribution:** HU

**REL 125 Comparative Religious Ethics 4 Credits**

How have thinkers within the three major Abrahamic traditions handled ethical questions and dilemmas throughout history? This course will focus on many issues including but not limited to violence and pacifism, debates concerning revelation versus reason, the different accounts of justice and peace, the nature of scripture and the divine. We will look comparatively both within and across these traditions.

**Attribute/Distribution:** HU

**REL 129 Jewish Philosophy 4 Credits**

How major Jewish thinkers from the first to the 20th centuries confronted questions at the intersection of religion and philosophy: the existence and nature of God, free will, evil, divine providence, miracles, creation, revelation, and religious obligation.

**Attribute/Distribution:** HU

**REL 132 Hasidic Tales 4 Credits**

Examines the mysterious and beautiful tales told by Hasidim, participants in the movement of spiritual revival which arose within 18th century Judaism. Compares Hasidic tales to European fairy tales, and shows how later writers transformed Hasidic narratives to express their own religious or literary meanings.

**Attribute/Distribution:** HU

**REL 133 Alternative Religions in the 21st Century 4 Credits**

An exploration of alternative religious beliefs and practices in the 21st century. Topics include the new pluralism, adaptations of Asian traditions, goddess religion, and spiritual environmentalism. What distinguishes a religion from a cult? What goes awry when violence is perpetrated in the name of religion?.

**Attribute/Distribution:** HU

**REL 138 Women in Jewish History 4 Credits**

Contributions of, and limitations on, women at different stages of Jewish history, using both primary sources and secondary material. Experience of modern Jewish women, and the contemporary feminist critique of traditional gender roles.

**Attribute/Distribution:** HU

**REL 139 Jewish Folklore 4 Credits**

Examines the transformation of folk and popular Judaism from the Old World, through the period of immigration to America, to ethnic and later forms of American Jewish culture. Attention paid to concept of folklore revivals and their meanings. Four case studies: folk tales and storytelling, klezmer music, life-cycle rituals, and food.

**Attribute/Distribution:** SS

**REL 141 Medieval Islamic Philosophy 4 Credits**

The medieval era was the golden age of Islamic civilization. Science, mathematics, theology, philosophy, logic, jurisprudence, and many other disciplines flourished during that time. Islamic scientific and philosophical thoughts were greatly influenced by the Greek intellectual tradition, and in turn the Islamic intellectual tradition influenced European thoughts during the Middle Ages and beyond. The course is an introduction to medieval Islamic philosophy. There is no indigenous Islamic philosophy other than medieval Islamic philosophy. Reading selections include works by al-Kindi, al-Razi, al-Farabi, Ibn Sina (Avicenna), al-Ghazali, Ibn al-Jayy, and Ibn Rushd (Averroes). The goal is to attain a thorough understanding of the reading selections instead of covering a large number of treatises.

**Attribute/Distribution:** HU

**REL 144 Raw Vision: Creativity and Ecstasy in the Work of Shamans, Mystics, and Artist Outsiders 4 Credits**

Comparative exploration of the nature and meaning of religious and artistic experience as reflected in shamanism (both prehistoric and tribal), mystic traditions (especially Daoism and Christianity), and contemporary self-taught artistic visionaries (e.g., Jean Dubuffet, Howard Finster, Mr. Imagination, Lonnie Holley, Norbert Kox). Various disciplinary perspectives will be employed including comparative religions, anthropology, art history, and psychology.

**Attribute/Distribution:** HU

**REL 145 Islam and the Modern World 4 Credits**

Examines how numerous Muslim thinkers-religious scholars, modernists, and Islamists-have responded to the changes and challenges of the colonial and post-colonial eras. Special emphasis is placed on the public debates over Islamic authority and authenticity in contemporary South Asia.

**Attribute/Distribution:** HU

**REL 146 Islam in South Asia 4 Credits**

A survey of the dynamic encounter between Islamic and Indic civilizations. Topics include: Islamic identity, piety and practice; art and aesthetic traditions; inter-communal exchange and conflict; the colonial legacy; and the politics of contemporary religious nationalism.

**Attribute/Distribution:** HU

**REL 148 Islam Across Cultures 4 Credits**

Explores the Muslim world's diversity and dynamism in multiple cultural contexts-from the Middle East and North Africa, to Asia and America-through literature, ethnography, and films. Topics include: travel and trade networks; education; women and gender; Islam and cultural pluralism; colonialism; and identity politics.

**Attribute/Distribution:** HU

**REL 149 Modern Islamic Ethics 4 Credits**

This course will focus on developments in Islamic thinking and ethics that emerge from the modern encounter between Muslim societies and the West. We will discuss Islamic modernism and fundamentalism through short primary texts from a variety of modern Muslim thinkers.

**Attribute/Distribution:** HU

**REL 152 American Judaism 4 Credits**

Diverse cultural and social forms through which American Jews express their distinct identity. Is American Jewry an example of assimilation and decline or creative transformation? What, if anything, do American Jews share in common? Compatibility of Judaism with individualism, pluralism, and voluntarism. How have the Holocaust and the State of Israel shaped the self-understanding of American Jewry?

**Attribute/Distribution:** HU

**REL 153 The Spiritual Quest in Contemporary Jewish Life 4 Credits**

What factors explain the current growth of spirituality in American Jewish life? How does spirituality differ from conventional religion? What is the impact of Jewish spirituality on contemporary Jewish worship? How does the growth of Jewish spirituality relate to the broader issues of Jewish identity? What accounts for the growing interest in Buddhism among Jews? What is the impact of feminism on Jewish spirituality? How does the growth of spirituality among Jews relate to the growth of spirituality in general American culture?.

**Attribute/Distribution:** HU

**REL 154 The Holocaust: History and Meaning 4 Credits**

The Nazi holocaust in its historical, political and religious setting. Emphasis upon moral, cultural and theological issues raised by the Holocaust.

**Attribute/Distribution:** HU

**REL 157 Europe in the Age of the Reformation 4 Credits**

The breakup of the religious culture of medieval Christian Europe in the reformation movements of the sixteenth century. The origins and varieties of Protestantism; the intersection of religious ideas and politics in Germany, Switzerland, Britain, France, and the Netherlands; the "wars of religion" and the emergence of the European state system.

**Attribute/Distribution:** HU

**REL 159 Roman Catholicism in the Modern World 4 Credits**

A survey of the various intellectual, cultural, political and ecclesiastical developments that have shaped contemporary Roman Catholic life and thought.

**Attribute/Distribution:** HU

**REL 160 The Taoist Tradition 4 Credits**

Consideration of the religious and cultural significance of Daoism in its various historical forms. Primary attention will be given to a close reading of some of the most important texts of the early philosophical tradition (e.g. Tao Te Ching, Chuang Tzu) and of the later religious tradition (e.g. Pao P'u Tzu and other selections from the Tao Tsang). Contemporary implications of Daoist thought will also be considered (e.g. "The Tao of Physics", "a Taoist on Wall Street", and "the Tao of Japanese Management").

**Attribute/Distribution:** HU

**REL 162 Zen Buddhism 4 Credits**

History, doctrines, and practices of Zen Buddhism in China, Japan, and the West. Monastic life, notable Zen masters, Zen's cultural impact, and enlightenment. Current aspects of the Zen tradition. (Optional meditation workshop.)

**Attribute/Distribution:** HU

**REL 166 Religious Nationalism in South Asia 4 Credits**

This course explores the conflation and conflict of religion and politics in one of the most complex, dynamic and volatile regions on the planet (South Asia). Through literature, film and scholarly writings, students will examine the history of cooperation and conflict between the Muslim and Hindu communities in South Asia-from the movements for national independence to twenty-first century identity politics.

**Attribute/Distribution:** HU

**REL 167 Engaged Buddhism 4 Credits**

Examines a contemporary international movement that applies Buddhist teachings and practices to social, political, and environmental issues. Topics include: important thinkers, forms of engagement, and areas of controversy.

**Attribute/Distribution:** HU

**REL 168 Buddhism in the Modern World 4 Credits**

Explores contemporary Buddhism in Asia, America, and Europe. Topics include the plight of Tibet, Buddhist environmentalism, and the emergence of a socially engaged Buddhism. How are Westerners adapting this ancient tradition to address present-day concerns?.

**Attribute/Distribution:** HU

**REL 171 Religion And Society 4 Credits**

An introduction to the sociology of religion. Covers classical and contemporary approaches to defining and studying the role of religion in society. Emphasis on understanding religious beliefs and practices in the United States, the sources and contours of religious change, and the effects of religion on individuals and society. Specific topics include religious fundamentalism, religious conversion, religious practices and authority, secularization, religion in public life, religion in social change, religious terrorism, and the ways in which religion impacts our personal health, educational attainment, and family life.

**Attribute/Distribution:** SS

**REL 174 Contemporary Theology 4 Credits**

Major 20th century movements within Christian and Jewish theology understood as responses to the problems of modern times. May be repeated for credit as the subject matter varies.

**Attribute/Distribution:** HU

**REL 180 Religion and the American Experience 4 Credits**

The historic development of major American religious groups from colonial times to the present; their place in social and political life, and the impact of the national experience upon them.

**Attribute/Distribution:** HU

**REL 184 Religion, Gender and Power 4 Credits**

Gender differences as one of the basic legitimations for the unequal distribution of power in Western society. Feminist critiques of the basic social structures, cultural forms, and hierarchies of power within religious communities, and the ways in which religious groups have responded.

**Attribute/Distribution:** HU

**REL 187 Science, Technology, and the Religious Imagination 4 Credits**

Impact of the scientific and technological culture on the Western religious imagination. Roots of science and technology in religious ideas and images. Ways of knowing and concepts of experience in religion and science.

**Attribute/Distribution:** HU

**REL 188 Religion and Literature 4 Credits**

Religious themes in the modern novel or the spiritual autobiography. Melville, Tolstoy, Camus, Updike, Walker, and Morrison; or Woolman, Tolstoy, Malcolm X, Wiesel, Frederick Douglass, Sojourner Truth, Kukai.

**Attribute/Distribution:** HU

**REL 189 Religion and the Visual Arts 4 Credits**

To what extent does the process and production of artistic images relate to visionary experience in the history of world religions, and expose a religious dimension in life? In what sense is an artistic vocation similar to the religious vocation of a shaman, prophet, or saint? In what way do artists and religious figures respond to, change, and create the "real" world?

**Attribute/Distribution:** HU

**REL 213 Ancient Roman Religion 4 Credits**

Religious experience of the Roman people from prehistory to end of the empire. Nature of polytheism and its interactions with monotheism (Christianity, Judaism). Theories of religion. Emphasis on primary source materials.

**Attribute/Distribution:** SS

**REL 220 Classics of Asian Religion 4 Credits**

Sacred scriptures of Asia and an introduction to the religions they represent. What do these texts teach about reality, humanity, divinity, and society? How is the path of spiritual practice presented in the different traditions?

**Attribute/Distribution:** HU

**REL 221 Topics in Asian Religions 4 Credits**

Selected thematic and comparative issues in different Asian religious traditions. May include Buddhism and Christianity, religion and martial arts, Asian religions in America, Taoist meditation, Zen and Japanese business, Buddhist ethics. May be repeated for credit. (H/S).

**REL 222 Topics In Western Religions 4 Credits**

Selected historical, thematic, and comparative issues in Judaism, Christianity, and Islam. May be repeated for credit as the subject matter varies.

**Attribute/Distribution:** HU

**REL 224 Topics in the Philosophy of Religion 4 Credits**

Selected problems and issues in the philosophy of religion. May be repeated for credit as the subject matter varies. Must have completed one HU designated course in Philosophy.

**Attribute/Distribution:** HU

**REL 225 Topics in Religion and Ethics 4 Credits**

Analysis of various moral problems and social value questions. Possible topics include: environmental and non-human animal ethics; medical ethics; drug and alcohol abuse; spiritual meaning of anorexia.

**Attribute/Distribution:** HU

**REL 226 From Black Death to AIDS:Plague,Pandemic,Ethics and Religion 4 Credits**

An investigation into the way religion and morality shape interpretations of plague and pandemics. Three specific pandemics are examined: the bubonic plague of the 14th century, the 1918 influenza pandemic, and the current global AIDS crisis. Moral issues provoked by institutional, political and social responses to pandemic disease are also considered.

**Attribute/Distribution:** HU

**REL 228 Theories Of Religion 4 Credits**

What is religion? Does it have a universal, cross-cultural and trans-creedal essence? Drawing on numerous academic disciplines, the course engages the major issues and most influential authors in the academic study of comparative religions.

**Attribute/Distribution:** HU

**REL 230 Kabbalah: Jewish Mystical Tradition 4 Credits**

Explores the history of the quest to know God, through mystical experience or theosophical speculation, as found in Jewish tradition. Examines such issues as the tensions between institutional religion and personal religious experience, between views of God as immanent in the world or transcending it, and between imagery for God and religious experience of God.

**Attribute/Distribution:** HU

**REL 231 Classic Jewish Texts 4 Credits**

While many people know that the Hebrew Bible ("Old Testament") is a foundational scripture for Judaism, fewer are familiar with the post-biblical Jewish classics. Yet these works shaped the understanding of God, the identity of the Jewish people, and the vision of history and of the ethical life that inform Judaism as we know it today. As students read the Talmud, Midrash, and traditional prayer-book, they will become familiar with the wisdom of the rabbinic sages, and the central concepts of Jewish tradition.

**Attribute/Distribution:** HU

**REL 234 Buddhist Visions of a Good Society 4 Credits**

This course examines Buddhist visions of a better world. Present-day Buddhist teachers, most notably the Dalai Lama, propose "zones of peace," advocate "a policy of kindness," and extol "compassionate consumption." Are there wiser ways to pursue happiness? What is the relation between individual transformation and social transformation? Can we imagine a community guided by altruism and nonviolence? The process of contemplating alternative societies is also a way to achieve a clearer understanding of one's own highest ideals.

**Attribute/Distribution:** HU

**REL 241 Critics Of Religion 4 Credits**

A seminar devoted to an analysis of the critiques of religion in the writings of Benedict Spinoza, Friedrich Nietzsche, Sigmund Freud, Michel Foucault and William E. Connolly.

**Attribute/Distribution:** HU

**REL 243 Religious Nationalism in a Global Perspective 4 Credits**

Religion has become a renewed political force on the world stage in recent years. This course will focus on how religion has often provided both the Ideological language and the organizing principles for many modern nationalisms. Our exploration of this topic will take the form of case studies from various parts of the world, including but not limited to Pakistan, Israel, No. Ireland, India, Iran and the USA.

**Attribute/Distribution:** HU

**REL 244 Globalization and Religion 4 Credits**

This course examines the complexity of globalization and its multi-layered impact on religious identity and piety. Though comparative in methodology and historical framework, the class will give special attention to Islam and Hinduism in South Asia. Topics include: European colonialism; Orientalism and its legacy; religious nationalism; Islamophobia; and the Internet and mass media.

**Attribute/Distribution:** HU

**REL 247 Islamic Mysticism 4 Credits**

Sufism, the inner or 'mystical' dimension of Islam, has deep historical roots and diverse expressions throughout the Muslim world. Students examine Sufi doctrine and ritual, the master-disciple relationship, and the tradition's impact on art and music, poetry and prose.

**Attribute/Distribution:** HU

**REL 251 Classical Mythology 4 Credits**

Myth, religion and ritual in ancient Greece and Rome. Emphasis on primary sources; introduction to ancient and modern theories of myth. Cross-cultural material.

**Attribute/Distribution:** SS

**REL 254 Buddhism and Ecology 4 Credits**

Buddhism's intellectual, ethical, and spiritual resources are reexamined in light of contemporary environmental problems. Is Buddhism the most green of the major world religions? What are the moral implications of actions that affect the environment?.

**Attribute/Distribution:** HU

**REL 262 Critics of Modernity 4 Credits**

Many modern thinkers find modernity and its forms of social organization and politics to be deeply troubling. Including both religious and non-religious critiques, this course will explore the varying meanings of modernity and how these thinkers challenge such meanings. Critics including but not limited to Gandhi, Hannah Arendt, Reinhold Neibuhr, Sayyid Qutb, Alasdair MacIntyre and Ruhollah Khomeini.

**Attribute/Distribution:** HU

**REL 300 Apprentice Teaching 1-4 Credit****REL 317 Topics in Jewish Literature 4 Credits**

Selected topics in Jewish literature, which may include: Contemporary Jewish Literature, Philip Roth's *Complaint*, and Jewish Women Writers. May be repeated for credit as title varies.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**REL 335 Religion, Witchcraft And Magic 4 Credits**

Addresses broad questions about the roles that religion, magic, and witchcraft play in human life, as philosophical systems of meaning, as useful tools for understanding, and as practical and moral guides for human action. Special focus on the role of witchcraft and magic in the modern world, especially in the lives of disempowered people.

**Attribute/Distribution:** SS

**REL 337 Buddhism and Society 4 Credits**

In this course we approach Buddhism as a lived tradition rather than as a textual tradition. We examine how Buddhist practices are integrated into local traditions and how religious practices become part of the larger social, political, and value systems. Societies examined may include Thailand, Nepal, Japan, China, and the United States. Students will develop a comparative framework that includes Theravada, Tibetan, and Zen Buddhism.

**Attribute/Distribution:** SS

**REL 347 American Religious Thinkers 4 Credits**

An examination of the writings of key figures in the history of American religious thought (such as Edwards, Emerson, Bushnell, Peirce, James, Royce, Dewey and the Niebuhrs). Attention will be directed both to the historical reception of these writings and to their contemporary significance.

**Attribute/Distribution:** HU

**REL 350 Religion and Politics in Comparative Perspective 4 Credits**

This research seminar attempts to identify the conditions under which religious parties arise and become influential, how religion influences popular understandings of secular politics and the extent to which religion is a necessary feature of modern public discourse. These topics are explored through country specific cases from around the world.

**Attribute/Distribution:** SS

**REL 361 Fieldwork 1-4 Credit**

Opportunity for students to work, or observe under supervision, religious organizations or institutions. Consent of chair required.

**Attribute/Distribution:** ND

**REL 371 Directed Readings 1-4 Credit**

Intensive study in areas appropriate to the interests and needs of students and staff.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** ND

**REL 374 Seminar for Majors 4 Credits**

A capstone seminar for departmental majors. Considers the methodologies of religious studies and assesses current issues in the field. Offers opportunities for in-depth work on a particular tradition under the guidance of a faculty member. Offered in spring semester. May be repeated for credit.

**Attribute/Distribution:** HU

**REL 375 Christian Right In America 4 Credits**

What do we know about the Christian Right? Who are they? What do they believe? Where do they come from? Seminar explores answers to such questions through a focus on the history of the Christian Right as well as its ideologies and beliefs, the people who are a part of it, and its evolving relationship to the American political system. Topics include some of the most divisive social issues of our time: abortion, homosexuality, capital punishment, pornography, taxes, education, and the separation of church and state. Must have completed one 100-level SSP course.

**Attribute/Distribution:** SS

**REL 389 Honors Project for Eckardt Scholars 1-8 Credit**

Opportunity for Eckardt Scholars to pursue an extended project for senior honors. May be repeated for credit up to a maximum 12 credit hours. Transcript will identify department in which project was completed. Consent of department required.

**Repeat Status:** Course may be repeated.

**REL 391 Senior Thesis in Religion 4 Credits**

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** ND

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**Science, Technology and Society**


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**Program Director: Stephen H. Cutcliffe, Ph.D.**

**(Lehigh)** (<http://cas.lehigh.edu/Roster/Profile.aspx?key=Yk9FYndtL1ZCNG13YINVODRzdmNSdz09&theme=dialog>)

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**Website:** <http://sts.cas2.lehigh.edu/>

*Supported by the Office of Interdisciplinary Programs 610-758-3996; [incasip@lehigh.edu](mailto:incasip@lehigh.edu)*

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The Science, Technology and Society (STS) program is the product of a continuing cross-college effort to create a common ground from which to explore the relations between science, technology and society: between ideas, machines and values.

The STS program serves as a focal point for a wide range of courses that study the natures of science and of technology, and analyze their social and personal implications. It lends coherence and visibility to offerings otherwise dispersed throughout the catalog.

**Science, Technology and Society (STS) Major**

The major in science, technology and society studies prepares students for graduate study or for a wide variety of career opportunities including policy analysis, planning, or community relations with public or private sector agencies concerned with the social relations of scientific research and technological innovation. The intrinsically cross-disciplinary character of science-technology-society interactions is reflected in the B.A. requirements. Majors must complete a minimum of 30 credit hours in STS courses, listed below, together with at least 15 credit hours in any traditional academic discipline: engineering, physical or life science, the humanities, or the social sciences. This collateral set of courses should be chosen in consultation with the program director to provide the foundation needed to engage STS studies issues in which that discipline is implicated. The senior seminar provides an opportunity for students to integrate the knowledge they have gained and the skills they have acquired in their coursework.

Opportunities for student research are available, especially through STS 181: Independent Study and STS 391: Honors Thesis.

STS studies is a social science major in the College of Arts and Science, and majors must fulfill the college's B.A. distribution requirements. A detailed description of the STS studies major requirements follows.

**Detailed Description of STS Major Requirements Course List**

<b>Core Courses</b>		20
STS 011	Technology and Human Values	
HIST 007 or HIST 008	Technology in America's Industrial Age Technology in Modern America	
STS/JOUR 124 or POLS 115	Politics of Science Technology As Politics	
PHIL 128 or PHIL 228	Philosophy Of Science Topics in the Philosophy of Science	
STS 381	Senior Seminar	
<b>Electives</b>		10-12
Select three additional advanced courses (at least two of which must be at the 100 level or higher) from the list of approved STS studies courses		
<b>Concentration Requirement</b>		15
One of the following: <sup>1</sup>		
Concentration in a Complementary Discipline		
Approved Departmental or Interdisciplinary Program Minor		
Double Major		
<b>Total Credits</b>		<b>45-47</b>

<sup>1</sup> Minimum of 15 hours to be chosen in conjunction with STS studies advisor.

**Honors in STS**

In order to receive Honors in STS, the student must attain a 3.5 grade-point average in courses presented for the major and a 3.2 grade-point average over all, and must complete the 4 credit Honors Thesis sequence (STS 391 and STS 392) beyond the required minimum of 30 Core credits required of all STS majors.

**STS Studies Minor**

The program also offers a minor in science, technology & society studies which is open to all undergraduates. Students electing the minor must take a set of courses totaling a minimum of 15 hours that includes STS 011 Technology and Human Values and electives chosen from the list of all courses eligible for STS studies which follows below.

**Core Course**

STS 011	Technology and Human Values	4
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**Electives**

Three electives from approved STS courses (minimum 11 credits)	11
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<b>Total Credits</b>	<b>15</b>
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**STS Courses**

Students should consult with the program director when selecting courses for either the major or the minor. To declare a minor in STS, students must complete a minor declaration form ([http://catalog.lehigh.edu/coursesprogramsandcurricula/artsandsciences/sciencetechnologyandsociety/STS\\_Minor\\_Declaration\\_Form.pdf](http://catalog.lehigh.edu/coursesprogramsandcurricula/artsandsciences/sciencetechnologyandsociety/STS_Minor_Declaration_Form.pdf)).

STS 011	Technology and Human Values	4
STS 012	Engineering and Society	4
STS/HIST/WGSS 117	Women, Science, and Technology	4
STS/HIST/HMS 118	History of Modern Medicine	4
STS/JOUR 124	Politics of Science	4
STS/HIST 145	Introduction to the History of Science	4
STS 181	Independent Study	1-4
STS/MAT 221	Materials in the Development of Man	3
STS/CSE/EMC 252	Computers, the Internet, and Society	3
STS/ES/HMS/JOUR 323	Health and Environmental Controversies	4
STS 341	Issues in American Competitiveness: At Home and Abroad	4
STS 381	Senior Seminar	4
STS 391	Honors Thesis (fall)	1

STS 392	Honors Thesis (spring)	3
STS 481	Readings in Science, Technology and Society <sup>1</sup>	3

<sup>1</sup> Open to undergraduates by petition only.

**Other STS courses**

These courses, appropriate to STS studies, are offered by various departments. Course descriptions may be found under the catalog entry for the individual department. New courses are frequently added to this list and announced in bulletins published by the STS program. For further information, please contact the program director.

ARCH 107	History of American Architecture	4
ARCH 210	20th Century Architecture	4
DES 066	Design History	4
ECO 311	Environmental Economics	3
ECO 314	Energy Economics	3
EES/ES/GCP 002	Introduction to Environmental Science	3
EES/ES 004	The Science of Environmental Issues	1
ES 001	Introduction to Environmental Studies	4
ES 331	Environmental Law I: Pollution & Risk Abatement	4
ES 338	Environmental Risk	4
HIST 007	Technology in America's Industrial Age	4
HIST 008	Technology in Modern America	4
HIST 107	Technology and World History	4
HIST 111	Engineering in the Modern World	4
HIST 308	Industrial America since 1945	4
HIST/ES 315	American Environmental History	4
HIST/ASIA 340	Japanese Industrialization	4
IR 034	Society, Technology and War	4
IR/ES 333	International Environmental Law & Policy	4
IR/ES 343	Comparative Environmental Law & Policy	4
IR 344	International Politics of Oil	4
JOUR/ES 125	Environment, the Public and the Mass Media	4
PHIL/REL/HMS 116	Bioethics	4
PHIL 128	Philosophy Of Science	4
PHIL 228	Topics in the Philosophy of Science	4
PHIL/COGS 250	Philosophy of Mind	4
POLS/ES 105	Environmental Policy and Planning	4
POLS/ES 106	Environmental Values and Ethics	4
POLS/ES 107	The Politics of the Environment	4
POLS 115	Technology As Politics	4
POLS/ES 328	U.S. Politics and the Environment	4
POLS/ES 355	Environmental Justice and the Law	4
POLS/ES 375	Seminar: Green Polity	4
REL 006	Religion and Ecological Crisis	4
REL/WGSS 008	Prehistoric Religion, Art, and Technology	4
REL 187	Science, Technology, and the Religious Imagination	4
SSP/HMS 160	Medicine and Society	4
SSP 302	The Sociology Of Cyberspace	4
SSP/JOUR 327	Mass Communication and Society	4
THTR/ARCH 161	Performing Arts Venue Design and Technology	4

**Courses****STS 011 Technology and Human Values 4 Credits**

Impact of technology on society in relation to ethical problems raised by the exploitation of technological innovations. Illustrations from history, social studies, philosophy, literature, and film.

**Attribute/Distribution:** SS

**STS 012 Engineering and Society 4 Credits**

An examination of the social, political, commercial, and cultural factors that determine the problems engineers are asked to solve as well as the terms of acceptable solutions to those problems. This is a discussion-based course using a mix of books, articles, and videos.

**Attribute/Distribution:** SS

**STS 112 Engineering and Society 4 Credits**

An examination of the social, political, commercial, and cultural factors that determine the problems engineers are asked to solve as well as the terms of acceptable solutions to those problems. This is a discussion-based course using a mix of books, articles, and videos.

**Attribute/Distribution:** SS

**STS 117 Women, Science, and Technology 4 Credits**

Explores the impact of technology and science on women's social roles and the contribution of women engineers and scientists to their disciplines. Will focus on the American experience. Among the topics discussed are invention, design, laboratory research, education, engineering, professionalism, labor force participation, office mechanization, household appliances, virtual spaces, childcare and reproduction.

**Attribute/Distribution:** SS

**STS 118 History of Modern Medicine 4 Credits**

Introduction to Western medical history from the 18th century to the present day. Students will explore patient/practitioner relationships, examine changing ideas concerning health, sickness, and disease, chart changes in hospital care and medical education, and tackle topics such as eugenics, medical experimentation, and health insurance.

**Attribute/Distribution:** HU

**STS 124 Politics of Science 4 Credits**

Analysis of the multidimensional interaction between the federal government and the scientific community. Explores historical growth of the science-government connection, the scientific establishment both past and present, and the role of scientific advice to the White House and Congress. Also examines scientific ethics, public attitudes toward science, science-society interactions, and case studies of scientific controversies.

**Attribute/Distribution:** SS

**STS 145 Introduction to the History of Science 4 Credits**

The history of modern science, primarily physical and biological, with emphasis on the development of major theoretical models since the seventeenth century.

**Attribute/Distribution:** SS

**STS 181 Independent Study 1-4 Credit**

Consent of program director required.

**Attribute/Distribution:** ND

**STS 221 Materials in the Development of Man 3 Credits**

Development of materials technology and engineering from the Stone Age to Atomic Age as an example of the interaction between technology and society. In-class demonstration laboratories on composition and structure of materials. Term projects using archaeological materials and alloys. Course intended for, but not limited to, students in the humanities and secondary science education. Engineering students may not use this course for engineering science or technical elective credit.

**Attribute/Distribution:** SS

**STS 252 Computers, the Internet, and Society 3 Credits**

An interactive exploration of the current and future role of computers, the Internet, and related technologies in changing the standard of living, work environments, society and its ethical values. Privacy, security, depersonalization, responsibility, and professional ethics; the role of computer and Internet technologies in changing education, business modalities, collaboration mechanisms, and everyday life.

**Attribute/Distribution:** SS

**STS 323 Health and Environmental Controversies 4 Credits**

Exploration of health, and environmental controversies from the perspectives of scientific uncertainty and mass media coverage. Examines genetic engineering, biotechnology, environmental health risks, and nanotechnology. Includes discussion of ethical and social responsibilities and interactions with the public.

**Attribute/Distribution:** SS

**STS 341 Issues in American Competitiveness: At Home and Abroad 4 Credits**

Issues affecting American commercial competitiveness focusing on topics associated with the recent emergence of a new commercial environment in all First World societies. Team taught in a highly interactive setting with industry, public sector, and government experts, in addition to academics from various disciplines and institutions. Students read topical articles and books, participate in team projects and debates, and conduct team research on competitiveness issues they have chosen for a term report.

**Attribute/Distribution:** SS

**STS 381 Senior Seminar 4 Credits**

In-depth study of selected topics in science, technology, and society with special attention to methodological issues. Subject matter may vary from semester to semester. Intended for STS majors and minors, but open to others. Prerequisites as noted below or consent of program director.

**Prerequisites:** STS 011

**Attribute/Distribution:** SS

**STS 391 Honors Thesis 1 Credit**

Preparation for honors research thesis (STS 392). Identification of topic, preliminary compilation of source materials, and preparation of a proposal. Program permission required.

**Attribute/Distribution:** ND

**STS 392 Honors Thesis 3 Credits**

Directed undergraduate research thesis required of students who apply and qualify for graduation with program honors. Prerequisites as noted below.

**Prerequisites:** (STS 391)

**Can be taken Concurrently:** STS 391

**Attribute/Distribution:** ND

**STS 481 Readings in Science, Technology and Society 3 Credits**

Readings seminar on selected themes and topics in science, technology, and society. May be repeated for credit with permission of the program director.

**Repeat Status:** Course may be repeated.

**Sociology and Anthropology**

Web site: <http://cas.lehigh.edu/socanthro>. The department houses two disciplines, sociology and anthropology. Sociology is concerned with the study of human beings in relationships with others. Anthropology takes a holistic approach to the study of humans today and in the past, in a global, comparative, and multidimensional perspective. Together these disciplines encompass the study of the broadest range of human activities, from the comparative examination of widely divergent past and present cultures and societies, to the inner life of individuals as this influences social behavior, to an examination of the most pressing social issues of our time.

The offerings within the department seek to foster self and societal awareness as well as an understanding of what it means to be human. Instruction within the department also provides students with the necessary analytic skills to understand and conduct social research. Central to the department's major programs is training in research methods, statistics, and the use of computer applications in social science.

The department offers three bachelor of arts majors: anthropology, sociology and anthropology, and sociology/social psychology. The three programs are parallel in structure and requirements and each consists of 40 credit hours of course work. The sociology and anthropology major is an interdisciplinary program for students desiring a wider familiarity with social science fields, whereas the anthropology and sociology/social psychology majors are for students desiring more traditional, disciplinary programs of study.



**Research Opportunities**

It is the explicit aim of the department to involve majors, minors and other interested students in the ongoing research activities of faculty members. Second semester sophomore, junior and senior students interested in a supervised research experience are encouraged to consult with the chair or appropriate faculty member. Course credit can be received for research experience. ANTH 001

**Internship Opportunities**

The department maintains close working relationships with a variety of social agencies and institutions in the area. Majors can earn course credit by carrying out supervised work in field settings—see <http://lehigh.edu/socanthro> for more details. This experience allows a student to apply the concepts learned in the classroom to a field setting and to evaluate vocational aspirations and interests.

**Senior Thesis**

All majors are encouraged to do independent research culminating in a senior thesis; this is especially recommended for students intending to go on to graduate or professional school. The time to begin discussing possible projects with faculty is during the second semester of the junior year. The department chairperson should be consulted for further details. Our web site has additional information.

**Departmental Honors**

To be eligible for departmental honors, students must have at least a 3.5 GPA in the major. In addition, students pursuing honors must take ANTH or SSP 399 and write a thesis during their senior year. Awarding of departmental honors is contingent on both the quality of the thesis, as judged by a department committee, and the candidate's GPA at time of graduation.

**Professors.** John B. Gatewood, DA (University of Illinois Urbana); Judith N. Lasker, PhD (Harvard University); James R. McIntosh, PhD (Syracuse University); David B. Small, PhD (University of Cambridge); Cameron Wesson, PhD (University of Illinois Urbana)

**Associate Professors.** David Casagrande, PhD (University Georgia Athens); Heather Beth Johnson, PhD (Northeastern University); Jacqueline Krasas, PhD (University of Southern California); Ziad Wael Munson, PhD (Harvard University); Nicola B. Tannenbaum, PhD (Iowa State University)

**Assistant Professors.** Kelly F Austin, PhD (North Carolina State University); Bruce Whitehouse, PhD (Brown University); Yuping Zhang, PhD (University of Pennsylvania)

**Emeriti.** Roy C. Herrenkohl, Jr., PhD (New York University); Robert E. Rosenwein, PhD (University of Michigan Ann Arbor)

**B.A. Major Programs****Anthropology****Collateral Requirement**

Select one of the following general courses in statistics: 3-4

MATH 012	Basic Statistics <sup>1</sup>
ECO 045	Statistical Methods
PSYC 110	Statistical Analysis of Behavioral Data
Or equivalent	

**Introductory**

ANTH 001 Introduction to Anthropology 4

**Disciplinary Core Courses**

Select one of the following: 4

ANTH 111	Comparative Cultures (fall)
ANTH 140	Introduction to Linguistics (spring)

Select one of the following: 4

ANTH 112	Doing Archaeology (spring)
ANTH 145	Human Evolution (fall, alternate years)

**Methodology**

SOAN 111 Research Methods and Data Analysis (fall) 4

**Major Electives**

Select five anthropology courses <sup>2</sup> 20

**Research, Internship, or Thesis**

Select one of the following: <sup>3</sup> 4

ANTH 300	Apprentice Teaching
ANTH 393	Supervised Research
ANTH 394	Field School
ANTH 395	Internship
ANTH 399	Senior Thesis <sup>4</sup>

Total Credits 43-44

1 Note: MATH 012 fulfills the College of Arts and Sciences requirement.

2 At least two of which must be at the 300-level. Individualized study courses ANTH 300, ANTH 393, ANTH 394, ANTH 395, and ANTH 399 cannot be used to fulfill this requirement; however, one SSP course can be substituted as an anthropology elective.

3 Preferably during the senior year, majors must complete at least four credits of experiential learning on a subject or in a context relevant to their major. Students may fulfill this requirement in a variety of ways - research, field school, internship, or thesis.

4 Students who intend going on to graduate or professional school are strongly encouraged to do the senior thesis option, and a senior thesis is required for departmental honors.

**Sociology and Anthropology****Collateral Requirement**

Select one the following general courses in statistics: 3-4

MATH 012	Basic Statistics <sup>1</sup>
ECO 045	Statistical Methods
PSYC 110	Statistical Analysis of Behavioral Data
Or equivalent	

**Introductory**

SSP 001 Introduction to Sociology and Social Psychology 4

ANTH 001 Introduction to Anthropology 4

**Theory and Methodology**

SOAN 111 Research Methods and Data Analysis (fall) 4

SOAN 112 Development Of Social Theory (spring) 4

**Major Electives**

Select three courses in sociology/social psychology <sup>2,3</sup> 12

Select three courses in anthropology <sup>2,4</sup> 12

Total Credits 43-44

1 Note: MATH 012 fulfills the College of Arts and Sciences' mathematics requirement.

2 One of which must be at the 300-level.

3 Individualized study courses SSP 300, SSP 393, SSP 395, and SSP 399 can be taken as major electives but cannot be used to fulfill the 300 level course requirement.

4 Individualized study courses ANTH 300, ANTH 393, ANTH 394, ANTH 395, ANTH 395, and ANTH 399 can be taken as major electives but cannot be used to fulfill the 300 level course requirement.

**Sociology/Social Psychology****Collateral Requirement**

Select one of the following general courses in statistics: 3-4

MATH 012	Basic Statistics <sup>1</sup>
ECO 045	Statistical Methods
PSYC 110	Statistical Analysis of Behavioral Data
Or equivalent	

**Introductory**

SSP 001 Introduction to Sociology and Social Psychology (fall) 4

**Theory and Methodology**

SOAN 111 Research Methods and Data Analysis (fall) 4

SOAN 112	Development Of Social Theory (spring)	4
<b>Major Electives</b>		
Select five courses in sociology/social psychology <sup>2</sup>		20
<b>Research, Internship, or Thesis</b>		
Select one of the following: <sup>3</sup>		4
SSP 300	Apprentice Teaching	
SSP 393	Supervised Research	
SSP 395	Internship	
SSP 399	Senior Thesis <sup>4</sup>	
<b>Total Credits</b>		39-40

- <sup>1</sup> Note: MATH 012 fulfills the College of Arts and Sciences' mathematics requirement.)
- <sup>2</sup> At least two of which must be at the 300-level. Individualized study courses SSP 300, SSP 393, SSP 395 and SSP 399 cannot be used to fulfill this requirement; however, one ANTH course can be substituted as a "sociology/social psychology" elective.
- <sup>3</sup> Preferably during the senior year, majors must complete at least four credits of experiential learning on a subject or in a context relevant to their major. Students may fulfill this requirement in a variety of ways: supervised research, field school, internship, or thesis.
- <sup>4</sup> Students who go on to graduate or professional school are strongly encouraged to do the senior thesis option, and a senior thesis is required for departmental honors.

### Concentrations within the Anthropology Major

Anthropology majors may choose to concentrate in cultural or archaeological anthropology. These optional concentrations in one or the other subfield entail additional constraints on course selection within the major electives category, as described below.

#### Concentration in Cultural Anthropology

Anthropology majors electing to concentrate in cultural anthropology must complete at least four courses in cultural anthropology at the 100-level or above. Regular course offerings that would satisfy this concentration include the following:

Select at least four of the following:		16
ANTH 106	Cultural Studies and Globalization	
ANTH 111	Comparative Cultures	
ANTH 121	Environment and Culture	
ANTH 123	Anthropology of Gender	
ANTH 140	Introduction to Linguistics	
ANTH 182	North American Indians	
ANTH 187	Peoples and Cultures of Southeast Asia	
ANTH 305	Anthropology Of Fishing	
ANTH 320	Global Capitalism	
ANTH 325	Economic Anthropology	
ANTH 330	Food For Thought	
ANTH 335	Religion, Witchcraft And Magic	
ANTH 376	Culture and the Individual	
<b>Total Credits</b>		16

Students choosing this concentration are strongly encouraged to use their general education electives to complete at least two physical anthropology/archaeology courses; the equivalent of two years of foreign language study; pursue courses in museum studies, mathematics, computer science, philosophy, religion studies, literature, biology, and geology as specific interests dictate; and take a wide range of courses in the social sciences, generally, such as SSP 001, PSYC 001, POLS 003, IR 010, ECO 001, and history offerings.

#### Concentration in Archaeological Anthropology

Anthropology majors electing to concentrate in archaeological anthropology must complete at least four courses in archaeological anthropology at the 100-level or above. Regular course offerings that would satisfy this concentration include the following:

Select at least four of the following:		16
ANTH 112	Doing Archaeology	
ANTH 121	Environment and Culture	

ANTH 145	Human Evolution	
ANTH 172	North American Archaeology	
ANTH 174	Greek Archaeology	
ANTH 176	Roman Archaeology	
ANTH 178	Mesoamerican Archaeology	
ANTH 340	Archaeological Theory	
ANTH 370	Historical Archeology	
ANTH 377	Archaeology Of Death	
ANTH 394	Field School	
<b>Total Credits</b>		16

Students choosing this concentration are strongly encouraged to use their general education electives to complete at least three courses in cultural anthropology; pursue courses in museum studies, mathematics, computer science, history, and the social sciences as interests dictate; and take a wide range of natural science courses of special relevance to archaeologists.

### Minor Programs

#### Anthropology

ANTH 001	Introduction to Anthropology	4
Select four courses at 100 level or above in anthropology		16
<b>Total Credits</b>		20

#### Sociology and Anthropology

ANTH 001	Introduction to Anthropology	4
or SSP 001	Introduction to Sociology and Social Psychology	
Select two courses in sociology at the 100 level or above		8
Select two courses in anthropology at the 100 level or above		8
<b>Total Credits</b>		20

#### Sociology/Social Psychology

SSP 001	Introduction to Sociology and Social Psychology	4
Select four courses at 100 level or above in sociology/social psychology		16
<b>Total Credits</b>		20

### Graduate Courses in Sociology

The Master's Program in Sociology prepares students to apply sociological perspectives and methods to the analysis of social realities. Grounded in a strong theoretical and substantive understanding of social institutions, social relations, and social policy, as well as in advanced research and data analytic skills, students are prepared to be effective and experienced practitioners in the field of applied social research or to continue into doctoral studies in the field.

#### Sociology MA program

The Sociology MA program requires 30 hours of course work. Required courses are:

Quantitative Research	3
Statistics for Sociological Inquiry	3
Qualitative Research	3
Social Theory	3
Select six electives	18
<b>Total Credits</b>	30

All students take a comprehensive exam. Students choose whether to write a thesis.

#### Community Fellows Program

Applicants for the Sociology MA program may also choose to apply to the Community Fellows Program, a one year Master's Program in which students work for 15 hours a week in a non-profit organization as part of their academic experience. Please see the program website at [www.lehigh.edu/communityfellows](http://www.lehigh.edu/communityfellows).

**Anthropology Courses****ANTH 001 Introduction to Anthropology 4 Credits**

General introduction to the four subfields of anthropology: biological, archaeological, cultural, and linguistic. Class will center around lectures and discussion of ancillary media.

**Attribute/Distribution:** SS

**ANTH 100 Seminar in Anthropology 1-4 Credit**

Topics in anthropology. May be repeated for credit.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** SS

**ANTH 104 Contemporary Issues in African Societies 4 Credits**

Using an anthropological lens to engage issues confronting African societies today, we examine local-level ethnographic accounts and analyses on continent-wide trends, and consider a range of topics including famine, political violence, AIDS, poverty, and corruption. Where does Africa fit into the current neoliberal world order and what is the role "African culture" plays in shaping all these issues?.

**Attribute/Distribution:** SS

**ANTH 106 Cultural Studies and Globalization 4 Credits**

This course closely examines the complex relationship between culture and globalization. The impact of globalization on local culture is an essential topic. But the interaction of globalization and culture is not a one-way process. People around the world adapt globalization to their own uses, merging global cultural flows with local practices in transformative ways. The course will study the interaction of local culture with globalizing forces; immigration and culture; the localizing of mass culture; cultures of diasporic and migratory groups, and globalization, gender and identity.

**Attribute/Distribution:** SS

**ANTH 111 Comparative Cultures 4 Credits**

Anthropology is a comparative discipline; through comparisons we learn what is unique to a particular culture, what is shared among a number of cultures, and how trait, idea, practice or belief are related to each other. Students will learn how anthropologists do comparisons and do their own comparative research utilizing both qualitative and quantitative techniques.

**Attribute/Distribution:** SS

**ANTH 112 Doing Archaeology 4 Credits**

Principles of archaeological method and theory. Excavation and survey methods, artifact analysis, dating techniques, and cultural reconstruction. Course includes field project.

**Attribute/Distribution:** SS

**ANTH 121 Environment and Culture 4 Credits**

Impact of environment upon cultural variability and change. Comparative study of modern and past cultures and their environments as well as current theories of human/ environmental interaction.

**Attribute/Distribution:** SS

**ANTH 123 Anthropology of Gender 4 Credits**

Comparative study of the meanings and social roles associated with gender. Psychological, symbolic, and cultural approaches.

**Attribute/Distribution:** SS

**ANTH 140 Introduction to Linguistics 4 Credits**

Relationship between language and mind; formal properties of language; language and society; how languages change over time.

**Attribute/Distribution:** SS

**ANTH 145 Human Evolution 4 Credits**

Principles of biological anthropology focusing on the evolution of the human species. Topics include evolutionary theory, nonhuman primate diversity and behavior, the relationship between biology and behavior in evolutionary terms, the hominid fossil record, and genetic variability among contemporary human populations. Prerequisites as noted below.

**Prerequisites:** ANTH 001

**Can be taken Concurrently:** ANTH 001

**Attribute/Distribution:** NS

**ANTH 155 Health, Illness & Healing 4 Credits**

Introduction to medical anthropology, a field of study that examines how conceptions of illness and health and methods of healing vary over time and across cultures. Introduces a number of culturally specific approaches to health and illness, including Western Biomedicine, and aims to provide a broad understanding of the relationship between culture, illness, and healing.

**Attribute/Distribution:** SS

**ANTH 172 North American Archaeology 4 Credits**

Development of prehistoric North American indigenous population north of Mexico, beginning with earliest evidence of people in the New World continuing up through European contact.

**Attribute/Distribution:** SS

**ANTH 174 Greek Archaeology 3-4 Credits**

Ancient Greek culture from the Neolithic to Hellenistic periods. Reconstructions of Greek social dynamics from study of artifacts.

**Attribute/Distribution:** SS

**ANTH 176 Roman Archaeology 3 Credits**

Cultures of the Roman Empire. Reconstructions of social, political, and economic dynamics of the imperial system from study of artifacts.

**Attribute/Distribution:** SS

**ANTH 178 Mesoamerican Archaeology 4 Credits**

Ancient civilizations of Mesoamerica: Olmec, Zapotec, Maya, Toltec, and Aztec. Reconstructions of urban centers, political and economic organizations, and theories of the Mayan collapse.

**Attribute/Distribution:** SS

**ANTH 182 North American Indians 4 Credits**

Culture areas of native North America prior to substantial disruption by European influences north of Mexico. Environmental factors and cultural forms.

**Attribute/Distribution:** SS

**ANTH 183 Peoples and Cultures of Africa 4 Credits**

Studies African modernity through a close reading of ethnographies, social stories, novels, and African feature films.

**Attribute/Distribution:** SS

**ANTH 187 Peoples and Cultures of Southeast Asia 4 Credits**

Peoples and cultures of Burma, Laos, Cambodia, Thailand, Malaysia, Singapore, Indonesia, and the Philippines. World view, religion, economy, politics, and social organization.

**Attribute/Distribution:** SS

**ANTH 188 Southeast Asian Migrants and Refugees 4 Credits**

Focus on migrants and refugees from Southeast Asia to the United States; examines cultures and practices while in Southeast Asia, the migration process, and the ways in which the people and their cultural practices have changed in the United States.

**Attribute/Distribution:** SS

**ANTH 300 Apprentice Teaching 1-4 Credit**

**Repeat Status:** Course may be repeated.

**ANTH 305 Anthropology Of Fishing 4 Credits**

Comparative study of fishing peoples and their technologies. Fishing strategies, control of information, and social organization of marine exploitation in subsistence and modern industrial contexts. Theory of common property resources and the role of social science in commercial fisheries management.

**Attribute/Distribution:** SS

**ANTH 312 The Anthropological Signature of the Past 4 Credits**

Course covers the basic tenets of different anthropological analyses of premodern cultures. Emphasis on the archaeological traces of different social constructions in the past.

**Attribute/Distribution:** SS

**ANTH 320 Global Capitalism 4 Credits**

Anthropological approach to the forms and effects of global capitalism. Topics include the structure of contemporary global capitalism, including the growth of multinational corporations, flexible corporate strategies, overseas manufacturing, and global branding and marketing; the impact of global capitalism on the environment and on the lives of people in "Third World" countries; consumer culture and the diversity of non-Western consumption practices; alternative capitalist systems, especially Asian capitalisms.

**Attribute/Distribution:** SS

**ANTH 324 Globalization and Development in Africa 4 Credits**

Course examines the challenges Africa presents to expectations of modernization and development. Have African societies been left behind by globalization, shut out from it, or do they reflect an unexpected side of globalization processes? What is Africa's place in the neoliberal world order? What role does "African culture" play in generating or blocking social change? How can anthropology illuminate prospects for change on what has long been regarded as the "dark continent"?

**Attribute/Distribution:** SS

**ANTH 325 Economic Anthropology 4 Credits**

Cross-cultural perspectives on the ways people produce, distribute, and consume goods; how these systems are organized; and how they are connected with other aspects of society, particularly political and ideological systems.

**Prerequisites:** ANTH 001 or ANTH 011 or SSP 005 or SSP 021 or PSYC 021 or SSP 001

**Attribute/Distribution:** SS

**ANTH 330 Food For Thought 4 Credits**

Symbolic and cultural analyses of foods and cuisines. Examines what people eat, who prepares it, what it means, and the social and religious uses of foods historically and cross-culturally.

**Attribute/Distribution:** SS

**ANTH 335 Religion, Witchcraft And Magic 4 Credits**

Addresses broad questions about the roles that religion, magic, and witchcraft play in human life, as philosophical systems of meaning, as useful tools for understanding, and as practical and moral guides for human action. Special focus on the role of witchcraft and magic in the modern world, especially in the lives of disempowered people.

**Attribute/Distribution:** SS

**ANTH 337 Buddhism and Society 4 Credits**

The course approaches Buddhism as a lived tradition rather than as a textual tradition. We examine how Buddhist practices are integrated into local traditions and how religious practices become part of the larger social, political, and value systems. Societies examined include Thailand, Nepal, Japan, China, and the U. S. Students will develop a comparative framework that includes Theravada, Tibetan, and Zen Buddhism.

**Attribute/Distribution:** SS

**ANTH 339 Seminar In Anthropology 4 Credits**

Topics in anthropology. Varying semester to semester: human evolution, politics and law, introduction to linguistics, human use of space, anthropology of deviance. May be repeated for credit.

**Repeat Status:** Course may be repeated.

**Prerequisites:** ANTH 001 or ANTH 011 or SSP 005 or SSP 021 or PSYC 021 or SSP 001

**Attribute/Distribution:** SS

**ANTH 340 Archaeological Theory 4 Credits**

Explores important issues in the interpretation of archaeological material. Issues include variable utility of anthropological analogies, unevenness of data, reconstructions of past cultures, processual and post-processual approaches. Students will write a sample NSF proposal.

**Attribute/Distribution:** SS

**ANTH 352 Environmental Archaeology 4 Credits**

This course reviews the various categories of archaeological data used to examine the nature of past human-environmental relationships. We will explore how archaeologists use data to recognize anthropogenic and natural environmental changes, as well as cultural adaptations to local environments.

**Attribute/Distribution:** SS

**ANTH 370 Historical Archeology 3-4 Credits**

This course exams the unique nature of historical archaeology of post contact America. Topics include reconstructing the past through the archaeological and historical record, exhibiting past culture, and capturing the real or imagined past. Course includes fieldwork and visits to famous historical archaeological sites.

**Attribute/Distribution:** SS

**ANTH 371 Special Topics 1-4 Credit**

Advanced work through supervised readings. May be repeated for credit. Consent of department chair required.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** SS

**ANTH 376 Culture and the Individual 4 Credits**

Concepts and methods of studying relations between the individual and the sociocultural milieu. Culture and personality language and thought, cross-cultural studies of cognition.

**Attribute/Distribution:** SS

**ANTH 377 Archaeology Of Death 4 Credits**

Course examines what we can determine about the past from human remains. Class will study health, age, and disease from the analysis of human bone, the cultural aspects of burial and funerals, and take part in a field project in Nisky Hill Cemetery in Bethlehem.

**Attribute/Distribution:** SS

**ANTH 378 Blood, Pyramids, and the Tree of Life 4 Credits**

This course explores the ways of life of the Maya people. We will take a close look at their religion, their foods, their family life, music, medicine, festivals, etc. An important part of this class explores the long tradition of the Maya, making connections between the modern Maya and the Maya of their past.

**Attribute/Distribution:** SS

**ANTH 389 Honors Project 1-8 Credit****ANTH 393 Supervised Research 1-4 Credit**

Conducting anthropological research under the supervision of a faculty member. May be repeated for credit. Consent of department chair required.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** SS

**ANTH 394 Field School 1-8 Credit**

Field school in archaeology or ethnography. Maximum of eight credits for a single season or field experience. May be repeated once for credit.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** SS

**ANTH 395 Internship 1-4 Credit**

Supervised experience involving nonpaid work in a setting relevant to anthropology. May be repeated once for credit. Open only to department majors.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** SS

**ANTH 399 Senior Thesis 2-4 Credits**

Research during senior year culminating in senior thesis. Required for anthropology majors seeking departmental honors. May be repeated up to a total of 4 credits. Consent of department chair required.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** SS

**Sociology and Anthropology Courses****SOAN 041 Human Sexuality 4 Credits**

Sexuality and gender roles across the life cycle, including human reproduction, decision-making, and the societal regulation of sexual behavior.

**Attribute/Distribution:** ND

**SOAN 042 Sexual Minorities 4 Credits**

How minority sexual identities have been the subject of speculation, misunderstanding, and sometimes violent attempts at correction or elimination. Sexual orientation, gender role, including transvestism and "drag", transsexualism, sexism, heterosexism, and homophobia. Emphasis on critical thinking, guest speakers, and discussions.

**Attribute/Distribution:** SS

**SOAN 111 Research Methods and Data Analysis 4 Credits**

Research skills in anthropology, sociology and social psychology. Problem formulation; research design; methods and measures; analysis and interpretation of data. Emphasis on the use of statistics in the research process.

**SOAN 112 Development Of Social Theory 4 Credits**

This course introduces some of the most influential theoretical ideas in sociology. It focuses on understanding the differences among several classical theoretical traditions and their strengths and weaknesses in analyzing societies. It also helps students learn to apply social theory to contemporary sociological research and problems, learning the ways theory can be used to answer questions and problems societies face today.

**Attribute/Distribution:** SS

**SOAN 381 Development of Social Theory 4 Credits**

Comparative study of social theory.

**Attribute/Distribution:** SS

**Sociology/Social Psychology Courses****SSP 001 Introduction to Sociology and Social Psychology 4 Credits**

Patterns of social interaction, group behavior and attitudes provide a focus on the relationship of the individual to society. Social structure and social change within the institutions of society provide a focus on the relationship of society to the individual. The influences of social class, gender and race are explored at each level of analyses. Theories, methods and research results provide micro and macro models for understanding society.

**Attribute/Distribution:** SS

**SSP 100 Seminar in Sociology and Social Psychology 1-4 Credit**

Topics in sociology and social psychology. May be repeated for credit.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** SS

**SSP 103 Race And Ethnicity in the Contemporary U.S. 4 Credits**

Course examines race and ethnicity from a sociological perspective. Focus on the role of the major racial and ethnic communities in modern American society. Explores the roles of race and ethnicity in identity, social relations, and social inequality. Topics include racial and ethnic communities, minority/majority groups, assimilation, prejudice and discrimination, identity, and the social construction of the concept of "race."

**Attribute/Distribution:** SS

**SSP 104 Political Sociology 4 Credits**

An introduction to political sociology through an examination of the major sociological questions concerning power, politics, and the state. Covers questions concerning state formation, nationalism, social movements, globalization, political culture and participation, and civil society. Includes examples such as racism, welfare reform, campaign financing, coal mining in Appalachia, revolution in Latin America, the rise of the Nazi party in Germany, and the place of the United States in a global society.

**Attribute/Distribution:** SS

**SSP 105 Social Origins Of Terrorism 4 Credits**

Examines the social, religious, and political foundations of terrorism by studying the roots of terrorism historically and cross-nationally. We will look at the differing kinds of terrorism, including political terrorism in the Middle East, antiabortion terrorism in the United States, ecoterrorism, and religious and state terrorism throughout the world. Students will have a chance to better understand the beliefs of terrorists, conditions that produce and sustain terrorism, and the origins of political violence more generally.

**Attribute/Distribution:** SS

**SSP 106 Race and Ethnicity in Latin America and the Spanish Speaking Caribbean 4 Credits**

A sociological examination of race and a look at an individual's experience. We consider how concepts like "race" and "ethnicity" have been defined and how they have been institutionalized in law, government, social policy, social thought, and economic structures. We consider the importance of concepts like "race," "cultures," and "mestizaje" to our understanding of citizenship and national identity, and we address contemporary African and indigenous movements against racial inequality.

**Attribute/Distribution:** SS

**SSP 109 Adulthood and Aging 4 Credits**

Social science approaches to the latter two-thirds of the life. Cognitive and personality development; attitudes toward aging; social behavior of older adults; widowhood; retirement. Prerequisites as noted below. May not be taken pass/fail.

**Prerequisites:** (PSYC 001 or SSP 001)

**Attribute/Distribution:** SS

**SSP 110 Women's Work in Global Perspective 4 Credits**

This course brings to the forefront the intersections of race, class, gender, and nation with women's employment around the world. We will examine women's paid and unpaid work in the U.S., Europe, Asia, Latin America, and Africa in an effort to understand the striking persistence of gender inequality over time and across the world. Topics of study include: work and family relations, women's domestic labor, factory work, and agribusiness. In addition, we will explore the ways in which women have organized for changes in work and in their communities in order to conceive of possibilities for the future of women's work.

**Attribute/Distribution:** SS

**SSP 114 Social Issues in Contemporary China 4 Credits**

Dramatic economic, cultural and social changes are underway in China today and have aroused much debate among social scientists, East and West. The following social issues are critical for understanding China's development trajectory: inequality and poverty; rapid demographic shifts; provision of health care services; provision of education services; and becoming an "information society." We will explore how these issues intersect with old hierarchies in China, urban-rural differences, and gender differences.

**Attribute/Distribution:** SS

**SSP 121 Social Psychology 4 Credits**

Theories, methods of investigation and results of research on the way social and psychological processes interact in human behavioral settings. Topics include analysis of self and relationships, dynamics of small groups, attitudes and persuasion, prejudice, pro-social and antisocial behavior. Prerequisites as noted below.

**Prerequisites:** ANTH 001 or SSP 001 or PSYC 001 or SSP 005

**Attribute/Distribution:** SS

**SSP 125 Social Psychology of Small Groups 4 Credits**

Theories and empirical research regarding interpersonal behavior in small groups. Classroom exercises and group simulations.

**Attribute/Distribution:** SS

**SSP 126 The Political Economy of Globalization 4 Credits**

This course studies the relationship among economic, political and cultural forces in an era of globalization. Focus is on how global capitalism, the world market and local economics shape and are shaped by social, cultural and historical forces. Topics include political and cultural determinants of trade and investment; culture and the global economy; global capitalism, especially studied through the lens of culture; globalization and patterns of economic growth; cross-cultural study of consumerism; poverty and inequality; the interplay of foreign and domestic economic policy; international economic organizations, such as the World Trade Organization, the International Monetary Fund, and the World Bank, and globalization and national development.

**Attribute/Distribution:** SS

**SSP 128 Race, Gender, and Work 4 Credits**

Race, Gender and Work is a class designed to help students understand racial and gender inequalities as they relate specifically to work and employment. We explore the origins and histories of inequalities, the ways in which inequalities persist and/or change today, and what steps might be taken toward creating a more equal society.

**Attribute/Distribution:** SS

**SSP 135 Human Communication 4 Credits**

Processes and functions of human communication in relationships and groups.

**Attribute/Distribution:** SS

**SSP 141 Social Deviance and Social Control 4 Credits**

Analysis of deviant social systems, supporting factors maintaining them, and societal responses to deviant roles and collectivities.

**Attribute/Distribution:** SS

**SSP 144 Global Hip Hop and Social Change 4 Credits**

Hip Hop has become a global phenomenon. We will analyze how and why socially Conscious Hip Hop, as a tool for social change, has expanded to Latin America, Africa, and the Middle East.

**Attribute/Distribution:** SS

**SSP 152 Alcohol, Science, and Society 4 Credits**

Alcohol use and abuse, its historical function in society, moral entrepreneurship, status struggles and conflict over alcohol. Current problems with attention to special population groups and strategies for prevention of alcohol abuse.

**Attribute/Distribution:** SS

**SSP 153 Personality 4 Credits**

Examination of the major theoretical frameworks psychologists use to understand human thought, feeling, and behavior. Whereas these frameworks each emphasize very different concepts (e.g., the unconscious mind vs. culture vs. neurotransmitters), they are united in their effort to answer the question: Why does a given individual think, feel, or behave as she does? Prerequisites as noted below.

**Repeat Status:** Course may be repeated.

**Prerequisites:** PSYC 001 or SSP 001

**Attribute/Distribution:** SS

**SSP 155 Afro-Latino Social Movements in Latin America & the Caribbean 4 Credits**

This course focuses on Afro-Latinos who make up nearly 70% of the population of the Americas. Despite the large amount of people of African descent living in the Americas, Afro-Latinos are an understudied population who face significant amounts of racial discrimination in their countries. Who are Afro-Latinos? Where do they live? How are they challenging the racism that they face? These are questions we will tackle in this course.

**Attribute/Distribution:** SS

**SSP 160 Medicine and Society 4 Credits**

Health, illness, and the health professions from the sociological perspective. Social epidemiology, social psychology of illness, socialization of health professionals, organization of health care, patient-professional relationships and ethical issues in medical care.

**Attribute/Distribution:** SS

**SSP 162 AIDS and Society 4 Credits**

Impact of the AIDS epidemic on individuals and on social institutions (medicine, religion, education, politics, etc.); social and health policy responses; international experience; effect of public attitudes and policy on people affected directly by AIDS.

**Attribute/Distribution:** SS

**SSP 163 Pass The Peas: Mapping the Blueprint of Hip Hop Culture 4 Credits**

The appearance of the hip hop movement can be traced to a specific time and place, the Bronx, New York, 1974. However, hip hop has no single cultural antecedent. To uncover the origins of hip hop culture, one must begin by discovering the richly layered history of African American and Jamaican music of the 20th century. Using this broad canvas, students will discover how young Bronx natives in the 1970s fused elements of past musical styles with their own personal expression. From this point, the course will chart the expansion of hip hop culture from a five borough folk movement to a multimillion dollar entertainment industry in the late 20th century.

**Attribute/Distribution:** SS

**SSP 165 Contemporary Social Problems 4 Credits**

Studies of major problems facing contemporary society.

**Attribute/Distribution:** SS

**SSP 166 Wealth and Poverty in the United States 4 Credits**

Course examines the sociology of wealth and poverty affluence and disadvantage, "rags and riches" in American Society. Focus is a critical analysis of the wealth gap, its causes, consequences, and social context. We will consider the roles of wealth and poverty in determining life chances and structuring opportunity, as well as their roles in the perpetuation of social inequality across generations. We will address contemporary debates surrounding public policy, tax laws, antipoverty programs and other reform efforts aimed at decreasing the gap between the "Haves" and the "Have-Nots."

**Attribute/Distribution:** SS

**SSP 171 Religion And Society 4 Credits**

An introduction to the sociology of religion. Covers classical and contemporary approaches to defining and studying the role of religion in society. Emphasis on understanding religious beliefs and practices in the United States, the sources and contours of religious change, and the effects of religion on individuals and society. Specific topics include religious fundamentalism, religious conversion, religious practices and authority, secularization, religion in public life, religion in social change, religious terrorism, and the ways in which religion impacts our personal health, educational attainment, and family life.

**Attribute/Distribution:** SS

**SSP 177 Cuba: Race, Revolution and Culture 4 Credits**

This course analyzes the role of race & "culture" in the Afro Cuban struggle for equality. By focusing on the arts: particularly music, film & literature, this course will analyze the development of race during Cuba's colonial period; the Afro Cuban challenge to the "race blind" political and cultural movements of the Cuban Republic. We will then wrap up the semester by addressing the significance of contemporary cultural movements that challenge the social issues currently facing Afro Cubans.

**Attribute/Distribution:** SS

**SSP 300 Apprentice Teaching 1-4 Credit****SSP 302 The Sociology Of Cyberspace 4 Credits**

An examination of social life on the Internet and the World Wide Web. Topics may include sociocultural and psychological aspects of communication in cyber-environments (e.g., email, chat rooms, news groups, MUDS, etc.), interpersonal relationships and group development, the nature of community, the politics of cyberspace (control and democracy), privacy and ethics, and economic dimensions. Examination of past and current case studies.

**Attribute/Distribution:** SS

**SSP 310 Gender, Race, and Sexuality: The Social Construction of Differences 4 Credits**

This course will provide the student with an opportunity to engage current debates about the meaning and use of racial and sexual classification systems in society. Using a multi disciplinary approach, we will examine the historical and sociological contexts in which specific theories of racial and sexual differences emerged in the U.S. Additionally, we will explore the ways in which changes in the images have implications on the role racial, gender, and sexual identity plays in our understanding of the relationship between difference and inequality. Prerequisites as noted below or consent of instructor.

**Prerequisites:** SSP 103

**Attribute/Distribution:** SS

**SSP 313 Social Movements 4 Credits**

Explores the origins, dynamics, and consequences of social movements through both sociological theory and empirical case studies. Covers questions of what constitutes a social movement, where and when social movements arise, who joins a social movement, and how social movements are able to contribute to change. Answers to these questions highlight issues of social movement recruitment and leadership, interactions between movements and the media, the state, and the broader public, ideology, strategies and tactics, and the factors contributing to the success and failure of social movements. Course readings drawn from case studies on civil rights, women's rights, gay rights, the environment, American Indians, abortion, globalization, antiapartheid, democratization, peace, and Islamic fundamentalism. Must have completed one 100-level SSP course.

**Attribute/Distribution:** SS

**SSP 314 Social Cognition 4 Credits**

Examines the cognitive processes through which people make sense of social groups, individual others, themselves, and the world. Topics include judgment and decision making, attitudes and persuasion, ordinary personology, stereotyping and prejudice, and the self. Consent of department required. Prerequisites as noted below.

**Prerequisites:** SSP 121 or PSYC 121

**Attribute/Distribution:** SS

**SSP 317 Seminar in Globalization and Social Issues 4 Credits**

Advanced seminar that focuses on research and discussion of specialized topics in globalization and social issues. Subjects vary by semester. May be repeated for credit. Junior or senior standing and departmental permission required.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** SS

**SSP 322 Global Health Issues 4 Credits**

Sociological dimensions of health, illness, and healing as they appear in different parts of the world. Focus on patterns of disease and mortality around the world, with special emphasis on major epidemics such as HIV/AIDS, and malaria; the relative importance of 'traditional' and 'modern' beliefs and practices with regard to disease and treatment in different societies; the organization of national health care systems in different countries; and the role of international organizations and social movements in promoting health.

**Attribute/Distribution:** SS

**SSP 323 The Child In Family and Society 4 Credits**

Influences such as marital discord, family violence, poverty and prejudice on the development of the child from birth through adolescence. Prerequisites as noted below.

**Prerequisites:** (ANTH 001 or SSP 001)

**Attribute/Distribution:** SS

**SSP 325 History of Sexuality and the Family in the U.S. 3,4 Credits**

Changing conceptions of sexuality and the role of women, men, and children in the family and society from the colonial to the post-World War II era. Emphasis on the significance of socioeconomic class and cultural background. Topics include family structure, birth control, legal constraints, marriage, divorce, and prostitution.

**Attribute/Distribution:** SS

**SSP 326 Social Class in American History 3-4 Credits**

Changing role of women, minority groups, and the family during the industrial era. Development of the modern class structure and the impact of the welfare state.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** SS

**SSP 327 Mass Communication and Society 4 Credits**

A review of theories and research on the relationship of mass communication to social processes. Intensive analysis of selected media products (e.g., TV news, dramas, and sitcoms; films; print; music videos, etc.). Prerequisites as noted below or consent of instructor.

**Prerequisites:** ANTH 001 or SSP 001

**Attribute/Distribution:** SS

**SSP 328 Global Food Systems 4 Credits**

Where does our food come from? How does it get to our tables? Why are there famines in some parts of the world and obesity epidemics in other parts of the world? This course will investigate these questions by focusing on food systems – the chains of social action that link food producers to food consumers. We will also explore a range of alternatives to global food systems that emphasize food democracy, security, and sustainability.

**Attribute/Distribution:** SS

**SSP 329 Global Migration 4 Credits**

International migration is transforming societies at both the global and national levels, and in both origin and destination areas. Why do people move? What are the consequences of these movements? We will investigate the political and economic explanations for international migration and explore how each act of migration contributes to the transnationalization of social relations, alters existing livelihoods, transforms economic production and social support arrangements, and recreates racial, ethnic, and national identities.

**Attribute/Distribution:** SS

**SSP 330 Society, Democracy and Revolution in Latin America 4 Credits**

Latin America is a region filled with protest and armed guerrilla movements. Since the fall of the Soviet Union in 1989, at least 5 nations in the region elected openly socialist or communist candidates, many of whom are still in power today. What is happening in Latin America? This course will focus on Latin American perspectives on democracy and social revolution. For many Latin American countries, the move to the 'left,' and the rejection of American capitalism is not that Latin American people embrace socialism, but rather it is a reflection of larger social dynamics at play... or is it?

**Attribute/Distribution:** SS

**SSP 331 Gendered Experience of Globalization 4 Credits**

Women and men experience globalization differently and globalization affects women in different cultural and national contexts. Gender stratification has been intensified by the transnational flow of goods and people. Course provides students with a survey of new development in feminist theories on globalization and on gender stratification and development, and links these theoretical frameworks to empirical research about gender issues that have become more prominent with globalization.

**Attribute/Distribution:** SS

**SSP 333 Social Psychology of Politics 4 Credits**

Political behavior viewed from a psychological and social psychological perspective. Prerequisite ANTH 1 or SSP 1; PSYC 1 or department permission.

**Prerequisites:** (ANTH 001 or SSP 001 or PSYC 001)

**Attribute/Distribution:** SS

**SSP 341 Women and Health 4 Credits**

Relationships of women to the medical system. Influence of medicine on women's lives and the impact of the women's movement on health care.

**Prerequisites:** ANTH 001 or ANTH 011 or ANTH 012 or SSP 005 or SSP 021 or PSYC 021 or SSP 001

**Attribute/Distribution:** SS

**SSP 345 Colonialism and the Black Radical Tradition 4 Credits**

Karl Marx was not the only figure who developed an influential theory of social revolution. A cadre of theorists from the Global South have extensively theorized about the issues facing their particular nations, and they have developed social theories that have challenged social and global inequality. This theory-based course will focus on the anti-colonial and post-colonial thought of radical black intellectuals from the Black America, the Caribbean, and West Africa.

**Attribute/Distribution:** SS

**SSP 351 Gender and Social Change 4 Credits**

Changes in gender roles from social psychological and structural perspectives. Comparative analyses of men and women (including people of color) in the social structure; their attitudes and orientations toward work, family, education, and politics.

**Attribute/Distribution:** SS

**SSP 355 Sociology Of Education 4 Credits**

Course examines the social organization of education as a social institution and the role of schools in society. Focus is primarily on educational processes in the United States. Topics include: IQ, curriculum, tracking, educational inequality, primary/secondary/higher education, private vs. public, informal education and social capital, effects on and of race/class/gender, schools as agents of socialization, educational policy and school reform. Prerequisites as noted below or consent of instructor.

**Prerequisites:** (ANTH 001 or SSP 001)

**Attribute/Distribution:** SS

**SSP 356 Seminar in Personality Psychology 4 Credits**

Topics in personality psychology: the self, personality consistency, motivation, psychological adjustment. Prerequisites as noted below or consent of instructor.

**Prerequisites:** PSYC 153 or SSP 153

**Attribute/Distribution:** SS

**SSP 361 Personality and Social Development in Adulthood 4 Credits**

Theories and current research. Prerequisites as noted below or consent of instructor.

**Prerequisites:** SSP 109 or PSYC 109

**Attribute/Distribution:** SS

**SSP 363 Personality and Social Development in Childhood 4 Credits**

Issues related to social development (e.g., attachment, social competence), social contexts (e.g., family, day care), and personality development (e.g., sex roles, aggression, temperament) from infancy through adolescence. Prerequisites as noted below or consent of instructor.

**Prerequisites:** (PSYC 107)

**Attribute/Distribution:** SS

**SSP 364 Sociology of the Family 3-4 Credits**

Sociological analysis of families in the United States, including investigations of historical and contemporary patterns. Issues addressed include parenting, combining work and family, divorce and remarriage, family policies.

**Prerequisites:** ANTH 001 or ANTH 011 or ANTH 012 or SSP 005 or SSP 021 or PSYC 021 or SSP 001

**Attribute/Distribution:** SS

**SSP 365 Inequalities at Work 4 Credits**

Primary focus is on race, gender, and class as axes of disadvantage and privilege in work and employment. We will explore both theories and empirical studies of inequality as well as their social, political, and practical ramifications for the workplace. The course will be conducted seminar-style and the class will rely heavily on student participation.

**Attribute/Distribution:** SS

**SSP 366 Sociology of Aging 4 Credits**

Residential patterns, social policies and services for the aged. Alternative political strategies, health programs, living arrangements and workplace choices considered. The changing roles of the elderly in American and other societies, and the special problems they face. Impact of changing age structure.

**Attribute/Distribution:** SS

**SSP 371 Special Topics 1-4 Credit**

Advanced work through supervised readings. May be repeated for credit. Consent of department chair required.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** SS

**SSP 373 Seminar In Sociology 4 Credits**

Intensive consideration of selected topics in contemporary theory or research in sociology. The subject matter varies from semester to semester. May be repeated for credit.

**Repeat Status:** Course may be repeated.

**Prerequisites:** ANTH 001 or ANTH 011 or SSP 005 or SSP 021 or PSYC 021 or SSP 001

**Attribute/Distribution:** SS

**SSP 374 Social Stratification: Race, Class, Gender 3 Credits**

This course is an introduction to social stratification. Examines social inequality as an organizing principle in complex societies. Explores the intersection of the "great divides" of race, class, and gender. Through readings from classical sociological theory to cutting-edge literature we embark on a critical analysis of the causes and consequences of social stratification and social mobility in the United States and in a global context. Prerequisites as noted below.

**Prerequisites:** ANTH 001 or SSP 001

**Attribute/Distribution:** SS

**SSP 375 The Christian Right In America 4 Credits**

What do we know about the Christian Right? Who are they? What do they believe? Where do they come from? Seminar explores answers to such questions through a focus on the history of the Christian Right as well as its ideologies and beliefs, the people who are a part of it, and its evolving relationship to the American political system. Topics include some of the most divisive social issues of our time: abortion, homosexuality, capital punishment, pornography, taxes, education, and the separation of church and state. Must have completed one 100-level SSP course.

**Attribute/Distribution:** SS

**SSP 379 Race and Class in America 4 Credits**

This course focuses on the ways in which race and class intersect in the social, economic, and political structures of American society. Through sociological literature, fiction, nonfiction, film, and other media we will explore the place of race and class in American society. We will examine how race and class operate on a personal, "micro" level, while at the same time operating on a large scale, "macro" level. Prerequisites as noted below or consent of instructor.

**Prerequisites:** SSP 103 or AAS 103

**Attribute/Distribution:** SS

**SSP 389 Honors Project 1-6 Credit**

**Repeat Status:** Course may be repeated.

**SSP 391 Evaluation Research 3 Credits**

Application of social research methods of evaluation of the effectiveness of social programs. Measurement, research design, criteria of effectiveness and decision making. Prerequisites as noted below or consent of department chair.

**Prerequisites:** SR 111

**Attribute/Distribution:** SS

**SSP 393 Supervised Research 1-4 Credit**

Conducting sociological or social psychological research under the supervision of a faculty member. May be repeated for credit. Consent of department chair required.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** SS

**SSP 395 Internship 1-4 Credit**

Supervised experience involving nonpaid work in a setting relevant to sociology/social psychology. May be repeated once for credit. Open only to department majors.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** SS



**SSP 399 Senior Thesis 2-4 Credits**

Research during senior year culminating in senior thesis. Required for sociology/social psychology majors seeking departmental honors. May be repeated up to a total of 4 credits. Consent of department chair required.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** SS

**SSP 401 Classical Social Theory 3 Credits**

Explores influential sociological theory, the differences among classical theoretical traditions, the main strengths and weaknesses of such traditions. Emphasis is placed on understanding the uses of theory in research, and the implications of theoretical models when applied to contemporary research and problems.

**SSP 402 Sociology of Cyberspace 3 Credits**

The course focus is on case-based discussion in the social psychology and sociology of the Internet and the World Wide Web. Questions of what it means to be an individual online, how relationships develop, the nature of groups, democracy and power, and education are considered.

**SSP 403 Sociology Of Cyberspace 3 Credits**

The course focus is on case-based discussion of the social psychology and sociology of the Internet and the World Wide Web. Questions of what it means to be an individual online, how relationships develop, the nature of groups, democracy and power, and education are considered. Evaluation is based on short papers related to the cases and assigned readings, both in hard copy and online.

**SSP 410 Statistics for Sociological Inquiry 3 Credits**

Principles of statistical inference including hypothesis testing and analysis of variance. Covers univariate and multivariate techniques, including probability, correlation, test statistics, and regression. Emphasis is on the choice of proper approaches to answer research questions and the interpretation of analysis results.

**SSP 411 Advanced Research Methods, Part I: Quantitative 3 Credits**

Study of quantitative methods of data collection and analysis, measurement and research design issues at an advanced level. Prerequisites as noted below.

**Prerequisites:** SOAN 111

**SSP 412 Adv Research Methods, Part II, Qualitative 3 Credits**

Study of a variety of qualitative methods for social research and of qualitative data analysis techniques.

**SSP 413 Research Practicum 3-6 Credits**

Supervised research, either with a faculty member or in a community agency, designed to apply research skills to a particular problem as defined by the faculty member or agency in collaboration with the student and supervising instructor. Final paper should demonstrate theoretical understanding, proper application of methodology and data analysis, and results of the project.

**SSP 415 Case Studies Of Social Control 3 Credits**

Social control leads to social order and also generates social deviance. The processes involved in this dual production are found in the formal institutions of society and in the informal patterns of interaction within groups. Macro and micro level approaches are explored, especially in the drug and alcohol area.

**SSP 418 Gendered Experience of Globalization 3 Credits**

Women and men experience globalization differently and globalization affects women in different cultural and national contexts. Gender stratification has been intensified by the transnational flow of goods and people. Course provides students with a survey of new development in feminist theories on globalization and on gender stratification and development, and links these theoretical frameworks to empirical research about gender issues that have become more prominent with globalization.

**SSP 419 Global Food Systems 3 Credits**

Where does our food come from? How does it get to our tables? Why are there famines in some parts of the world and obesity epidemics in other parts of the world? This course will investigate these questions by focusing on food systems – the chains of social action that link food producers to food consumers. We will also explore a range of alternatives to global food systems that emphasize food democracy, security, and sustainability.

**Attribute/Distribution:** SS

**SSP 420 Global Migration 3 Credits**

International migration is transforming societies at both the global and national levels, and in both origin and destination areas. Why do people move? What are the consequences of these movements? We will investigate the political and economic explanations for international migration and explore how each act of migration contributes to the transnationalization of social relations, alters existing livelihoods, transforms economic production and social support arrangements, and recreates racial, ethnic, and national identities.

**SSP 441 Women and Health 3 Credits**

Relationships of women to the medical system. Influence of medicine on women's lives and the impact of the women's movement on health care.

**Attribute/Distribution:** SS

**SSP 454 Urban Education: Inequality and Public Policy 1-4 Credit**

Social inequality is found throughout American Society but problems of inequality related to education have perhaps received more attention than those of any other contemporary social institution. Researchers, scholars, journalists, social critics, and observers have studied, written, and talked about educational inequality to an enormous extent. Social service organizations, activists, policymakers, legal professionals, and government officials have focused massive reform efforts and political agendas to tackle inequality in education. Many sociologists have long viewed education not just as an arena of inequality but as the solution to the widespread inequalities they see reflected in society. Urban education has been an especially complex and controversial subject of scrutiny in recent scholarly and popular debates. This course will focus with a sociological perspective on urban education, inequality, and public policy in the contemporary United States. The first portion of the course examines research and literature relevant to the contemporary social problems of urban education and inequality. The second portion of the course will explore the role of public policy in perpetuating educational inequality, and as a potentially promising solution to it.

**SSP 461 Seminar In Sociology 1-4 Credit**

Topics vary.

**SSP 465 Inequalities at Work 3 Credits**

Primary focus is on race, gender, and class as axes of disadvantage and privilege in work and employment. We will explore both theories and empirical studies of inequality as well as their social, political, and practical ramifications for the workplace.

**Attribute/Distribution:** SS

**SSP 471 Special Topics 1-3 Credit**

Intensive study in an area of sociology that is appropriate to the interests and needs of staff and students.

**SSP 472 Special Topics 1-3 Credit**

Continuation of SSP 471.

**SSP 473 Social Basis Of Human Behavior 3 Credits**

Development of human behavior from a social psychological perspective. Emphasis placed on the impact of society upon school-age children and adolescents.

**SSP 476 Issues In Health Policy Analysis 3 Credits**

Sociological analyses of health care and health care policy issues of current concern in American and other societies. Application of analytic frameworks to several major issues such as organization and financing of services, effects of aging populations on needs, impact of new diseases and of new technologies. Students will analyze selected health care problems faced by local communities.

**SSP 477 Advanced Computer Applications 3 Credits**

Uses of computers in social sciences, including data collection, management, and analysis, simulations, and decision-making; includes weekly lab.

**SSP 490 Master's Thesis 1-6 Credit****South Mountain College**

Joan Ramage Macdonald, *program director*

South Mountain College is a residential academic program in the College of Arts and Sciences that unites a community of students and faculty in the exploration of intellectually exciting and practically significant topics of investigation. Students in South Mountain College are challenged to assume responsibility for their educations and make connections across disciplinary barriers. Assisted by core faculty – along with faculty and staff ‘friends’ of the program – South Mountain students also draw from the curricular resources and intellectual capital of the University. South Mountain College consists of a physical place (a dedicated residence), a curriculum (a unique set of courses and activities), and an intellectual community. Its guiding philosophy is that the problems and conundrums which confront us as individuals and as citizens are so thoroughly interconnected that our only hope of disentangling them is through creative, critical and comparative thinking across the full range of academic disciplines, and beyond. More information about South Mountain College as well as information about application procedures can be found at the program’s web site (<http://lehigh.edu/smc>).

Participation in South Mountain College (SMC) involves a one-year residential commitment in its dedicated living space, pursuit of a traditional Lehigh major, enrollment in SMC courses (described below), participation in SMC activities such as the annual planning retreats and extracurricular events, and completion of free electives to meet University graduation requirements. Students work closely with their traditional major advisors, faculty within SMC, and peers having a range of experience in the program. As outcomes of their South Mountain College experience, students will experience a strong liberal-arts education focused on the connections across disciplines, and they will gain tangible skills in critical analysis, grappling with complex issues and problems, and managing their own work and that of others to make timely progress on difficult issues.

Students who have joined South Mountain College will spend roughly one third of their credits pursuing a traditional major, one third sampling free electives, and one third in the formal South Mountain College curriculum. This curriculum has two components, augmented by formal and informal extracurricular activities and events. First, in all semesters, students will join a section of an ongoing multidisciplinary seminar devoted to the discussion and analysis of important ideas; in consultation with their faculty mentor, students will participate in selecting both the topics to be considered and the works through which to examine them. Second, in all semesters, students will work either in groups or alone on investigations related to one of the annual South Mountain themes chosen by the faculty and student community in a May retreat. Again, the nature of this work, how goals will be achieved, and what products or end-result is desired will be determined by students working with faculty mentors devoted to each theme. A strong focus on writing and communication skills is an important part of both the South Mountain College Seminar and Investigations courses, and the theme-based work is aimed at concrete outcomes no matter what path a student or group of students chooses to take in working on the theme.

When taking free electives or courses in their declared major, South Mountain College students earn letter grades and accrue a grade-point average like any other Lehigh student. However, in SMC courses, letter grades are not used and students simply earn credit towards graduation if they successfully complete the course (a notation of “CR” will appear on their transcript). In lieu of letter grades, for each offering of each course, students receive a narrative assessment provided by their instructor, and these assessments become part of their permanent record. To continue in South Mountain College, students must remain in good academic standing in the University and also in good standing within the program.

Students admitted to the program have most College requirements waived for them, including the first-year English Composition sequence, the first-year College Seminar, the junior writing-intensive requirement, and distribution requirements (in Math, Natural Sciences, Social Sciences, and Arts and Humanities). They do need to complete one of the majors offered by the College, meet all South Mountain College requirements, and take free electives to meet the graduation requirement of at least 120 credits. In principle the program is open to students from other colleges at Lehigh, but they would have to meet all major and graduation requirements for their College and degree program in addition to SMC requirements.

Students can apply to South Mountain College in parallel with application for admission to Lehigh and participate in the program throughout their four years at the University. It is possible to join the program after the first year, and interested students should contact the program office for information about procedures. Students who choose to leave the program before graduation can do so without penalty, given that they will already be completing a major and accruing credits towards graduation; students in this situation should contact the SMC Director for information about returning to the traditional Lehigh curriculum.

**Degree Requirements for South Mountain College**

1. Residence in South Mountain College housing for at least 2 semesters.
2. Participation in the annual planning retreats, each year (usually in May and in August before First-Year orientation)
3. Completion of a Lehigh B.A. or B.S. major (Note: most B.S. majors will require careful planning in order to meet all requirements in a timely fashion)
4. Completion of free electives, so as to meet the minimum University graduation requirement of 120 credits.
5. Maintenance of good standing in the South Mountain College program.
6. Completion of the South Mountain College Curriculum (40 credits)

**First Year**

<b>Fall</b>	<b>CR Spring</b>	<b>CR</b>
SMC 050	3 SMC 050	3
SMC 010	2 SMC 010	2
Free Electives	10 Free Electives	10
	<b>15</b>	<b>15</b>

**Second Year**

<b>Fall</b>	<b>CR Spring</b>	<b>CR</b>
SMC 200	2 SMC 200	2
SMC 250	3 SMC 250	3
Free Electives	10 Free Electives	10
	<b>15</b>	<b>15</b>

**Third Year**

<b>Fall</b>	<b>CR Spring</b>	<b>CR</b>
SMC 200	2 SMC 200	2
SMC 250	3 SMC 250	3
Free Electives	10 Free Electives	10
	<b>15</b>	<b>15</b>

**Fourth Year**

<b>Fall</b>	<b>CR Spring</b>	<b>CR</b>
SMC 200	2 SMC 200	2
SMC 250	3 SMC 250	3
Free Electives	10 Free Electives	10
	<b>15</b>	<b>15</b>

Total Credits: 120

Notes: Two credits of SMC Seminar are required each semester a student is enrolled on-campus, for a total of up to 16 credits. Three credits of SMC Investigation is required each semester a student is enrolled on-campus for a total of 24. Students who are involved in Study Abroad or other off-campus activities may request a waiver from the South Mountain courses for that semester. South Mountain College

encourages students to take advantage of opportunities like Study Abroad and will assist students in developing a program that works.

#### Courses

##### **SMC 010 South Mountain College Seminar 2 Credits**

The subject of this multidisciplinary seminar is the critical analysis of significant ideas. Each offering is organized around the discussion of books, articles, compositions, performances, films, and artworks selected by the students in consultation with their faculty mentor; sources will be drawn from across disciplines. May include associated workshops that provide a special focus on writing and communication skills. This course is intended for first-year students in the SMC program, and meets concurrently with SMC 200. May be repeated once for credit.

**Repeat Status:** Course may be repeated.

##### **SMC 050 South Mountain College Investigations 3 Credits**

Studies related to the annual theme, involving work across disciplines by members of South Mountain College. Can involve individual or group work, weekly meetings and discussions, and written, artistic, technical or other work as required to explore or make progress on the issue under study. The advising and mentoring associated with this course include coverage equivalent to Arts 100 (Choices and Decisions). This course is intended for first-year students in the SMC program, and meets concurrently with SMC 250. May be repeated once for credit.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** ND

##### **SMC 200 South Mountain College Advanced Seminar 2 Credits**

The subject of this multidisciplinary seminar is the critical analysis of significant ideas. Each offering is organized around the discussion of books, articles, compositions, performances, films, and artworks selected by the students in consultation with their faculty mentor; sources will be drawn from across disciplines. May be repeated for credit. May be taken by non-South Mountain students dependent on available space, by permission.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** ND

##### **SMC 250 South Mountain College Advanced Investigations 3 Credits**

Studies related to the annual theme, involving work across disciplines by members of South Mountain College. Can involve individual or group work, weekly meetings and discussions, and written, artistic, technical or other work as required to explore or make progress on the issue under study. May be repeated for credit.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** ND

#### **Sustainable Development**

**Program Director: Mark Orrs, Professor of Practice (Columbia University)**

**Email: [mark.orr@lehigh.edu](mailto:mark.orr@lehigh.edu) # Phone: 610-758-2533**

**Website: <http://sdp.cas2.lehigh.edu/>**

*Supported by the Office of Interdisciplinary Programs 610-758-3996; [incasip@lehigh.edu](mailto:incasip@lehigh.edu)*

Students of any discipline who are interested in helping solve the triple bottom line challenge of their generation: economic well-being, environmental protection, and social inclusion, are invited to join with like-minded students to collaborate in devising and implementing solutions to real-world challenges of Sustainable Development (SDEV).

#### **Minor in Sustainable Development**

The minor in SDEV consists of a minimum of at least 15 hours of study that includes a combination of core courses and approved electives. Minors are required to complete a total of 8 core credits (SDEV 010, SDEV 201 and SDEV 202) or (SDEV 010 and SDEV 203). The remaining 7 credits may be selected from the Additional Course Electives listed below or in consultation with the Program Director. Completion of ECO 001 is a prerequisite for enrollment in the Sustainable Development minor, except for those for whom the program director waives the prerequisite.

To declare a minor in Sustainable Development, students must complete a minor declaration form ([http://catalog.lehigh.edu/coursesprogramsandcurricula/artsandsciences/sustainabledevelopment/Sustainable\\_Development\\_Minor\\_Declaration\\_Form.pdf](http://catalog.lehigh.edu/coursesprogramsandcurricula/artsandsciences/sustainabledevelopment/Sustainable_Development_Minor_Declaration_Form.pdf)).

#### **Core Courses**

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SDEV 010 & SDEV 201 & SDEV 202	Challenges of Sustainable Development and Sustainable Development Solutions, I and Sustainable Development Solutions, II
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or

SDEV 010 & SDEV 203	Challenges of Sustainable Development and Research in Sustainable Development
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#### **Additional Core Electives**

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ECO 203	Microfinance: Financial Inclusion for the Poor
ENTP 307	International Social Entrepreneurship
SDEV 122	Sustainable Dev:CR Experience
SDEV 372	Independent Study in Sustainable Development
ANTH 305	Anthropology Of Fishing
ANTH 324	Globalization and Development in Africa
SSP 328	Global Food Systems

#### **Courses**

##### **SDEV 010 Challenges of Sustainable Development 4 Credits**

History and principles of sustainable development, including their application to projects in both rich and poor countries. Survey of current environmental, social and economic challenges to sustainable development. Philosophy and ethics of external intervention for poverty alleviation and green development, especially in poor societies. Integrated approaches to sustainable development practice, including the inter-relationship of the health sciences, natural sciences, social sciences and management.

**Attribute/Distribution:** SS

##### **SDEV 122 Sustainable Dev:CR Experience 3 Credits**

Investigation of the concept of sustainable development as currently being practiced in Costa Rica. Case studies in diverse areas (e.g. agriculture, bio-prospecting, ecotourism, energy, and land use) demonstrate how current approaches to sustainable development are influenced by the history and ecology of Costa Rica, as well as the structure of its political, social, and economic systems. Attention to theories of sustainable development and of consumption help to frame the Costa Rican experience. Students maintain individual "sustainability" journals based on their experiences from which they draw for team-based research and writing projects. The course is offered through Lehigh Abroad and consists of 5 evening classes during the fall semester and required course travel to Costa Rica between the fall and winter semesters (approximately 18 days). Final course projects are due early in the spring semester. Course participation will require additional fees as described by Lehigh Abroad (airfare and program fee). Prerequisites as noted below.

**Prerequisites:** SDEV 010

**Attribute/Distribution:** SS

**SDEV 201 Sustainable Development Solutions, I 2-4 Credits**

Projects practicum in which cross-disciplinary teams of 5-6 students focus on understanding the context of a particular NGO amidst the broader social, economic, and scientific challenges to sustainable development. Analytic techniques for designing, implementing and evaluating projects. Nuts and bolts of development practice. Teams work on needs assessment related to their NGO's proposed goals and devise innovative solutions for implementing development projects. On-the-ground field experience, whether international or domestic, is required. Course fee may apply. Oral presentations and written reports. Prerequisites as noted below.

**Prerequisites:** SDEV 010

**Attribute/Distribution:** SS

**SDEV 202 Sustainable Development Solutions, II 2-4 Credits**

Continuation and extension of projects begun in SDEV 201. Refine implementation strategies and develop project evaluation protocol. Oral presentations and written reports. Prerequisites as noted below.

**Prerequisites:** SDEV 201

**Attribute/Distribution:** SS

**SDEV 203 Research in Sustainable Development 2-4 Credits**

Students will work on sustainable development research projects not involving field work. May be repeatable for a maximum of 4 credits. Consent of instructor required. Prerequisites as noted below.

**Repeat Status:** Course may be repeated.

**Prerequisites:** SDEV 010

**Attribute/Distribution:** SS

**SDEV 372 Independent Study in Sustainable Development 1-4 Credit**

Opportunity for students to pursue individual sustainable development projects or continue work begun in SDEV 201/202. May not count towards minor's credit requirements. Prerequisites as noted below. Consent of department required.

**Prerequisites:** SDEV 010

**Attribute/Distribution:** HU, SS

**Theatre**

To study theatre is to examine its many internal disciplines. Acting and directing combine with design, technical theatre, dramatic literature and theatre history to form the body of our art. Students may pursue general theatre studies or focus on particular areas such as performance, design or history and literature. They may major in theatre, minor in theatre or participate strictly in our production program. Students may even complete a minor in theatre from outside the College of Arts and Sciences.

The bachelor of arts degree in theatre is granted after at least 48 credit hours of study. Because we believe that undergraduate theatre education should be broad based with an emphasis on diversity of experience, students are encouraged to take a variety of courses outside the major. Many students complete double majors. Those with the talents and aspirations for a career in theatre have gone to graduate schools offering intense, pre-professional training. Other majors who have not pursued a theatrical career have gone from our program directly into careers in business, social services, sales. Theatre study is an excellent preparation for vocations in which self presentation is important, such as law. The problem solving, analytical and interpersonal skills gained from this discipline are applicable across a wide range of careers. An understanding and appreciation of the complex art of the theatre will enrich a lifetime.

The department's active production program is curricular and promotes collaborative projects involving students, faculty, staff and guest artists. Our large performance facility is the Diamond Theater, a 300-seat thrust theatre housed in the Zoellner Arts Center. The core of our work in this space is dedicated to productions featuring primarily student actors directed by faculty or guest artists. When possible, a highly qualified student may direct or design in this space. In addition to our own productions, we regularly invite outside professional performers and ensembles to work with us and perform. We also operate a lab theatre (Zoellner's Black Box Theatre) for student and faculty experimentation. The availability of valuable hands-on experience and the very close working relationships developed between students and faculty uniquely

characterize the department of theatre. The department enjoys a special relationship with Bethlehem's professional theatre company, Touchstone Theatre. Performance and administrative internships with the company are available to qualified students and the department and Touchstone often collaborate on workshops and seminars.

Students interested in designing a major or minor in theatre should consult with the department chairperson. Experienced theatre students with questions regarding accurate placement in any theatre course should, likewise, consult with the chairperson.

Lehigh University is an accredited institution of the National Association of Schools of Theatre.

**Professors.** Erica Hoelscher, MFA (Northwestern University); Jeffrey R. Milet, MFA (Yale University); Pam Pepper, MFA (Ohio University); Augustine Ripa, Jr., MFA (Northwestern University)

**Associate Professor.** Kashi K. Johnson, MFA (University of Pittsburgh)

**Assistant Professors.** Melpomene Katakalos, MA (University of California San Diego); Darius Williams, PhD (Ohio State University)

**Theatre Major**

Through the selection of appropriate electives, students may concentrate their major in one of these areas:

- Acting/Directing
- Design/Technical Theatre
- Theatre History/Dramatic Literature
- General Theatre Studies

The major in theatre consists of 48 hours distributed as follows:

**Coursework required of all majors**

THTR 001	Introduction To Theatre	4
THTR 060	Dramatic Action	4
THTR 087	Design for the Theatre	4
THTR 127	The Development of Theatre and Drama I	4
THTR 128	The Development of Theatre and Drama II	4
Acting, any appropriate level		4
THTR 315	Senior Study	0

**Production Requirement**

Select four of the following: <sup>1</sup>		8
THTR 020	Stagecraft I	
THTR 021	Stagecraft II	
THTR 022	Stage Properties and Decoration	
THTR 023	Basic Scene Painting	
THTR 025	Costume Construction I	
THTR 026	Costume Construction II	
THTR 027	Lighting Technology and Production I	
THTR 028	Lighting Technology and Production II	
THTR 030	Sound Technology and Production I	
THTR 031	Sound Technology and Production II	
THTR 035	Performance	
THTR 045	Stage Management	
THTR 067	Stage Crew	
THTR 068	Costume Crew	
THTR 069	Lighting Crew	
THTR 175	Special Projects	

**Electives**

Select four courses with an advisor, emphasizing depth or breadth of study

Total Credits 48

<sup>1</sup> Advanced courses may be substituted.

**Recommended electives from other departments**

The departments of art and architecture, English, modern languages and literature, music and others all offer courses of value to a theatre major or minor. Consult with your advisor about enriching your academic career outside the theatre department.

**Theatre Minor**

The minor in theatre consists of at least 22 hours of course work selected in consultation with a departmental advisor. This includes at least five courses (18-20 hrs) and two semesters in theatre production totaling at least 4 credits. Fulfill the production requirement through an approved production-oriented course. An approved minor in theatre will include some academic diversity beyond a single curricular area.

**Departmental Honors**

The exceptional student may elect to pursue departmental honors in the senior year. This student must have a GPA of 3.3 in all theatre courses presented for the major. No later than the fall of the senior year the student, with faculty supervision, elects a special project in a particular area of theatre. This may take the form of preparing to direct a play, researching a role to be performed, preparing a design presentation or researching in an area of theatre scholarship in preparation for the writing of a substantial report. In the next semester, usually the spring of the senior year, the report or project would be executed. The student would enroll in two, four-credit independent study courses, one each senior semester.

**The Acting Sequence**

Students with little or no prior acting experience should elect THTR 011, Introduction to Acting, as their first course. Students with some prior acting experience should consult with the department chairperson for accurate placement and waiver of the THTR 011 prerequisite.

**Courses****THTR 001 Introduction To Theatre 4 Credits**

Foundations of theatre: historical, literary and practical.

**Attribute/Distribution:** HU

**THTR 011 Introduction To Acting 4 Credits**

Preparation for scene study and characterization.

**Attribute/Distribution:** HU

**THTR 020 Stagecraft I 2 Credits**

Introduction to the art of scenic construction and technical theatre. Scenic construction materials, techniques, tools, rigging and safety. Practical experience in executing scenery for the stage.

**Attribute/Distribution:** HU

**THTR 021 Stagecraft II 2 Credits**

A continuation of THTR 20 – Stagecraft I. Specialty tools, materials, methods and problem-solving. Practical experience in executing scenery for the stage. Prerequisites as noted below.

**Prerequisites:** THTR 020

**Attribute/Distribution:** HU

**THTR 022 Stage Properties and Decoration 2 Credits**

Creating props and decor for the stage. Production assignment as assistant property master.

**Attribute/Distribution:** HU

**THTR 023 Basic Scene Painting 2 Credits**

Painting for the stage. Production assignments painting with scenic artist.

**Attribute/Distribution:** HU

**THTR 025 Costume Construction I 2 Credits**

Introduction to the art of costume construction. Costume construction materials, techniques, tools and safety. Practical experience in executing costumes for the stage.

**Attribute/Distribution:** HU

**THTR 026 Costume Construction II 2 Credits**

Continuation of THTR 25 - Costume Construction I, including pattern drafting, fitting, crafts and accessories. Materials, methods and problem solving. Practical experience in executing costumes for the stage. Prerequisites as noted below.

**Prerequisites:** THTR 025

**Attribute/Distribution:** HU

**THTR 027 Lighting Technology and Production I 2 Credits**

Introduction to the art of lighting technology and production. Lighting techniques, tools and safety. Practical experience in executing lighting for the stage.

**Attribute/Distribution:** HU

**THTR 028 Lighting Technology and Production II 2 Credits**

Specialty equipment, methods and problem solving. Practical experience in programming the lighting console for production. Assignment as light board operator on a production.

**Attribute/Distribution:** HU

**THTR 030 Sound Technology and Production I 2 Credits**

Introduction to the art and technology of sound reinforcement. Audio theory, methods and practice. Practical experience in executing audio technical support for the stage.

**Attribute/Distribution:** HU

**THTR 031 Sound Technology and Production II 2 Credits**

Advanced techniques of sound technology and production. Specialty equipment, methods and problem solving. Practical experience in systems engineering, design implementation and trouble shooting. Assignment as sound engineer on production. Prerequisites as noted below.

**Prerequisites:** THTR 030

**Attribute/Distribution:** HU

**THTR 035 Performance 2 Credits**

Performing in a department-approved production. May be repeated for credit.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**THTR 045 Stage Management 2 Credits**

Organization, scheduling, coordination of various production specialties. Production assignment as assistant stage manager.

**Attribute/Distribution:** HU

**THTR 054 Greek Tragedy 3 Credits**

Aspects of Greek theater and plays of Aeschylus, Sophocles, and Euripides in their social and intellectual contexts.

**Attribute/Distribution:** HU

**THTR 056 Jazz Dance 2 Credits**

Jazz dance styles and combinations. May be repeated for credit. Fee required.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**THTR 057 Modern Dance 2 Credits**

Modern dance styles and combinations. May be repeated for credit. Fee required.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**THTR 058 Greek and Roman Comedy 4 Credits**

Study of comedy as a social form through plays of Aristophanes, Menander, Plautus, and Terence.

**Attribute/Distribution:** HU

**THTR 060 Dramatic Action 4 Credits**

How plays are put together; how they work and what they accomplish. Examination of how plot, character, aural and visual elements of production combine to form a unified work across genre, styles and periods. Recommended as a foundation for further studies in design, literature, or performance.

**Attribute/Distribution:** HU

**THTR 065 Introduction to Playwriting 4 Credits**

An introduction to writing for the stage, with an emphasis on creating characters, maintaining tone, shaping metaphor, and using the resources available to theatre artists to a writer's best advantage. This course combines in-class exercises with seminar-style discussion of the student's work.

**Attribute/Distribution:** HU

**THTR 067 Stage Crew 2 Credits**

Production run crew assignment. Can be repeated for credit.

**Repeat Status:** Course may be repeated.

**Prerequisites:** (THTR 020)

**Attribute/Distribution:** HU

**THTR 068 Costume Crew 2 Credits**

Production run crew assignment in wardrobe, hair and makeup. Can be repeated for credit.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**THTR 069 Lighting Crew 2 Credits**

Production run crew assignment as master electrician. Can be repeated for credit. Permission of instructor.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**THTR 077 Ballet 2 Credits**

Classical ballet for beginners and those who have had some training. May be repeated for credit. Fee required.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**THTR 087 Design for the Theatre 4 Credits**

Introduction to the process of creating integrated designs in theatre production. The study and practice of the principles of visual representation, historical and conceptual research and the study of theatrical styles. SPRING.

**Attribute/Distribution:** HU

**THTR 111 Sound Design 2 Credits**

Techniques, materials, and methods of designing sound for theatrical production.

**Attribute/Distribution:** HU

**THTR 127 The Development of Theatre and Drama I 4 Credits**

Survey of Western theatre and dramatic literature from ritual origins to the Renaissance.

**Attribute/Distribution:** HU

**THTR 128 The Development of Theatre and Drama II 4 Credits**

Survey of Western theatre and dramatic literature from the renaissance to the present.

**Attribute/Distribution:** HU

**THTR 129 History of Fashion and Style 4 Credits**

Dress and culture in the Western Hemisphere from pre-history to today. The evolution of silhouette, garment forms and technology. The relationship of fashion to politics, art and behavior. Cultural and environmental influences on human adornment.

**Attribute/Distribution:** HU

**THTR 130 Drafting For The Theatre 4 Credits**

Theatre drafting techniques and conventions. Material, methods and theory in stage graphics. Model building techniques and practice. An introduction to computer drafting.

**Attribute/Distribution:** HU

**THTR 132 Hip Hop Theatre 4 Credits**

Introduction to the creation and performance of Hip Hop theatre. Exploration of the history and culture of Hip Hop through original written material, live performance, music, film, video and web based content. Public performances. Must audition. Consent of instructor required.

**Attribute/Distribution:** HU

**THTR 135 Playwriting II 4 Credits**

For students interested in continuing and deepening their writing for the stage. Instructor approval required.

**Attribute/Distribution:** HU

**THTR 140 African American Theatre 4 Credits**

Studies in African American theatre: literary, and practical and historical. May be repeated for credit.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**THTR 144 Directing 4 Credits**

Introduction to the theatrical director's art. Research, rehearsal techniques, scene work. Prerequisites as noted below or consent of chairperson.

**Repeat Status:** Course may be repeated.

**Prerequisites:** (THTR 060)

**Attribute/Distribution:** HU

**THTR 145 Advanced Stage Management 1-4 Credit**

Advanced application, practice, and leadership development of stage management role and skills: production assignment as stage manager.

**THTR 147 Acting Modern Realism 4 Credits**

Characterization and scene study in modern realistic drama e.g. Ibsen, Chekov, O'Neill, Hellman, Miller and Williams. Prerequisites as noted below.

**Prerequisites:** THTR 011

**Attribute/Distribution:** HU

**THTR 148 Acting Contemporary Drama 4 Credits**

Characterization and scene study in modern contemporary drama.

Prerequisites as noted below.

**Prerequisites:** THTR 011

**Attribute/Distribution:** HU

**THTR 152 Stage Make-up 4 Credits**

Theatrical make-up techniques for the actor and designer.

**Attribute/Distribution:** HU

**THTR 154 Scene Painting 4 Credits**

Study and practice of basic and advanced methods of painting for the theatre. Includes basic elements and principles of design, color theory, the influence of light, atmosphere and aesthetics for the theatre.

**Attribute/Distribution:** HU

**THTR 161 Performing Arts Venue Design and Technology 4 Credits**

Designing theatres. Theatre equipment systems and acoustics. Function and form. (

**Attribute/Distribution:** HU

**THTR 175 Special Projects 1-4 Credit**

Theatrical topics of current or special interest. Can be repeated for credit.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**THTR 181 Theater Management 3 Credits**

Concepts, techniques and practices related to managing the theatrical enterprise.

**Attribute/Distribution:** HU

**THTR 185 Production Seminar 1-4 Credit**

Practicum in various approaches to theatre production, e.g. performance ensemble. Must audition, or consent of the chairperson required. Can be repeated for credit.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**THTR 186 Lighting Design 4 Credits**

An introduction to the art and practice of lighting design for the theatre. Script analysis, research, and the interplay of lighting technology and design. Students will develop a sense of the dramatic while creating a portfolio of lighting designs. Prerequisites as noted below.

**Prerequisites:** THTR 087 or DES 087

**Attribute/Distribution:** HU

**THTR 188 Scenic Design 4 Credits**

An introduction to the art and practice of scenic design for the theatre. Script analysis, research, drafting and modeling techniques. Students will develop a sense of the dramatic while creating a portfolio of scenic designs. Prerequisites as noted below.

**Prerequisites:** THTR 087 or DES 087

**Attribute/Distribution:** HU

**THTR 189 Costume Design 4 Credits**

An introduction to the art and practice of costume design for the theatre. Script analysis, research, and rendering techniques. Students will develop a sense of the dramatic while creating a portfolio of costume designs. Prerequisites as noted below.

**Prerequisites:** THTR 087 or DES 087

**Attribute/Distribution:** HU

**THTR 222 Readings in Non-Realism 4 Credits**

Through close readings and analysis of a variety of non-realistic play scripts, this class catalogs what a grammar of non-realism might look like. Students will conduct close readings of non-realistic scripts that make use of the grammar available to the writer writing for the stage.

**Attribute/Distribution:** HU

**THTR 236 Acting Presentational Styles 4 Credits**

Elements of characterization and scene study in presentational dramatic literature from classical through post-modern periods. Must have completed 100-level acting course, or consent of chairperson required.

**Prerequisites:** THTR 147 or THTR 148

**Attribute/Distribution:** HU

**THTR 244 Acting Shakespeare 4 Credits**

Monologue scene study and ensemble work from Shakespeare's dramatic and poetic canon. Must have completed a 100-level acting course.

**Attribute/Distribution:** HU

**THTR 245 Advanced Directing 4 Credits**

Continuation of Theatre 144. The director's voice. Supervised practical experience. Prerequisites as noted below.

**Prerequisites:** (THTR 144)

**Attribute/Distribution:** HU

**THTR 253 Scene Painting II 4 Credits**

Applied advanced scene painting methods for the theatre. Shop management for the scenic artist. Collaboration with designers and stage technology. Prerequisites as noted below.

**Prerequisites:** (THTR 153)

**Attribute/Distribution:** HU

**THTR 255 The Collectively Devised Text 4 Credits**

This class explores theater as a vehicle for civic engagement. Theater artists as varied as Moises Kaufman, the Civilians, Cornerstone, Culture Clash and Caryl Churchill have worked on scripts that were devised either in whole or in part collectively. Students will outline a plan for choosing a theme, identifying stakeholders, generating text and either writing or shepherding a full-length script to completion. Instructor approval required.

**Attribute/Distribution:** HU

**THTR 260 Design Practicum 1-4 Credit**

Scenic, costume, lighting or sound design for the theatre. Realized design production assignments and portfolio building. Collaboration, process and presentation. Consent of department required. Repeatable for credit.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**THTR 275 Internship 1-4 Credit**

Professionally supervised work in theatres and theatrical organizations in the areas of performance, design, technical theatre, theatre administration and management. May be repeated for credit. Consent of department chair required.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** ND

**THTR 300 Apprentice Teaching 1-4 Credit**

**Repeat Status:** Course may be repeated.

**THTR 315 Senior Study 0 Credits**

Seminar for senior theatre majors. Enhancement of current theatre studies while preparing for further theatre studies or activity.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** ND

**THTR 328 Shakespeare 3,4 Credits**

An introduction to Shakespearean drama including comedies, histories, tragedies, and romances. Emphasis on textual study, cultural contexts, and performance strategies.

**Attribute/Distribution:** HU

**THTR 347 Advanced Characterization in Realism 4 Credits**

A continuation of THTR 147 for the advanced acting student.

**Attribute/Distribution:** HU

**THTR 348 Advanced Characterization in Expressionism 4 Credits**

A continuation of THTR 148 for the advanced acting student.

**Prerequisites:** THTR 148

**Attribute/Distribution:** HU

**THTR 351 Advanced Special Projects 1-8 Credit**

Independent study in theatre. Consent of department chair required. Can be repeated for credit.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**THTR 387 Scenography II 0 Credits**

Advanced projects in theatrical design. Portfolio readiness and resume preparation. Prerequisites as noted below.

**Prerequisites:** (THTR 087 or DES 087) and (THTR 186 or DES 186 or THTR 188 or DES 188 or THTR 189 or DES 189)

**Attribute/Distribution:** HU

**THTR 389 Honors Project 1-8 Credit**

**Repeat Status:** Course may be repeated.

**Women, Gender, and Sexuality Studies**

**Program Director:** Jackie Krasas, Ph.D. (U. of Southern California)

**Email:** [jkr205@lehigh.edu](mailto:jkr205@lehigh.edu) **Phone:** 610-758-5119

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*Supported by the Office of Interdisciplinary Programs 610-758-3996; [incasip@lehigh.edu](mailto:incasip@lehigh.edu)*

The Women, Gender, and Sexuality Studies Program has several major goals: to expand students' understanding of women's present status and rich history; to stimulate a critical examination of sex/gender and sexuality systems with regard to social institutions and individual lives; to develop in students an integrative analysis in which gender is multifaceted, diverse, and embedded in a matrix of power relations including (but not limited to) race, class, sexuality, and nationality. Women, Gender, and Sexuality Studies draws on multi- and interdisciplinary perspectives including: history, literatures, cultural studies, the arts, the social sciences, and science. In the best tradition of a liberal arts education, Women, Gender, and Sexuality Studies encourages women and men to think critically and constructively, to redesign knowledge, and to gain a better understanding of themselves and their world. Women, Gender, and Sexuality Studies offers an undergraduate minor, and undergraduate major, and a graduate certificate.

**Undergraduate Major in Women, Gender, and Sexuality Studies**

The Women, Gender, and Sexuality Studies BA will provide students an in depth education in an interdisciplinary field of academic inquiry that critically examines the diverse realities of women's lives and the ways in which gender and power differentials shape human lives and human societies. WGSS pursues a fundamental critique of knowledge by challenging the basic assumptions, methods of inquiry, theoretical frameworks, and knowledge claims of traditional fields of inquiry that have thought it unimportant to study women, gender, or sexuality. WGSS seeks to create new paradigms of knowledge and inquiry, to develop more truthful and comprehensive understandings of humans and our world, and to explore nonsexist alternatives for more richly human lives and more fully human social orders.

The WGSS major requires 38-40 credits of coursework and is designed to complement other areas of study within CAS in order to facilitate double-majors for our students. WGSS majors can stand alone; however, many students find the major an invaluable asset as part of

a double major. The major will have a core curriculum, a concentration (social sciences or humanities), electives, and a senior experience.

### Major Core Courses

Major Core Courses		
WGSS 001	Women & Men in Society (SS)	4
WGSS/HIST 124	Women in America (SS)	4
WGSS 350	Seminar in Feminist Theory (ND)	4
Global/Diversity (select one of the following) <sup>1</sup>		4
WGSS/SOAN 042	Sexual Minorities (SS)	
WGSS/ASIA/GCP/MLL 073	Film, Fiction, and Gender in Modern China (HU)	
WGSS/SSP 110	Women's Work in Global Perspectives (SS)	
WGSS/ANTH 123	Anthropology of Gender (SS)	
WGSS/SSP 128	Race, Gender and Work (SS)	
WGSS/REL 138	Women in Jewish History (HU)	
WGSS/AAS 145	African American Women Writers (HU)	
WGSS/AAS/SSP 310	Gender, Race, and Sexuality: The Social Construction of Differences (SS)	
WGSS/SPAN/LAS 326	Tradition and Resistance: Women Writers of Latin America (HU)	
WGSS/FREN 327	Women Writing in French (HU)	
WGSS/LAS/GS 342	Gender and Third World Development	
WGSS/SSP 365	Inequalities at Work (SS)	

### Major Concentration

Students must concentrate in Social Science or Humanities	8
Select two courses in Social Science or Humanities <sup>2,3</sup>	

### Major Non-concentration

Select one of the following: <sup>2</sup>	4
One social science course if humanities concentration	
One humanities course if social sciences concentration	

### Major Electives

Select any combination of social science and humanities courses <sup>2</sup>	8
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### Major Senior Experience

Select one of the following:	2-4	
WGSS 271	Independent Reading and Research (HU/SS)	
WGSS 330	Internship in Women, Gender and Sexuality Studies (SS)	
WGSS 373	Internship in Women's Center (SS)	
WGSS 399	Senior Thesis (ND)	

Total Credits	38-40
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<sup>1</sup> Cannot be double-counted in categories.

<sup>2</sup> See list of Social Science and Humanities courses below.

<sup>3</sup> Required Social Science Courses choose any 2 from the social science list for a total of 8 credits; OR Required Humanities Courses choose any 2 from the humanities list for a total of 8 credits.

### Social Science Courses

Or any other course cross-listed with WGSS that carries a SS designation:

WGSS/SOAN 041	Human Sexuality (ND)	4
WGSS/SOAN 042	Sexual Minorities (SS)	4
WGSS/SSP 110	Women's Work in Global Perspectives (SS)	4
WGSS/HIST/STS 117	Women, Science, and Technology (SS)	4
WGSS/ANTH 123	Anthropology of Gender (SS)	4
WGSS/SSP 128	Race, Gender and Work (SS)	4
WGSS/POLS 179	Politics of Women (SS)	4

WGSS/ENTP 232	Gender Issues in Entrepreneurship (Gender Issues in Entrepreneurship)	4
WGSS/AAS/SSP 310	Gender, Race, and Sexuality: The Social Construction of Differences (SS)	4
WGSS/PSYC 318	Seminar in Gender and Psychology (SS)	4
WGSS/HIST/SSP 325	History of Sexuality and the Family in the U.S. (SS)	3-4
WGSS/HMS/PSYC 334	The Psychology of Body Image and Eating Disorders (SS)	4
WGSS/HMS/SSP 341	Women and Health (SS)	4
WGSS 350	Seminar in Feminist Theory (ND)	4
WGSS/SSP 351	Gender and Social Change (SS)	4
WGSS/SSP 364	Sociology of the Family (SS)	3-4
WGSS/SSP 365	Inequalities at Work (SS)	4
WGSS 091	Special Topics (ND)	1-4
WGSS 191	Special Topics (ND)	1-4
WGSS 272	Special Topics (ND)	1-4
WGSS 291	Special Topics (ND)	1-4
WGSS 371	Special Topics (ND)	1-4
WGSS 381	Special Topics (ND)	1-4
WGSS 382	Special Topics (ND)	1-4
WGSS 391	Special Topics (ND)	1-4
WGSS 392	Special Topics (ND)	1-4

### Humanities Courses

Or any other course cross-listed with WGSS that carries a HU designation:

WGSS/REL 008	Prehistoric Religion, Art, and Technology (HU)	4
WGSS/ASIA/GCP/MLL 073	Film, Fiction, and Gender in Modern China (HU)	4
WGSS/ART 121	Women in Art (HU)	4
WGSS/DES/THTR 129	History of Fashion and Style (HU)	4
WGSS/REL 138	Women in Jewish History (HU)	4
WGSS/AAS 145	African American Women Writers (HU)	4
WGSS/REL 184	Religion, Gender, and Power (HU)	4
WGSS/PHIL 226	Feminism and Philosophy (HU)	4
WGSS/LAS/SPAN 275	Introduction to Hispanic Women Writers (HU)	4
WGSS/GERM/MLL 303	Grimms' Fairy Tales: Folklore, Feminism, Film (HU)	4
WGSS/ENGL 311	Gender and Literature (HU)	3-4
WGSS/SPAN 326	Tradition and Resistance: Women Writers of Latin America (HU)	4
WGSS/FREN 327	Women Writing in French (HU)	4
WGSS/LAS/SPAN 346	Contemporary Hispanic Women Writers: The Novelists (HU)	4
WGSS 350	Seminar in Feminist Theory (ND)	4
WGSS 091	Special Topics (ND)	1-4
WGSS 191	Special Topics (ND)	1-4
WGSS 272	Special Topics (ND)	1-4
WGSS 291	Special Topics (ND)	1-4
WGSS 371	Special Topics (ND)	1-4
WGSS 381	Special Topics (ND)	1-4
WGSS 382	Special Topics (ND)	1-4
WGSS 391	Special Topics (ND)	1-4
WGSS 392	Special Topics (ND)	1-4

### Honors in Women, Gender, and Sexuality Studies

In order to receive honors in Women, Gender, and Sexuality Studies, the student must attain a 3.5 grade-point average in courses presented for the major and a 3.2 grade-point average overall, and must take WGSS 399 and write a thesis during their senior year.



**Undergraduate Minor in Women, Gender, and Sexuality Studies**

The minor in WGSS engages students in the study of three interrelated subjects. The first is an examination of the cultural, historical, and social experiences and contributions of women. The second is an exploration of gender (the social construction of differential identity for males and females) and of the ways in which gender distinctions shape human consciousness and human society. The third is an examination of sex/gender and sexuality systems.

Nearly all academic disciplines have defined human nature and significant achievement in terms of male experience and have underestimated the impact of gender on social structures and human lives. By contrast, WGSS courses attend to women's diverse experiences and perspectives and acknowledge the critical significance of gender and sexuality. By shifting the focus to women, gender, and sexuality, WGSS seeks to provide an alternative paradigm for understanding human experience. Students in WGSS courses are encouraged to reevaluate traditional assumptions about human beings, human knowledge, and human culture and society, and to explore nonsexist alternatives for a more fully human social order.

The minor in WGSS consists of a minimum of 18 credit hours. Students pursuing the minor are required to take the introductory course (WGSS 001) and one upper-level course from among those concerned with the theory and practice of women, gender, and sexuality studies. Courses completed must include at least one course in the arts and humanities and one course in the natural and social sciences. Students arrange their program in consultation with the program director.

**Undergraduate Minor**

WGSS 001	Women & Men in Society	4
Select 2 credits from following:		2
WGSS 271	Independent Reading and Research	
WGSS 330	Internship in Women, Gender and Sexuality Studies	
WGSS 373	Internship in Women's Center	
Select one 300-level course <sup>1</sup>		4
Select two electives or new course as approved <sup>1</sup>		8
<b>Total Credits</b>		<b>18</b>

<sup>1</sup> One course must be HU and one course must be SS

**Graduate Certificate in Women, Gender, and Sexuality Studies**

The Graduate Certificate in WGSS is designed as a complement to a disciplinary graduate program or as a standalone post-baccalaureate course of study. The Certificate is a small, flexible program that provides students with breadth and the challenge of working outside their home discipline in concentrated interdisciplinary study of women and gender. In recognition of contemporary educational and employment contexts that are increasingly diverse and international, the WGSS Program offers the graduate certificate as a means to enrich academic, personal, and employment horizons. A certificate in WGSS will be especially beneficial to those who wish to incorporate a broader perspective into their teaching (either in secondary or higher education), and qualifies them for positions that require such expertise. Additionally, individuals interested in fields such as social policy, human resources, and business will also gain from understanding how gender operates at individual, organizational, and institutional levels. Students will work closely with outstanding faculty from diverse disciplinary backgrounds.

**Basic Requirements**

WGSS 450	Seminar in Feminist Theory	3
Select three additional courses <sup>1,2</sup>		9
<b>Total Credits</b>		<b>12</b>

<sup>1</sup> 2 courses outside home department (for matriculating students)

<sup>2</sup> No more than 6 credits at the 300-level

**Admissions**

Students in degree programs must be in good standing in their programs and are encouraged to apply early in their course of studies. Non-degree students must hold a bachelor's degree or equivalent with a 3.0 GPA.

**Course Descriptions**

In addition to these courses, new courses may be offered annually. Students should check with the director for an updated list.

**Courses****WGSS 001 Women & Men in Society 4 Credits**

The course introduces students to key concepts, theoretical frameworks, and interdisciplinary research in the field of Women's and Gender Studies. Examines how gender interacts with race, age, class, sexuality, etc., to shape human consciousness and determine the social organization of human society. The course may include topics such as: gender and work; sexuality and reproduction; women's health; media constructions of gender and race; gender, law, and public policy.

**Attribute/Distribution:** SS

**WGSS 008 Prehistoric Religion, Art, and Technology 4 Credits**

Origins and early development of religions, with focus on interactions of religion, art, and technology in the Paleolithic and Neolithic periods. Special attention to the emergence of patriarchal social forms and the figure of the goddess. Interdisciplinary methods with a consideration of feminist theories of cultural development.

**Attribute/Distribution:** HU

**WGSS 041 Human Sexuality 4 Credits**

Sexuality and gender roles across the life cycle, including human reproduction, decision-making, and the societal regulation of sexual behavior.

**Attribute/Distribution:** ND

**WGSS 042 Sexual Minorities 4 Credits**

How minority sexual identities have been the subject of speculation, misunderstanding, and sometimes violent attempts at correction or elimination. Sexual orientation, gender role, including transvestism and "drag", transsexualism, sexism, heterosexism, and homophobia. Emphasis on critical thinking, guest speakers, and discussions.

**Attribute/Distribution:** SS

**WGSS 073 Film, Fiction, and Gender in Modern China 4 Credits**

Study of the struggle for an individual "modern" identity out of traditionally defined roles for men and women as depicted by Chinese writers and filmmakers. Class, texts, and films in English. Students interested in setting up a corollary Chinese language component for credit as CHIN 251 may discuss this possibility with the professor.

**Attribute/Distribution:** HU

**WGSS 091 Special Topics 1-4 Credit**

Intensive study of a topic of special interest not covered in other courses. May be cross-listed with relevant offerings in major department or other programs. May be repeated for credit as topic varies. Consent of program director required.

**Repeat Status:** Course may be repeated.

**WGSS 110 Women's Work in Global Perspectives 4 Credits**

This course brings to the forefront the intersections of race, class, gender, and nation with women's employment around the world. We will examine women's paid and unpaid work in the U.S., Europe, Asia, Latin America, and Africa, in effort to understand the striking persistence of gender inequality over time and across the world. Topics of study include: work and family relations, women's domestic labor, factory work, and agribusiness. In addition we will explore the ways in which women have organized for changes in work and in their communities in order to conceive of possibilities for the future of women's work.

**Attribute/Distribution:** SS

**WGSS 117 Women, Science, and Technology 4 Credits**

Explores the impact of technology and science on women's social roles, and the contribution of women engineers and scientists to their disciplines. Will focus on the American experience. Among the topics discussed are invention, design, laboratory research, education, engineering professionalism, labor force participation, office mechanization, household appliances, virtual spaces, childcare and reproduction.

**Attribute/Distribution:** SS

**WGSS 121 Women in Art 4 Credits**

A history of women artists from Renaissance to present day, with emphasis on artists of the 20th and 21st century from a global perspective. We explore attitudes toward women artists and their work as well as the changing role of women in art world. There may be required visits to museums and/or artists' studios.

**Attribute/Distribution:** HU

**WGSS 123 Anthropology of Gender 4 Credits**

Comparative study of the meanings and social roles associated with gender. Psychological, symbolic, and cultural approaches.

**Attribute/Distribution:** SS

**WGSS 124 Women in America 4 Credits**

Roles of women in American society from colonial to present times : attitudes toward women, female sexuality, women's work, and feminism.

**Attribute/Distribution:** SS

**WGSS 128 Race, Gender and Work 4 Credits**

Race, Gender and Work is a class designed to help students understand racial and gender inequalities as they relate specifically to work and employment. We explore the origins and histories of inequalities, the ways in which inequalities persist and/or change today, and what steps might be taken toward creating a more equal society.

**Attribute/Distribution:** SS

**WGSS 129 History of Fashion and Style 4 Credits**

Dress and culture in the Western Hemisphere from prehistory to today. The evolution of silhouette, garment forms and technology. The relationship of fashion to politics, art and behavior. Cultural and environmental influences on human adornment.

**Attribute/Distribution:** HU

**WGSS 138 Women in Jewish History 4 Credits**

Contributions of, and limitations on, women at different stages of Jewish history, using both primary sources and secondary material. Experience of modern Jewish women, and the contemporary feminist critique of traditional gender roles.

**Attribute/Distribution:** HU

**WGSS 145 African American Women Writers 4 Credits**

Literature by African American women writers with a focus on the experiences and images of black women in the U.S. Explores the written portraits and voices of 20th century black female novelists and poets, including Hurston, Petry, Morrison, Angelou, and Walker.

**Attribute/Distribution:** HU

**WGSS 179 Politics of Women 4 Credits**

Selected social and political issues relating to the role of women in American society. Focuses on such questions as economics equality, poverty, and work roles, the older woman, gender gap, political leadership, reproduction technology, and sexual violence.

**Attribute/Distribution:** SS

**WGSS 184 Religion, Gender, and Power 4 Credits**

Gender differences as one of the basic legitimations for the unequal distribution of power in Western society. Feminist critiques of the basic social structures, cultural forms, and hierarchies of power within religious communities, and the ways in which religious groups have responded.

**Attribute/Distribution:** HU

**WGSS 191 Special Topics 1-4 Credit**

Intensive study of a topic of special interest not covered in other courses. May be cross-listed with relevant offerings in major department or other programs. May be repeated for credit as topic varies. Consent of program director required.

**Repeat Status:** Course may be repeated.

**WGSS 226 Feminism and Philosophy 4 Credits**

Analysis of the nature, sources and consequences of the oppression and exploitation of women, and justification of strategies for liberation. Topics include women's nature and human nature, sexism, femininity, sexuality, reproduction, mothering. Must have completed one HU designated course in Philosophy or one course in Women, Gender, and Sexuality Studies.

**Attribute/Distribution:** HU

**WGSS 232 Gender Issues in Entrepreneurship 4 Credits**

Explores role of women entrepreneurs in society & economic development; impacts of women's entrepreneurship in different economic and cultural contexts; research on why women still represent a minority or entrepreneurs; gender differences in patterns of entrepreneurship; related policy challenges. Also addresses pragmatic and personal life choices facing women entrepreneurs, including identifying key characteristics of entrepreneurial opportunities and mapping those against values, skills, ethics and definitions of success; and planning for professional and personal development.

**Attribute/Distribution:** SS

**WGSS 271 Independent Reading and Research 1-4 Credit**

Independent study of selected topics designated and executed in close collaboration with a member of Women, Gender, and Sexuality Studies faculty. Students taking this course as a requirement for the minor must elect at least the three-credit option. May be repeated for elective credit. Consent of program director required.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU, SS

**WGSS 272 Special Topics 1-4 Credit**

Intensive study of a topic of special interest not covered in other courses. May be cross-listed with relevant offerings in major department or other programs. May be repeated for credit as topic varies. Consent of program director required.

**Repeat Status:** Course may be repeated.

**WGSS 275 Introduction to Hispanic Women Writers 4 Credits**

The objective of this class is to introduce students to Hispanic contemporary female authors from Latin America, Spain, and the United States through the analysis of all literary genres (novel, short story, poetry, essay, and drama). This class provides students with a solid introduction to Hispanic women's writing from the last years of the Nineteenth Century to the present, as well as to feminist literary theory.

**Attribute/Distribution:** HU

**WGSS 291 Special Topics 1-4 Credit**

Intensive study of a topic of special interest not covered in other courses. May be cross-listed with relevant offerings in major department or other programs. May be repeated for credit as topic varies. Consent of program director required.

**Repeat Status:** Course may be repeated.

**WGSS 300 Apprentice Teaching 1-4 Credit**

Supervised participation in various aspects of the teaching of a course. Transcript will identify department in which apprentice teaching was performed. Prerequisite: consent of department chairperson and permission of the Dean. The transcript will reflect the subject area in which the teaching was done.

**Repeat Status:** Course may be repeated.

**WGSS 303 Grimms' Fairy Tales: Folklore, Feminism, Film 4 Credits**

This intercultural history of the Grimms' fairy tales investigates how folktale types and gender stereotypes developed and became models for children and adults. The course covers the literary fairy tale in Germany as well as Europe and America. Versions of "Little Red Riding Hood", "Cinderella", or "Sleeping Beauty" exist not only in the Grimms' collection but in films and many forms of world literature. Modern authors have rewritten fairy tales in feminist ways, promoting social change. Taught in English. German language students may receive a German component.

**Attribute/Distribution:** HU

**WGSS 310 Gender, Race, and Sexuality: The Social Construction of Differences 4 Credits**

This course will provide the student with an opportunity to engage current debates about the meaning and use of racial and sexual classification systems in society. Using a multidisciplinary approach, we will examine the historical and sociological contexts in which specific theories of racial and sexual differences emerged in the U.S. Additionally, we will explore the ways in which changes in the images have implications on the role racial, gender and sexual identity plays in our understanding of the relationship between difference and inequality. Prerequisites as noted below or consent of program director.

**Prerequisites:** WGSS 001

**Attribute/Distribution:** SS

**WGSS 311 Gender and Literature 3-4 Credits**

Exploration of constructions of gender and sexuality in literature from different historical periods, traditions, and nationalities. How do female and male writers envision what it means to be a "woman" or to be a "man" at various moments in history and from various places around the world? How have gendered (and sexed) identities been shaped in various constraining and empowering ways in the literary imagination? What specifically gendered issues (such as love and violence) have been represented in literature? Content changes each semester. May be repeated for credit as title changes.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**WGSS 318 Seminar in Gender and Psychology 4 Credits**

Gender as shaped by psychological and social psychological processes. Socialization, communication and power, gender stereotypes, methodological issues in sex differences research. Consent of program director required. Prerequisites as noted below or consent of instructor.

**Prerequisites:** PSYC 210

**Can be taken Concurrently:** PSYC 210

**Attribute/Distribution:** SS

**WGSS 325 History of Sexuality and the Family in the U.S. 3-4 Credits**

Changing conceptions of sexuality and the role of women, men, and children in the family and society from the colonial to the post-World War II era. Emphasis on the significance of socioeconomic class and cultural background. Topics include family structure, birth control, legal constraints, marriage, divorce, and prostitution.

**Attribute/Distribution:** SS

**WGSS 326 Tradition and Resistance: Women Writers of Latin America 4 Credits**

Study of poetry and narrative works by Latin American women writers. Authors include Rosario Ferré, Rosario Castellanos, Elena Poniatowska, Cristina Peri Rossi, among others. Prerequisites as noted below.

**Prerequisites:** SPAN 152

**Attribute/Distribution:** HU

**WGSS 327 Women Writing in French 4 Credits**

Reading and discussion of works written by women in French. The emphasis is on 19th and 20th Century writers, such as G. Sand, Colette S. de Beauvoir, M. Duras, Andrée Chérid.

**Attribute/Distribution:** HU

**WGSS 330 Internship in Women, Gender and Sexuality Studies 1-4 Credit**

Supervised work in women's organizations or settings, combined with an analysis, in the form of a major paper, of the experience using the critical perspectives gained in WGSS courses. Placements arranged to suit individual interests and career goals; can include social service agencies, women's advocacy groups, political organizations, etc. May be repeated for credit. Consent of program director required. Prerequisites as noted below.

**Repeat Status:** Course may be repeated.

**Prerequisites:** WGSS 001

**Attribute/Distribution:** SS

**WGSS 331 Gendered Experience of Globalization 4 Credits**

Women and men experience globalization differently and globalization affects women in different cultural and national contexts. Gender stratification has been intensified by the transnational flow of goods and people. Course provides students with a survey of new development in feminist theories on globalization and on gender stratification and development, and links these theoretical frameworks to empirical research about gender issues that have become more prominent with globalization.

**Attribute/Distribution:** SS

**WGSS 334 The Psychology of Body Image and Eating Disorders 4 Credits**

The course addresses the psychosocial aspects of the development of healthy and unhealthy body image and eating disorders. The roles of personality traits/individual factors, family and interpersonal functioning, and cultural factors will be examined, as will the impact of representations of body image in mass media. Public health and psychological interventions for prevention and treatment will be explored. Personal accounts/memoirs, clinical case presentations, and documentary and dramatic films will be incorporated in the presentation of topics. Open only to declared HMS minors, declared WGSS minors, or those who have taken WGSS 001 or WGSS 101. Prerequisites as noted below.

**Prerequisites:** WGSS 001

**Attribute/Distribution:** SS

**WGSS 341 Women and Health 4 Credits**

Relationships of women to the medical system. Influence of medicine on women's lives and the impact of the women's movement on health care.

**Prerequisites:** ANTH 001 or ANTH 011 or ANTH 012 or SSP 001 or SSP 005 or SSP 021 or PSYC 021

**Attribute/Distribution:** SS

**WGSS 342 Gender and Third World Development 3-4 Credits**

Focus on gender implications of contemporary strategies for Third World economic growth, neo-liberalism. How do economic theories affect 'real people?' How do economic theories affect men vs. women? What is the role of people who want to 'help?' Some background in economic theories and/or Third World politics desired, but not required. Prerequisites as noted below.

**Prerequisites:** POLS 001 or WGSS 001

**Attribute/Distribution:** SS

**WGSS 346 Contemporary Hispanic Women Writers: The Novelists 4 Credits**

This course explores the works of Hispanic women writers who have been oppositional to hegemonic cultural politics during the Twentieth Century in Latin America and Spain. Grounding the readings in their particular contexts, the class discusses the issues these writers define as important in their work, the impact of their creations in both the literary canon as well as in the politics of their countries, the use of literature as a weapon to empower minority positions, and the effect of their narratives on the changing literary canon. Special attention will be paid to issues related to interpretations of history, exile, different forms of violence and repression, expressions of desire, and sexuality.

**Attribute/Distribution:** HU

**WGSS 350 Seminar in Feminist Theory 4 Credits**

An upper-level seminar serving as a capstone experience that challenges students to systematize insights gained from introductory and elective courses through the more deeply analytical lens of feminist theory. Prerequisites as noted below or consent of program director.

**Prerequisites:** WGSS 001

**Attribute/Distribution:** ND

**WGSS 351 Gender and Social Change 4 Credits**

Changes in gender roles from social psychological and structural perspectives. Comparative analyses of men and women (including people of color) in the social structure; their attitudes and orientations toward work, family, education, and politics.

**Attribute/Distribution:** SS

**WGSS 364 Sociology of the Family 3-4 Credits**

Sociological analysis of families in the United States, including investigations of historical and contemporary patterns. Issues addressed include parenting, combining work and family, divorce and remarriage, family policies.

**Attribute/Distribution:** SS

**WGSS 365 Inequalities at Work 4 Credits**

Primary focus is on race, gender, and class as axes of disadvantage and privilege in work and employment. We will explore both theories and empirical studies of inequality as well as their social, political, and practical ramifications for the workplace. The course will be conducted seminar-style and the class will rely heavily on student participation.

**Attribute/Distribution:** SS

**WGSS 371 Special Topics 1-4 Credit**

Intensive study of a topic of special interest not covered in other courses. May be cross-listed with relevant offerings in major department or other programs. May be repeated for credit as topic varies. Consent of program director required.

**Repeat Status:** Course may be repeated.

**WGSS 373 Internship in Women's Center 1-3 Credit**

Supervised work in the Women's Center allows students to bring critical perspectives on women and gender into the campus community. Students who wish to fulfill the internship requirement of the WGSS minor must take the Women's Center internship for (3). This course may be repeated for credit up to a maximum of 6 credits. Consent of program director required. Prerequisites as noted below.

**Repeat Status:** Course may be repeated.

**Prerequisites:** WGSS 001

**Attribute/Distribution:** SS

**WGSS 381 Special Topics 1-4 Credit**

Intensive study of a topic of special interest not covered in other courses. May be cross-listed with relevant offerings in major department or other programs. May be repeated for credit as topic varies. Consent of program director required.

**Repeat Status:** Course may be repeated.

**WGSS 382 Special Topics 1-4 Credit**

Intensive study of a topic of special interest not covered in other courses. May be cross-listed with relevant offerings in major department or other programs. May be repeated for credit as topic varies. Consent of program director required.

**Repeat Status:** Course may be repeated.

**WGSS 391 Special Topics 1-4 Credit**

Intensive study of a topic of special interest not covered in other courses. May be cross-listed with relevant offerings in major department or other programs. May be repeated for credit as topic varies. Consent of program director required.

**Repeat Status:** Course may be repeated.

**WGSS 392 Special Topics 1-4 Credit**

Intensive study of a topic of special interest not covered in other courses. May be cross-listed with relevant offerings in major department or other programs. May be repeated for credit as topic varies. Consent of program director required.

**Repeat Status:** Course may be repeated.

**WGSS 399 Senior Thesis 2-4 Credits**

Research during senior year culminating in a senior thesis. May be repeated up to a total of 4 credits. Consent of program director required.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** ND

**WGSS 403 Grimms' Fairy Tales: Folklore, Feminism, Film 3 Credits**

This intercultural history of the Grimms' fairy tales investigates how folktale types and gender stereotypes developed and became models for children and adults. The course covers the literary fairy tale in Germany as well as Europe and America. Versions of "Little Red Riding Hood", "Cinderella", or "Sleeping Beauty" exist not only in the Grimms' collection but in films and many forms of world literature. Modern authors have rewritten fairy tales in feminist ways, promoting social change. Taught in English. German language students may receive a German component.

**WGSS 405 Experiencing the United Nations: NGOs in Education Policy and Practice 3 Credits**

Building on the Lehigh University/United Nations partnership initiative, this course provides a structured practical experience for students to learn about the dynamics of NGO/UN relationships by representing one of the underrepresented international NGOs at the United Nations. Equips students with necessary experience, understanding, and skills in international education development such as policy brief writing and education sector analysis.

**WGSS 411 Gender and Literature 3 Credits**

This seminar explores constructions of gender and sexuality in literature from different historical periods, traditions, and nationalities. Content changes each semester. May be repeated for credit as title changes.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**WGSS 418 Gendered Experience of Globalization 3 Credits**

Women and men experience globalization differently and globalization affects women in different cultural and national contexts. Gender stratification has been intensified by the transnational flow of goods and people. Course provides students with a survey of new development in feminist theories on globalization and on gender stratification and development, and links these theoretical frameworks to empirical research about gender issues that have become more prominent with globalization.

**WGSS 430 Internship in Women, Gender and Sexuality Studies 1-3 Credit**

Internship related to women, gender, and sexuality studies. Supervised by WGSS faculty. Consent of program director required.

**WGSS 441 Women and Health 3 Credits**

Relationships of women to the medical system. Influence of medicine on women's lives and the impact of the women's movement on health care.

**Attribute/Distribution:** SS

**WGSS 450 Seminar in Feminist Theory 3 Credits**

A graduate seminar providing foundational study of multidisciplinary theoretical frameworks of women, gender, and sexuality studies.

**Attribute/Distribution:** HU, ND

**WGSS 458 Readings in Gender History 3 Credits**

Study in small groups under the guidance of a faculty member on the literature of an issue, period, country or culture within gender history.

May be repeated for credit with permission of the faculty advisor.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** HU

**WGSS 465 Inequalities at Work 3 Credits**

Primary focus is on race, gender, and class as axes of disadvantage and privilege in work and employment. We will explore both theories and empirical studies of inequality as well as their social, political, and practical ramifications for the workplace.

**Attribute/Distribution:** SS

**WGSS 484 Psychology of Gender 3 Credits**

Major theoretical approaches and empirical debates in the psychology of gender, with a focus on the interplay of nature and nurture in producing gender similarities, gender differences and gender variation in personality, social behaviors, cognitive abilities, achievement, sexuality, and mental health. Methodological issues in gender research. Consent of program director required.

**WGSS 491 Independent Study 3 Credits**

Individually supervised course in area of women, gender, and sexuality studies not ordinarily covered in regularly listed courses. Consent of program director required.

**Repeat Status:** Course may be repeated.

## College of Business and Economics

Thomas J. Hyclak, interim dean; Katrina A. Zalatan, associate dean, director of undergraduate programs; Andrew J. Ward, associate dean, graduate programs; Paul Brockman, associate dean for global initiatives; Parveen P. Gupta, chair, department of accounting; James Dearden, chair, department of economics; Richard J. Kish, chair, Perella Department of Finance; Robert J. Trent, chair, department of management; D. Griffith, chair, department of marketing.

The College of Business and Economics offers the bachelor of science degree in business and economics. In the dynamic global environment of the 21st Century, today's business students face unprecedented challenges. Lehigh's College of Business and Economics prepares them to meet these challenges and to succeed. The mission of Lehigh University's College of Business and Economics is to provide an intellectual and professional learning environment that advances knowledge through research and scholarship and that develops future leaders through experiential learning, rigorous analysis and the discipline of a strong work ethic – the hallmarks of a Lehigh University business education.

The College of Business and Economics consists of five departments: accounting, economics, Perella Department of Finance, management and marketing. Its programs, accredited by the AACSB International—The Association to Advance Collegiate Schools of Business—provide students with a solid foundation in business and economics principles. In addition to the traditional undergraduate majors of accounting, economics, finance, management and marketing, the College offers innovative programs and courses that respond to today's unique business requirements, including:

The Business Information Systems major that answers a recognized need in the business world. As businesses seek to make themselves more productive and competitive, they have become more reliant on information technology. Students with a good understanding of information systems can help businesses enhance their use of this technology.

The Supply Chain Management major is another response to the complex environment facing business graduates. This undergraduate major gives students solid exposure to supply management, logistics, business-to-business marketing and operations management.

The College of Business and Economics has joined with the College of Engineering to offer two cross-college programs. These programs, Integrated Business and Engineering (IBE) and Computer Science and Business (CSB) are described in full in the following "Crossing Boundaries" section.

All minors offered by the College of Arts and Sciences are available to CBE undergraduate students. The engineering minor offered by the College of Engineering is also available to all CBE undergraduates.

### Crossing Boundaries

A major strength of the College of Business and Economics is its ability to develop programs by partnering across academic disciplines within the College, across the colleges within the University and with the business community. Students are able to cross traditional boundaries and take advantage of all that the College of Business and Economics and other colleges of the University have to offer. The partnerships built with alumni and the business community afford students the opportunity for internships in their areas of interest.

As the needs in the marketplace change, the ingredients necessary for success must reflect these new requirements. From courses in e-commerce to supply chain management and joint degree programs, the College of Business and Economics provides today's undergraduate students with the skills necessary to become tomorrow's business leaders.

### Entrepreneurship Minor

The program aims to prepare students from all undergraduate colleges at Lehigh with the skill sets, attitudes, and understanding of the processes to realize their entrepreneurial goals in either an emerging or established company setting. The program is designed to be generally accessible to students from all disciplines with an emphasis upon

innovation, the entrepreneurial process, and cross-functional integration. The minor can be added to any undergraduate degree at the university.

### Integrated Real Estate Minor

Integrated Real Estate At Lehigh (ire@l) is a three or four year course of study designed to complement a wide range of majors, from art and architecture to civil engineering to environmental science to finance to marketing to economics. The mission of the ire@l program is to prepare the next generation of real estate leaders. Students completing the ire@l program will earn a minor in real estate.

### Career Placement

The undergraduate programs in the College of Business and Economics provide the students with a strong foundation in business and economic principles necessary for success in business. Upon graduation, the majority of students from the College of Business and Economics enter business in many different professional positions including accounting, investment banking, advertising, marketing, management consulting and information systems. Further professional studies in law, graduate business schools or specialized graduate education in economics, operations research, or other related fields are additional options open to graduates.

### Variety of Options

While preparing students for a career in business and economics, we recognize the importance of a well-rounded individual. At Lehigh, this important exposure to science, language and the arts and humanities is accomplished by distribution requirements, within which the student has wide choice. Students take 48 credits outside the College of Business and Economics.

The bachelor of science in business and economics may also lead to admission into the master of business administration program at Lehigh or another institution after graduates have at least 2-3 years of work experience. In addition, the college also offers the following graduate degrees: doctor of philosophy, master of business administration and engineering, master of business administration and educational leadership, master of science in accounting and information analysis, master of science in economics, and master of science in analytical finance.

### Bachelor of Science in Business and Economics

The College of Business and Economics at Lehigh University prepares students to become business and community leaders in a broad range of organizations. Our undergraduate students acquire the knowledge and skills needed to excel in business. Overall, we expect our graduates to be able to successfully solve complex, unstructured business problems.

For the bachelor of science degree in business and economics, 124 credit hours are required. A writing requirement, which is included within the required 124 credit hours, is also a part of the college curriculum.

### Planning Courses of Study

First Year	CR
ENGL 001	3
Select one of the following:	3
ENGL 002	3
ENGL 004	3
ENGL 006	3
ENGL 008	3
ENGL 010	3
MATH 021 or 081	4
ECO 001	4
BUS 001	3
ECO 045 <sup>1</sup>	3
ECO 029	3
BUS 005	1
	<b>39</b>
Second Year	CR
ACCT 151 <sup>1</sup>	3
ACCT 152	3

BIS 111 <sup>1</sup>	3
ECO 146	3
FIN 125	3
MGT 143	3
MKT 111	3
SCM 186	3
<b>Third Year</b>	<b>24</b>
LAW 201	CR 3
<b>Fourth Year</b>	<b>3</b>
MGT 301	CR 3
<b>Total Credits: 69</b>	

<sup>1</sup> Excel competency must be successfully completed before ECO 045, ACCT 151, and BIS 111.

### Major Programs (15 credits - 23 credits)

By the end of the second semester of the sophomore year, students select a major consisting of sequential or related courses in one of the following major programs: accounting, business economics, business information systems, economics, finance, management, marketing and supply chain management. A GPA of 2.0 or higher in the major program is required for graduation.

### Double Majors

Students in the College of Business & Economics may pursue a double major within the CBE according to college guidelines. Students must declare a single major prior to declaring a second major. Students planning to pursue more than one major within the CBE must meet a pre-requisite GPA of 2.0 or higher.

### Globalization and Diversity Requirements

Each student must complete a minimum of 3 credits in Diversity and 3 credits in Globalization. These courses may simultaneously fulfill other CBE degree requirements.

### Electives (52-55 credits) - depending on major

Students will earn 52-55 credits of electives. A minimum of 48 credits are to be taken outside the College of Business and Economics.

Students are required to take six (6) credits of humanities (HU), six (6) credits of social science (SS), and three (3) credits of science (NS) for a total of 15 credits of distribution requirements. Students should refer to the department in the catalog to determine which course offerings may be taken to satisfy these requirements.

In the College of Business and Economics, the pass-fail option is available for elective courses only. A student desiring Lehigh credit for a course taken at another institution must complete a transfer credit form and obtain approval from the appropriate Lehigh academic department in advance.

### Business Minor

The purpose of the business minor program is to enable non-CBE students to pursue a course of business studies which enables them to supplement their major studies and enhances their career options upon graduation. The overall learning objective of the program is to provide non-CBE students with the knowledge and skills with which to make more informed business decisions.

Courses offered in the business minor program are not open to students currently in the CBE, nor may these classes count as substitutes for CBE core classes should a student later decide to transfer into the CBE.

### Program of Studies

The business minor consists of 14 credit hours. The courses are integrated across the entire program and must be taken in a stepped sequence. These 14 credit hours plus the prerequisite consist of the following courses:

### Required prerequisite course

ECO 001 – Principles of Economics (4) ECO 001 can be taken in either the freshman or sophomore year and must be completed prior to entering the business minor program.

### Required courses

#### First Year

Fall	CR Spring	CR
BUS 125	1 BUS 127	3
BUS 126	3	
	<b>4</b>	<b>3</b>

#### Second Year

Fall	CR Spring	CR
BUS 225	3 BUS 226	3
	BUS 326	1
	<b>3</b>	<b>4</b>

Total Credits: 14

### Recommended courses

#### Probability Theory and Statistics

For example:

ECO 045	Statistical Methods	3
MATH 012	Basic Statistics	4
IE 111	Engineering Probability	3
PSYC 110	Statistical Analysis of Behavioral Data	4

#### An Integrated Learning Experience

For example:

ME/BUS 211	Integrated Product Development (IPD)	3
MGT 311	Small Business Consulting	3

#### Internship

The courses required in the business minor program will be offered in a stepped sequence requiring completion of each course in the sequence before being able to continue to the next course. That is, students must first complete GBUS 401 and ECO 401 before taking BUS 127, BUS 127 before taking BUS 225, and BUS 225 before taking BUS 226. BUS 125 and BUS 326 are to be taken in conjunction with BUS 126 and BUS 226, respectively.

### Program admission requirements

Each spring, 80 students will be accepted into the business minor program for the following fall. Applications to the program will be made by students and submitted to the program director by the first Monday in March. An admissions committee comprised of the business minor program director, associate dean for the undergraduate CBE program and the business minor curriculum committee will make admission decisions based on G.P.A., experience, and interest in pursuing business opportunities upon graduation from Lehigh (to be evaluated on the basis of a written essay). Students will be notified of admissions decisions prior to registration for the fall semester. Entrance into business minor classes will be controlled by restricted overrides by the director of business minor program. The Director of the Business Minor program is Robert Kuchta, Professor of Practice, Department of Management, 330 Rauch Business Center (rok8@lehigh.edu).

The College of Business and Economics and the Computer Science and Engineering department in the P.C. Rossin College of Engineering and Applied Science jointly offer the Computer Science and Business (CSB) program. It is a four-year program and the nation's only program that is fully accredited by AACSB International, the Association to Advance Collegiate Schools of Business, and by the Computing Accreditation Commission of ABET, 111 Market Place, Suite 1050, Baltimore, MD 21202-4012, telephone (410) 347-7700.

### Graduate Degrees in Business Administration and Economics

Candidates for admission to graduate study in the College of Business and Economics must provide the results obtained in the Graduate Management Admissions Test (GMAT) for the degree in accounting and information analysis. The GMAT or the Graduate Record Examination general test (GRE) must be submitted for degrees in business

administration, economics and analytical finance. International students applying to any graduate programs in the College of Business and Economics are required to take the TOEFL for admission to the program.

### Master of Business Administration

The Lehigh MBA program is accredited by AACSB International- the Association to Advance Collegiate Schools of Business. The Lehigh MBA program provides a rich, integrated learning experience for students. Business issues are viewed and taught from the perspective of the firm as a whole rather than along departmental lines. Lehigh's MBA curriculum is a fully integrated model which simulates the business environment in the classroom. MBA students acquire skills in leadership, managerial communication, and resource allocation coupled with a comprehensive understanding of complex domestic and global business issues.

Due to the compact and integrated core, students have increased flexibility to tailor the program to their individual needs. Students may select a concentration in corporate entrepreneurship, finance, international business, marketing, project management, or supply chain management or pursue a broader experience by selecting courses from a variety of disciplines. Students may only have one concentration.

The MBA program is available through on campus study or through distance education. Students may elect to follow one mode exclusively or mix and match modes. MBA concentrations in supply chain management and project management are currently available through distance study.

### MBA Mission Statement

The MBA program will further the development of organizational leaders and managers. This is accomplished by honing students' knowledge, skills and abilities through a comprehensive and integrated core curriculum and customized concentrations designed to meet individual needs. The MBA program will also foster life-long learning through continuing professional education programs.

### Innovative Structure

The MBA Program requires 36 credit hours. Full-time students can fulfill that requirement in 12 to 16 months. Part-time students average three years to complete the degree.

### Core Courses

MBA 401	Introduction to the Organization and its Environment	2
MBA 402	Managing Financial and Physical Resources	4
MBA 403	Managing Information	4
MBA 404	Managing Products and Services	4
MBA 405	Managing People	4
MBA 406	Integrative Experience	3

### Electives

Select 15 credit hours of elective course work <sup>1</sup>	15
<b>Total Credits</b>	<b>36</b>

<sup>1</sup> Students are permitted to design an area of study in consultation with their adviser to best suit their career goals or they may choose to complete an area of concentration. Concentrations in international business and supply chain management require nine credit hours of approved electives. Concentrations in corporate entrepreneurship, finance, marketing, and project management require twelve credit hours of approved electives. Students may also complete a maximum of six credit hours of electives outside of the College of Business and Economics (but within Lehigh University). All elective courses must be at the 400 level.

### Prerequisites

Students should have completed undergraduate courses in computer literacy, and principles of microeconomics and macroeconomics. The prerequisites of financial accounting and statistics may be completed after acceptance into the MBA program

The statistics prerequisite may be fulfilled by having taken a class within the past 5 years and receiving a "B" or better, by taking a proficiency exam administered through the College, or by enrolling in Basic Statistics for Business and Industry or equivalent. The Accounting prerequisite may be waived by enrolling in , Financial Accounting for

Managers and Investors at Lehigh or by taking a proficiency exam administered by the College.

If a student has no previous background in financial accounting or statistics, he/she is encouraged to take a course in the subject area. If a student has previously taken coursework but has not achieved a grade of "B" or the course has exceeded the time limit, self-directed learning and a proficiency exam may be appropriate.

The prerequisites of financial accounting and statistics must be completed before enrolling in MBA 402 Managing Financial and Physical Resources and/or MBA 403 Managing Information.

### Electives

Students will take 15 credit hours of elective course work. Students are permitted to design an area of study in consultation with their adviser to best suit their career goals or they may choose to complete an area of concentration. Concentrations in international business and supply chain management require nine credit hours of approved electives. Concentrations in corporate entrepreneurship, finance, marketing, and project management require twelve credit hours of approved electives. Students may also complete a maximum of six credit hours of electives outside of the College of Business and Economics (but within Lehigh University). All elective courses must be at the 400 level.

### Waiver Policy

There are no waivers for courses in the MBA Program.

### GMAT or GRE Scores

All applicants are required to take the Graduate Management Admissions Test (GMAT) administered by Pearson Vue or the Graduate Record Exam (GRE) administered by the Educational Testing Service (ETS). Only GRE scores from the revised version taken after August 1, 2011 will be accepted.

### Work Experience

Students are required to have a minimum of 2 years of full-time, professional work experience.

### International Students/TOEFL

International students must have 16 years of formal education, including four years at the university level, to be considered for admission to Lehigh's graduate programs. Applicants whose native language is not English are required to take the Test of English as a Foreign Language (TOEFL). For information, write or call the TOEFL Registration Office, P.O. Box 6154, Princeton, N.J., 08541-6154 or at [www.toefl.org](http://www.toefl.org) (<http://www.toefl.org>).

### Flexible Class Scheduling

Classes are scheduled Monday through Thursday evenings, with seminars offered on Fridays and Saturdays. Part-time students may complete the entire program during evening classes. Many students accelerate completion of the program by taking courses during the two six-week summer sessions.

Further information about the MBA Program may be obtained by contacting the Graduate Programs Office of the College of Business and Economics, Lehigh University, College of Business and Economics, 621 Taylor Street, Bethlehem PA 18015

phone: (610) 758-3418

email: [mba.admissions@lehigh.edu](mailto:mba.admissions@lehigh.edu)

[www.lehigh.edu/mba](http://www.lehigh.edu/mba)

### Certificate Programs (non-degree)

#### Certificate in Corporate Entrepreneurship

Businesses often nurture the entrepreneurial spirit by forming new venture groups within their organizations. The members of these groups require a special blend of education to develop the skills of discovery, innovation and leadership that starting a new enterprise requires. This certificate program prepares students to successfully evaluate business opportunities within a corporate environment.

#### Requirements

The certificate requires 12 credit hours of coursework with six credit hours of directed electives plus an additional six credits.

**Directed Electives**

GBEN 403	Anatomy of Entrepreneurship: Startups and Established Companies	1
GBEN 404	Market Opportunity: Targeting Strategies and Selling Tactics	1
GBEN 406	Performing a Business Enterprise Audit: Developing an Industry Perspective	1
GBEN 408	The New Venture Organization: Management, Design, and Governance	1
GBEN 409	Financial Forecasting: Developing Pro Forma Financial Statements	1
GBEN 410	Financing StartUps: Seeking Outside Venture Capital	1

**Elective Courses**

Select 6 credit hours from the following:		6
GBEN 401	The Business Plan I: Strategic Considerations (2)	
GBEN 402	The Business Plan II: Operating Strategies and Implementation (2)	
GBEN 405	Intellectual Property: Management and Valuation (1)	
GBEN 407	Processes and Infrastructure: Creating Production and Delivery (1)	
GBEN 411	Establishing Credit Facilities: Asset-Based and Cash Flow Financing (1)	
GBEN 412	Developing Exit Strategies: Concepts and Approaches (1)	
GBEN 413	Integrative Experience/New Venture Internship (1-4)	
<b>Total Credits</b>		<b>12</b>

**Admission Requirements**

Students admitted to the certificate program in entrepreneurship will enter as non-degree students. Applicants are required to have a 3.0 undergraduate GPA and to have earned a 4 year baccalaureate degree from an accredited college or university. Two years of full time professional work experience is also required.

**Certificate in Supply Chain Management**

Increasingly sophisticated information technology applications and the shift toward global economic activity have shaped a competitive environment that rewards creating value for customers while reducing cost and cycle time. Through in depth study of the organizations' value chain -logistics, operations, marketing, sales and service- the certificate in supply chain management demonstrates how these activities are linked both internally and externally.

**Required Courses**

GBUS 432	Demand and Supply Chain Planning	3
GBUS 450	Strategic Supply Management	3
GBUS 453	Transportation and Logistics Management	3
GBUS 456	Applied Supply Chain Models	3
<b>Total Credits</b>		<b>12</b>

**Admission Requirements**

Students admitted to the certificate program will enter as non-degree students. Applicants are required to have a 3.0 undergraduate GPA and to have earned a 4 year baccalaureate degree from an accredited college or university.

**Certificate in Project Management**

This 12 credit hour certificate will prepare students to take the Project Management Professional certification exam offered by the Project Management Institute (PMI) - the field's leading global professional association. Lehigh University is a Registered Education Provider (R.E.P.) with the Project Management Institute. The certificate is completed within 12 months through both on-line and on-campus modules that are taken sequentially.

**Directed Electives (12 credits)**

PMGT 401	Project Management: Course Framework & Project Leader Assessment	1
PMGT 402	Project Management: Skills and Abilities for Effective Leadership of Teams	1
PMGT 403	Project Management: Initiating the Project and Planning Scope and Schedule	2
PMGT 404	Project Management: Planning Resources, Communication, Quality and Risk Management	2
PMGT 405	Project Management: Project Leader Communications Expertise and Evaluating Team Performance	1
PMGT 406	Project Management: Implementing and Managing Projects	2
PMGT 407	Project Management: Controlling Performance and Assessing Outcomes	2
PMGT 408	Project Management: Problem Solving, Decision Making and Ethics	1
<b>Total Credits</b>		<b>12</b>

**Admission Requirements**

Students admitted to the certificate program will enter as non-degree students. Applicants are required to have a 3.0 undergraduate GPA, two years of professional work experience, and a 4 year baccalaureate degree from an accredited college or university. Graduate students at Lehigh University may apply for the program without meeting additional requirements.

Further information about certificate programs may be obtained by contacting the Graduate Programs Office of the College of Business and Economics, Lehigh University, College of Business and Economics, 621 Taylor Street, Bethlehem PA 18015

phone: (610) 758-3418

email: [business@lehigh.edu](mailto:business@lehigh.edu)

[www.lehigh.edu/certificates](http://www.lehigh.edu/certificates)

**Master of Science in Accounting and Information Analysis**

The Lehigh Master of Science in Accounting and Information Analysis (MSAIA) degree program offers an outstanding opportunity to prepare for a career in today's demanding field of accounting. Accounting professionals are engaged in a variety of services, including assurance (auditing), business valuation, information resources, and consulting. The program focuses on using information and technology to improve business processes and forge business solutions. Accredited by AACSB International, the Association to Advance Collegiate Schools of Business, Lehigh's M.S. in Accounting and Information Analysis program satisfies the 150-hour CPA educational requirement adopted by almost all states. The program serves as an excellent foundation for professional careers as CPAs, CMAs and related fields. It provides the broad business education employers value so highly.

The Master of Science in Accounting and Information Analysis curriculum is designed to be flexible so that students may choose to concentrate their electives in a specific field, such as finance, or use them for breadth.

Students are encouraged to obtain an internship during the summer prior to beginning the program. The internship will complement the chosen concentration and provide an excellent practical framework to enrich the academic coursework experience.

**Non-Accounting Majors**

The M.S. in Accounting and Information Analysis program seeks applicants from a variety of academic backgrounds. Those with undergraduate business degrees in fields other than accounting often lack twelve credits of background requirements in intermediate accounting, accounting information systems and auditing. To the



extent possible, applicants should take those courses during their undergraduate programs.

Applicants who do not have an undergraduate business degree will likely require two years to complete the program. The first year is devoted to background courses and the second to the graduate program itself.

#### Mission Statement

Lehigh University's Master of Science in Accounting and Information Analysis provides a broad business education and the specialized coursework for a professional career in accounting. Graduates aspire to leadership positions at top-tier organizations in fields that include public accounting, corporate accounting, financial services, consulting, and information systems. Through this program, Lehigh continues a long tradition of providing accounting majors with the necessary educational requisites for licensure as certified public accountants within the United States and its territories. The program seeks only the best and the brightest applicants: motivated, dedicated to their studies, not afraid of challenges, possessing confidence, self-discipline, and the ability to articulate their ideas orally and in writing. The program continually pursues the excellence necessary to meet the standards of only the highest-quality educational institutions.

#### Core Program

The MSAIA core consists of eighteen credits in the courses shown below and thirty credits overall. Designed specifically for this program, and dedicated to it, these innovative courses seek to develop a set of skills and experiences not available in undergraduate programs that will enhance MSAIA students' ability to perform throughout their chosen careers. Core courses are offered once each academic year.

MACC 401	Professional Issues in Accounting - Negotiation	1
MACC 402	Professional Issues in Accounting - Case Analysis	1
MACC 403	Professional Issues in Accounting – Ethics	1
MACC 412	IT Auditing	3
MACC 413	The Corporate Financial Reporting Environment	3
MACC 420	Forensic Accounting and Auditing	3
MACC 424	Governance, Risk and Control	3
MACC 427	Accounting for Financial Instruments & Advanced Financial Statement Analysis	3
<b>ELECTIVES</b>		
Select 12 elective credit hours in consultation with MSAIA Program Director		12
<b>Total Credits</b>		<b>30</b>

#### Electives

The MSAIA curriculum provides for twelve elective credits that students may use to specialize in an area of interest or to augment one's general business education. Frequently-taken electives include graduate-level courses in taxation and business decisions, financial statement analysis, corporate financial management, investments, strategic supply management, managerial economics, and strategic marketing management.

#### Waiver Policy

There are no waivers for courses in the M.S. in Accounting and Information Analysis Program.

#### GMAT Scores

All applicants are required to take the Graduate Management Admissions Test (GMAT) administered by Pearson Education, Inc. GMAT scores have been averaging 630. A score of at least 580 and 50<sup>th</sup> percentile in the quantitative sections will improve the prospects for admission. Undergraduate students should take the exam in the senior year. To make an appointment to take the GMAT exam call 1-800-717-GMAT (4628) or by registering online at [www.mba.com](http://www.mba.com) (<http://www.mba.com>). The GMAT is waived for Lehigh accounting

majors with an overall GPA of 3.0 and an accounting GPA of 3.0. All offers of admission are conditional until the calculation of the final GPA.

#### Presidential Scholars

Presidential Scholars must meet normal admission standards.

#### International Students/TOEFL®

International students must have 16 years of formal education, including four years at the university level, to be considered for admission to Lehigh's graduate programs. Applicants whose native language is not English are required to take the Test of English as a Foreign Language (TOEFL®). For information, contact [www.ets.org/toefl](http://www.ets.org/toefl) (<http://www.ets.org/toefl>). The MSAIA program features considerable student/faculty interaction in class. Very good English language skills are therefore highly important to success in the program. An internet-based TOEFL (IBT) of 105 will improve the prospects for admission. Admitted applicants typically are required to complete the English as a Second Language American Business English (ABE) program before beginning their graduate program.

Further information about the MSAIA program may be obtained by contacting the Graduate Programs Office of the College of Business and Economics, Lehigh University, 621 Taylor Street, Bethlehem PA 18015; phone: (610) 758-3418 email: [business@lehigh.edu](mailto:business@lehigh.edu); or Professor David Hinrichs, Director, M.S. in Accounting and Information Analysis Program, email: [djh404@lehigh.edu](mailto:djh404@lehigh.edu), phone (610) 758-4674. [www.lehigh.edu/msaccounting](http://www.lehigh.edu/msaccounting)

#### Master of Science in Economics

The Master of Science program in Economics Program is available for students wishing to pursue graduate study in the areas of economics or economics and business. The program offers considerable flexibility with respect to the selection of courses as well as the ability to concentrate in a particular area of study. Students may pursue the degree on either a full-time or part-time basis. Recent graduates of the M.S. program have accepted employment in industry, while other students have pursued the master's degree as a stepping stone to the Ph.D. degree.

A minimum of 30 semester hours of course work is required.

ECO 402	Managerial Economics	3
ECO 412	Mathematical Economics	3
ECO 415	Econometrics I	3
ECO 417	Advanced Macroeconomic Analysis	3
ECO 447	Economic Analysis of Market Competition	3
Select 15 credit hours of electives		15
<b>Total Credits</b>		<b>30</b>

Students may also elect to write an M.S. thesis. The thesis is worth six hours of credit toward the degree and is particularly encouraged for those who may be considering the Ph.D. program.

Further information about the M.S. in Economics Program may be obtained by contacting the Graduate Programs Office of the College of Business and Economics or Dr. Robert Thornton, Director M.S. in Economics Program, Lehigh University, College of Business and Economics, 621 Taylor Street, Bethlehem PA 18015

phone: (610) 758-3460

email: [business@lehigh.edu](mailto:business@lehigh.edu)

[www4.lehigh.edu/business/academics/graduate/mseconomics/default.aspx](http://www4.lehigh.edu/business/academics/graduate/mseconomics/default.aspx)

#### Doctor of Philosophy

The Ph.D. degree in business and economics is designed to provide advanced knowledge and the capacity to carry on independent research in various areas of business and economics. Holders of the Ph.D. are normally employed in academic positions in departments of economics or in schools of business administration, or in policy analysis and research positions in banks, business, government, and research organizations. Employment opportunities are excellent for graduates with this degree.

The Ph.D. program requires a minimum of 48 semester hours of study (including dissertation) beyond the master's degree or 72 hours of study

beyond the bachelor's degree. Each student is expected to choose one major and two minor fields of specialized study. Students must take core courses in microeconomics, macroeconomics, econometrics, and mathematical economics. Students must also take written, qualifying examinations in microeconomic theory and econometrics as well as an examination in their major field of study. As a condition for advancement to candidacy, a student must write an original third-year paper (the pre-dissertation research project) suitable for submission to a scholarly journal. The major fields of specialization normally available include, but are not necessarily limited to, health economics, labor economics, applied econometrics, and industrial organization.

Under the guidance of a dissertation chairperson and committee, the candidate undertakes research culminating in a dissertation. The Ph.D. is awarded upon the successful completion of the doctoral dissertation and its oral defense.

Further information about the Ph.D. in Business and Economics Program may be obtained by contacting the Graduate Programs Office of the College of Business and Economics or Dr. Chad Meyerhoefer, Director Ph.D. in Business and Economics Program, Lehigh University, College of Business and Economics, 621 Taylor Street, Bethlehem PA 18015

phone: (610) 758-3445

email: [business@lehigh.edu](mailto:business@lehigh.edu)

[www4.lehigh.edu/business/academics/graduate/phdeconomics/default.aspx](http://www4.lehigh.edu/business/academics/graduate/phdeconomics/default.aspx)

## Accounting

The Department of Accounting provides a variety of courses to support College of Business and Economics (CBE) core requirements and to provide an undergraduate major in accounting and a M.S. degree in accounting.

The mission of the Accounting Department is to provide rigorous accounting education that prepares high quality undergraduate and graduate students with diverse backgrounds for life-long learning and positions of leadership in the business community, and to emphasize faculty research efforts that contribute to the body of knowledge in accounting. Consistent with the missions of Lehigh University and the College of Business and Economics, the Accounting Department continuously seeks to be recognized as one of a select group of programs in the United States where an educational experience of the highest possible quality is obtainable.

Within the accounting major, there is an opportunity to explore the various career opportunities within the broad field of accounting: Public Accounting Assurance and Tax Services, Financial Services and Corporate Accounting, and Information Systems. In addition to the undergraduate program, the Master of Science in Accounting and Information Analysis degree (see Master of Science in Accounting and Information Analysis program (p. 245)) offers an outstanding opportunity to prepare graduate students for a career in today's demanding field of accounting. Lehigh's unique program recognizes the impact of technology on business processes and the value chain while paying respect to the time honored usefulness of accounting information. The Accounting Program recognizes the learning objectives set forth by the College of Business and Economics as an integral part of the curriculum, as well as the importance of providing students with a strong foundation in liberal arts, humanities, and science as set out in the CBE core curriculum. In addition to the CBE core curriculum, the accounting curriculum is designed to foster the following learning objectives:

- Preparing and understanding general purpose financial statements for parties outside the firm.
- Using accounting information for decision-making inside the firm.
- Understanding the information systems governing the flow of and control over financial information inside the firm.

To the extent that the above objectives are achieved, Accounting graduates will be well-prepared for positions in public accounting, industry, not-for-profit organizations, and graduate school. Although preparation for professional examinations is not a primary objective,

graduates will have the background to take professional examinations in accounting.

**Professors.** Parveen P. Gupta, PhD (The Pennsylvania State University); Heibatollah Sami, PhD (Louisiana State University); Kenneth P. Sinclair, PhD (University of Massachusetts Amherst)

**Associate Professor.** James A. Hall, PhD (Oklahoma State University)

**Assistant Professors.** Sanaz Aghazadeh, PhD (University of Oklahoma); David M. Folsom, PhD (University of Iowa); Yoon Ju Kang, PhD (University of Illinois Urbana-Champaign); Tamara A. Lambert, PhD (Drexel University); Hye Seung Lee, PhD (University of Arizona); Yunfang Y. Lu, PhD (Stanford University); Marietta Peytcheva, PhD (Rutgers University Newark)

**Lecturer.** David J. Hinrichs, MS (Lehigh University)

**Professor Of Practice.** Jay D. Brodish, Sr., BS (Lehigh University)

**Emeriti.** Dunham R. Bainbridge, PhD (Lehigh University); Karen M. Collins, PhD (Virginia Polytechnic Institute and State University); James A. Largay, III, PhD (Texas Tech Univ); Frank F. Luh, PhD (Ohio State University); John W. Paul, PhD (Lehigh University)

## The Accounting Major

The undergraduate program in accounting is accredited by AACSB - The International Association for Management Education. This achievement places the program within a small group of schools which have satisfied a rigorous examination of the program, faculty, and students that extend beyond the accreditation standards applied to the entire College of Business and Economics undergraduate and graduate programs.

### Sophomore Prerequisites

ACCT 151	Introduction to Financial Accounting	3
ACCT 152	Introduction to Managerial Accounting	3

### Core Requirements, typically taken junior year

ACCT 315	Financial Accounting I	3
ACCT 316	Financial Accounting II	3
ACCT 311	Accounting Information Systems	3
ACCT 324	Cost Accounting	3

### Concentration, typically taken senior year

Concentration, three courses, one of which is accounting (See below)	9
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Total Credits	27
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### Concentrations

#### Public Accounting Assurance and Tax Services

This concentration is suited for students interested in entering public accounting.

ACCT 307	Fundamentals of Federal Income Taxation	3
ACCT 320	Fundamentals of Auditing	3
ACCT 317	Advanced Financial Accounting	3
Total Credits	9	

#### Financial Services and Corporate Accounting

This concentration may appeal to students seeking accounting positions at financial services firms and industrial corporations. For some time representatives from these companies have sought Lehigh students with a strong accounting background. External constituencies suggest that a dose of finance will strengthen these students and make them even more attractive.

FIN 323	Investments	3
FIN 328	Corporate Financial Policy	3
ACCT 318	Analysis of Financial Statements	3
Total Credits	9	

## Information Systems

Public accounting firms seek graduates for the rapidly growing area of global risk management (GRM). Students entering GRM will be responsible for assessing accounting system and computer risks that impact the financial statements of the organization and for evaluating internal controls in place to minimize such risks. Their findings become an important element in the conduct of the financial audit. This new career path thus requires students who possess strong systems skills and an understanding of financial accounting, management accounting, and auditing. Taxes and advanced financial accounting topics are less important in this setting. Therefore, the following courses comprise this concentration.

ACCT 320	Fundamentals of Auditing	3
BIS 311	Managing Information Systems Analysis and Design	3
Select one of the following:		3
BIS 335	Web Application Development for Business	
BIS/SCM 342	e-Business Enterprise Applications	
BIS 360	Business Information Systems Practicum	
Total Credits		9

The description and requirements of the Master of Science in Accounting and Information Analysis Program are found under Graduate Study and Research.

Course descriptions for the College of Business and Economics graduate courses can be found under Business and Economics Graduate courses (p. 256).

### Courses

#### ACCT 108 Fundamentals of Accounting 3 Credits

A one-semester survey of accounting principles and practices designed for those students which includes an introduction to industrial cost systems designed for those non-CBE students planning to take only one accounting course. Other students should take the Acct 151-152 sequence.

#### ACCT 151 Introduction to Financial Accounting 3 Credits

The organization, measurement and interpretation of economic information. Introduction to accounting theory, concepts and principles, the accounting cycle, information processing, and financial statements. Exposure to controversial issues concerning income determination and valuation. Must have sophomore standing and successful completion of Excel competency exam.

**Prerequisites:** CBEC 1 or BUS 003 or MGT 001 or ENGR 001 or CSC 010 or CSE 010

#### ACCT 152 Introduction to Managerial Accounting 3 Credits

An introduction to internal accounting information for all levels of management. Topics include cost flow in a manufacturing operation; planning, evaluating and controlling through budgeting and standard costing; and decision-making using cost-volume-profit analysis, direct costing, and relevant costs. Prerequisites as noted below.

**Prerequisites:** ACCT 151

#### ACCT 307 Fundamentals of Federal Income Taxation 3 Credits

An introductory study of the principles and concepts of federal income taxation of individuals, corporations, partnerships, and fiduciaries; and federal gift and estate taxes. Determination of tax liabilities and opportunities for planning are emphasized. Problem-solving using the source materials of tax law and tax research are important components of the course. Prerequisites as noted below.

**Prerequisites:** ACCT 151

#### ACCT 309 Advanced Federal Income Taxation 3 Credits

An advanced study of the taxation of business organizations, estates, trust, and wealth transfer taxes. Planning and research are the basic components of the course. Problem-solving and written research are emphasized. Prerequisites as noted below.

**Prerequisites:** ACCT 307

#### ACCT 311 Accounting Information Systems 3 Credits

An introduction to the concepts underlying information systems as they relate to organizational structure, managerial decision making and accounting. The course acquaints students with the reports and documents generated by information systems, as well as procedures and controls employed in a variety of business applications. Students apply these concepts, techniques and procedures to the planning, analysis and design of manual and computer-based information systems. Prerequisites as noted below.

**Prerequisites:** ACCT 152 and BIS 111

#### ACCT 315 Financial Accounting I 3 Credits

Intensive study of the basic concepts and principles of financial accounting, emphasizing the problems of fair presentation of an entity's financial position and operating results. Consideration of the conceptual framework of accounting, review of the accounting process, and measurement and valuation of current assets, current liabilities, plant assets, intangibles, investments, and long-term debt. Problem-solving skills and critical analysis are stressed. Prerequisites as noted below.

**Prerequisites:** ACCT 152

#### ACCT 316 Financial Accounting II 3 Credits

The sequel to Accounting 315, this course continues with intensive study of such topics as stockholders' equity, valuation and disclosure of leases and pensions, income tax allocation, changing prices, revenue issues, earnings per share, and complexities related to the statement of changes in financial position. Analysis and interpretation of financial statements and problem-solving skills are integral parts of the course. Prerequisites as noted below.

**Prerequisites:** ACCT 315

#### ACCT 317 Advanced Financial Accounting 3 Credits

A study of specialized topics in financial accounting, including partnership accounting, business combinations and consolidated financial statements, segment and interim reporting, foreign currency transactions and translation, and accounting and reporting for governmental and other nonprofit organizations. Involves considerable problem-solving and critical evaluation of controversial theoretical issues. Prerequisites as noted below.

**Prerequisites:** ACCT 315 or ACCT 316

#### ACCT 318 Analysis of Financial Statements 3 Credits

This course uses financial statement information to analyze companies' profitability and risk. Understanding the form, content and relationships among the financial statements is integrated with the use of ratios and analytic adjustments to augment the information in published financial reports. Current developments, business strategies and off-balance-sheet financing are linked to assessments of companies, performance. Case studies, team projects and presentations involve actual companies, financial statements. Open only to graduating seniors. Prerequisites as noted below.

**Prerequisites:** ACCT 316

**Can be taken Concurrently:** ACCT 316

#### ACCT 320 Fundamentals of Auditing 3 Credits

An introduction to auditing theory, objectives, and practices related largely to the responsibilities of independent professional accountants. The auditing environment, generally accepted auditing standards, internal control theory, and reporting alternatives are considered. Exposure to operational auditing is provided. Prerequisites as noted below.

**Prerequisites:** (ACCT 311 or CSB 311) and (ACCT 315)

#### ACCT 324 Cost Accounting 3 Credits

An in-depth study of cost concepts appropriate for product costing in a manufacturing operation, planning and controlling routine operations, and nonroutine decision-making. Topics include job order and process costing, joint and by-products, cost allocation, budgeting, standard costing, direct costing, cost-volume-profit analysis, and relevant costs for decisions. Prerequisites as noted below.

**Prerequisites:** ACCT 152

**ACCT 371 Directed Readings 1-3 Credit**

Readings and research in various fields of accounting; designed for superior students who have a special interest in some topic or topics not covered by the regularly rostered courses. Written term paper(s) required. Must have preparation acceptable to the department chair.

**Repeat Status:** Course may be repeated.

**ACCT 372 Special Topics 1-3 Credit**

Special problems and issues in accounting for which no regularly scheduled course work exists. When offered as group study, coverage varies according to interests of the instructor and students. Must have preparation in accounting acceptable to the program coordinator.

**Business**

The designation of "business" refers to general business courses.

**Business Minor**

Program Admission Requirements: Each spring, 80 students will be accepted into the Business Minor Program for the following fall. Applications to the program will be made by students and submitted to the program director by the second Monday in February. An admissions committee comprised of the Business Minor Program director and the Business Minor curriculum committee will make admission decisions based on G.P.A., experience, and interest in pursuing business opportunities upon graduation from Lehigh (to be evaluated on the basis of a written essay). Students will be notified of admissions decisions prior to registration for the fall semester. Entrance into business minor classes will be controlled by restricted overrides by the Director of the Business Minor Program, Robert Kuchta, Professor of Practice, rok8@lehigh.edu, RBC 330.

**Professor Of Practice.** Joseph M. Manzo, MBA (Lehigh University)

**Business Courses****BUS 001 Introduction to Business 3 Credits**

An introduction to business, emphasizing critical issues impacting the business world, such as globalization, technology, ethics, and diversity. Provides an overview of the various functional areas of business and how they fit together. Stresses experiential learning and develops team-building skills. Strengthens written and oral communications skills. Provides an introduction to career opportunities and curriculum choices in business and economics. Course is offered only in the fall and is open only to College of Business and Economics students.

**BUS 005 Values Based Decision Making for Business 1 Credit**

An introduction to the foundations of business integrity. The role of individual decisions and ethics in business is explored. Students evaluate cases and ethical issues they are likely to face in business. Covers fundamentals of corporate governance and cases in governance failures such as WorldCom and Enron. Social responsibility, ethical business leaders, and current topics in business ethics are addressed. Class dialog is emphasized along with reflective writing. Open only to CBE students.

**BUS 125 Behavioral Skills Workshop 1 Credit**

BUS 125 is a course aimed to equip students to work with others in a business setting in making business decisions. The focus of the class is on effective decision making and includes such topics as group and team decision making, conflict resolution and negotiation, ethical decision making, and creative problem solving. This course is offered as a series of intensive workshops in the fall semester and is heavily focused on experiential learning. Prerequisites as noted below.

**Prerequisites:** ECO 001

**BUS 126 Information Analysis and Financial Decision Making I 3 Credits**

An integrated introduction to business, accounting and finance. Students are introduced to the goals, people and activities of business, before focusing on the fundamental elements of accounting and finance, including financial statement construction and analysis, time value of money, financing and investing with equity and debt, and the impact of various operating decisions on business. Experiential learning and development of team/communication skills are encouraged through portfolio simulation and financial analysis projects. Prerequisites as noted below.

**Prerequisites:** BUS 125

**Can be taken Concurrently:** BUS 125

**BUS 127 Information Analysis and Financial Decision Making II 3 Credits**

This course builds upon the foundational teachings of BUS 126 through examination of topics in portfolio management, capital investment decision making, business planning, analysis and reporting, and various specialized topics such as entrepreneurship, business law, ethics, internal control systems, and E-business. Experiential learning, and development of team/communication skills are encouraged through group projects and guest speakers. Prerequisites as noted below.

**Prerequisites:** BUS 126

**BUS 173 Non-Major Summer Internship 1-4 Credit**

CBE internships expose students to the business world, enriching their understanding of ideas and problems encountered in their business courses. This course is available summers and open to students in the College of Business & Economics and those in the following programs: CSB, IBE, and Business Minor. Students are evaluated on a directed writing assignment and on a detailed evaluation provided by the work supervisor. A minimum of 150 hours of work must be completed in the internship, and verified by work supervisor. Course registration and related arrangements must be made in advance of the work experience. This course does not satisfy any major requirements. Must have completion of a minimum of 24 college credits.

**BUS 211 Integrated Product Development (IPD) I 3 Credits**

Business, engineering, and design students work in cross disciplinary teams of 46 students on marketing, financial and economic planning, economic and technical feasibility of new product concepts. Team work on industrial projects with faculty advisors. Oral presentations and written reports. Must have junior standing in business, economics, arts or engineering.

**BUS 212 Integrated Product Development (IPD) II 2 Credits**

Business, engineering, and design arts students work in cross disciplinary teams of 4-6 students on the detailed design including fabrication and testing of a prototype of the new product designed in IPD course 1. Additional deliverables include a detailed production plan, marketing plan, detailed base-case financial models, project and product portfolio. Teams work on industrial projects with faculty advisors. Oral presentations and written reports. Prerequisites as noted below.

**Prerequisites:** BUS 211 or ENGR 211

**BUS 225 Developing, Producing, and Marketing Products and Services I 3 Credits**

Introduction to the key elements in the marketing framework of a corporation. Focus on defining marketing, analyzing the market and competitors, developing effective marketing strategies, segmenting the market, creating customer value, satisfaction, and loyalty, analyzing consumer and business markets, creating brand equity, and managing an effective marketing program to deliver the right products and services to the right audience at the right place at the right price and the right time. Emphasis on business writing skills. Experiential learning through the development of a product or service marketing plan. Prerequisites as noted below.

**Prerequisites:** BUS 127

**BUS 226 Developing, Producing, and Marketing Products and Services II 3 Credits**

This course extends the marketing management principles initiated in BUS 225 with the creation, development, and delivery of new product ideas to the marketplace. Comprehensive overview of the new product development process, including how to develop an effective development strategy, manage cross-functional teams across the organization, generate and evaluate concepts, manage the technical development of a product, develop the marketing plan, and manage the financial aspects of a project. As product innovation is a multi-disciplinary field, this course, while focusing on marketing's role in product innovation, relies heavily on techniques that encompass engineering, research and development, management, production, and design. Emphasis on business writing skills and creativity. Experiential learning through the implementation of a new product idea and the performance assessment of both the supporting marketing and business plan. Prerequisites as noted below.

**Prerequisites:** BUS 225

**BUS 300 Apprentice Teaching 1-3 Credit****BUS 311 Managing Information Systems Analysis and Design 3 Credits**

This course focuses on managing the requirements analysis and system design methodology and techniques for business information systems. Students learn current methods and techniques for system requirement analysis as well as system design, and apply them to real world projects. It covers cost benefit analysis and risk management of business systems development, JAD and structured walkthroughs, structured and object oriented methodologies, and software package evaluation. It emphasizes the factors for effective communication and integration with users and user systems and encourages interpersonal skill development with client users, team members, and others associated with development, operation, and maintenance of the system.

**Prerequisites:** BIS 111

**BUS 325 Business Data Management 3 Credits**

This course covers the fundamentals of database management systems (DBMS), including database development, processing, logical and physical design, access, implementation and administration. Students will gain extensive experience in developing data models, creating relational databases, and formulating and executing complex queries. The focus in the course will be on analyzing the connections between data and business organizational information needs and decisions, and understanding the principles of managing organizational data. The course includes a project with hands-on experience with a large scale database and SQL.

**Prerequisites:** BIS 311

**BUS 326 Business Strategy 1 Credit**

Business Strategy is a capstone course covering total enterprise problems in determination, execution, and control within a global setting. The course integrates the theories of production, marketing, finance and organization and provides an opportunity to study the function of higher level management as related to the total business environment through a team-based business simulation. Students will develop a business strategy and make decisions that impact performance metrics of the firm. Prerequisites as noted below.

**Prerequisites:** BUS 226

**Can be taken Concurrently:** BUS 226

**BUS 347 Practicum in Real Estate I 2 Credits**

This course is an interdisciplinary study of the creation of value in commercial real estate. Organized into groups, with each group assigned a different subject commercial real property, the class engages in the study of the physical and locational characteristics of commercial real estate as they relate to value including: property history; architecture; physical attributes that add to or detract from value; tenent mix; the immediate neighborhood environment; and, the specific market in which the real property competes for tenants. Each group submits a written report of their findings and produces a 10-minute video documentary on their subject property. Prerequisites: Permission of the instructor. Students enrolling in this course must also commit to enrolling in the follow-on course - Bus 348 - Practicum in Real Estate II.

**Prerequisites:** (ECO 145 or ECO 045 or ECO 146) and ACCT 151 and FIN 225

**BUS 348 Practicum II in Real Estate 2 Credits**

This course is a continuation of the interdisciplinary study of the creation of value in commercial real estate begun in Bus 347 - Practicum in Real Estate I. Organized into groups, with each group continuing with the subject commercial real property assigned to them in Bus 347, the class engages in the study of the market and financial characteristics of commercial real estate as they relate to value through: a financial analysis of the market in which their property is located to include market rents, market vacancy rates and market absorption rates; and, financial analysis of the subject property to include both historical results, and pro forma estimates of revenues, expenses, cash flow and residual value.

**Prerequisites:** BUS 347

**BUS 490 Thesis (Moc) 1 Credit****BUS 499 Dissertation (Moc) 1 Credit****Integrated Program Real Estate Courses****IPRE 001 Introductory Seminar in Real Estate 3 Credits**

Required of all entering ire@l students, this seminar explores a variety of issues related to real estate, entrepreneurship and leadership. Topics include: the relationship of real estate to finance, architecture, environmental issues, government, engineering, urban planning and economic development; the role of the entrepreneur in real estate and real estate development; ethical considerations in real estate; and, models of leadership. The seminar will consist of lectures and presentations by a variety of Lehigh faculty, entrepreneurs, and real estate professionals. Must have freshman OR sophomore standing. Consent of instructor required.

**IPRE 002 Field Laboratory 2 Credits**

An introduction to the real estate development process. Using an actual, planned commercial real estate development, the class will engage in an extensive inquiry into the breadth and depth of the real estate development process. Topics include: the sequence of events in the development process; parallel and sequential activities; impediments to highest and best use; strategies for overcoming impediments; managing relationships with various constituents; sources of capital; and, market analysis. Each class member will submit a final report detailing his or her findings with respect to these topics. Consent of instructor required. Prerequisites as noted below.

**Prerequisites:** IPRE 001

**IPRE 101 Real Estate Practicum Clerkship I 1 Credit**

Just as medical school and law school students serve clerkships as a key part of their academic preparation, ire@l students may serve clerkships in the Real Estate Practicum. Clerkship students will rotate among all of the groups engaged in the Real Estate Practicum - accompanying Practicum groups on site visits, observing those groups' interactions with various faculty and real estate professionals, and assisting those groups in the completion of numerous tasks. During the fall semester, the focus of these rotations be on the physical characteristics of the Practicum properties including design considerations, structural integrity, floor plans, building systems and tenant improvements. Students will also develop an understanding of the property's location, and how that location affects the use(s) of the property. Finally, students will gauge the area in which the property is located. Concurrent with these rotations, these students will reference their Field Laboratory property that is in an earlier stage of development, drawing a contrast between a completed property and a property under development. Consent of instructor required.

**Prerequisites:** (IPRE 001 and IPRE 002)

**IPRE 102 Real Estate Practicum Clerkship II 1 Credit**

A continuation of the fall semester, the spring semester rotations focus on the real estate markets in which the Practicum properties are located, and on the financial analysis (valuation) of the Practicum properties. As in the fall, at the conclusion of each rotation, the clerkship student will receive evaluations from faculty, practitioners and Practicum group members on their performance. Likewise, clerkship students will reference their Field Laboratory property to contrast the difference between the demonstrated value created (in a completed property) and the value that is expected to be created (in a property under development). Consent of instructor required.

**IPRE 300 Apprentice Teaching 1-4 Credit**

**Repeat Status:** Course may be repeated.

**IPRE 301 Case Studies in Real Estate Value Creation 3 Credits**

An investigation into ways in which the entrepreneur is able to create value through the development or redevelopment of real estate. Issues: establishing a real property's highest and best use; the entrepreneurial thought process; zoning, planning and land use regulations and their effects on real estate development; real and potential environmental impacts and their effects on real estate development; the role of government in stimulating (or destimulating) real estate development; overcoming barriers to real estate development; negotiation techniques; and, application of alternative strategies in the development process. The course is taught using the case method with the majority of the cases from previous Real Estate Practica. The course is a combination of lectures, presentations by entrepreneurs, and site visits to (re)developed properties as well as properties in the planning phase. Consent of instructor required.

**IPRE 302 IPRE Internship 1 Credit**

Open to students in the Integrated Real Estate At Lehigh (ire@l) Program. The student will be evaluated on a directed writing assignment of no fewer than 9 pages and on a detailed evaluation provided by his or her work supervisor. A minimum of 150 hours of work must be completed in the internship, and verified by work supervisor. It should be noted that the work experience itself is not the basis for academic credit. Course registration and related arrangements must be made in advance of the work experience. This course cannot be used to satisfy any major requirements. Consent of program director required. In extraordinary circumstances and with the consent of the program director this requirement can be altered according to the director's stipulations.

**Prerequisites:** (IPRE 001 and IPRE 002)

**IPRE 347 Practicum in Real Estate I 2 Credits**

Organized into teams, with each team assigned a different subject commercial real property, the class engages in the study of the physical and locational characteristics of commercial real estate as they relate to value including: property history; architecture; physical attributes that add to or detract from value; tenant mix; the immediate neighborhood environment; and, the specific market in which the real property competes for tenants. Each team meets with the property owner and conducts a thorough review of the property's development process including, where applicable, previous attempts to develop the property, prior uses for the property, and significant phase points in the development process (for example, "deal killing" impediments that were overcome). Each team submits a written report of their findings and produces a 10-minute video documentary on their subject property. Permission of the instructor required.

**IPRE 348 Practicum in Real Estate II 2 Credits**

A continuation of the study of the creation of value in commercial real estate begun in the Practicum in Real Estate I. Each student team continues with the subject commercial real property assigned to them in Practicum I. The class engages in the study of the market and financial characteristics of commercial real estate as they relate to value through: a financial analysis of the market in which their property is located to include market rents, market vacancy rates and market absorption rates; and, financial analysis of the subject property to include both historical results, and pro forma estimates of revenues, expenses, cash flow and residual value. Each team also studies the financial characteristics of comparable properties. The grand finale of the Real Estate Practicum (and the IPRE curriculum) is the Collins Family Scholarship Competition. Held at the conclusion of the spring semester, this competition is the public vehicle for the Practicum teams to present the results of their property studies. Consent of instructor required. Prerequisites as noted below.

**Prerequisites:** IPRE 347

**Business Information Systems**

Business information systems serve as a conduit for business change and they are the heart of today's business model. Our diverse faculty and contemporary curriculum is targeted at preparing our students to play a vital, value-added role in today's rapidly changing business information environment.

Beyond understanding the key prerequisite technical skills, students will learn how businesses can leverage information technology and business information systems in conjunction with various management techniques in order to meet corporate tactical and strategic goals. By being introduced to the spectrum of today's leading technologies, students will understand the business implications and opportunities addressed in today's global economy.

The business information systems field is vibrant and exciting. There are a broad range of employment opportunities. Successful completion of the BIS program would invite students to pursue a wide range of career opportunities, including careers as a systems analyst/designer, information systems manager, information systems project manager, and information systems consultant.

The Business Information Systems major requires four (4) courses and two (2) electives beyond the core requirements of the College of Business and Economics. Students are required to take BIS 111, Introduction to Information Systems, as part of the business and economics core. Other courses are as follows:

**Required Courses**

BIS 311	Managing Information Systems Analysis and Design	3
BIS 324	Business Data Management	3
BIS 335	Web Application Development for Business	3
BIS 350	Project Management	3

**Elective Courses**

Select two of the following:

6

ACCT 311	Accounting Information Systems	
BIS 333	Enterprise Security and Risk Management	
BIS/SCM 342	e-Business Enterprise Applications	
BIS 372	Special Topics in Information Systems	1
CSB 314	International Practicum	
Total Credits		18

1 Courses focusing on different applications of IS in business, including: Data Warehousing and Mining, HR Applications in IS, Numerical Methods of Business Decisions, etc. Consult Professor Ridings for other related courses.

### Business Information Systems Minor

This minor provides an overview of the major technical functions in IS, such as design of systems and the development and management of databases. In addition, the student explores the applications of IS to business problems in one of several electives. This minor is available only to students with a declared major in the College of Business and Economics.

Program of Studies: The BIS minor consists of 3 courses equaling 9 credit hours. These credit hours consist of the following courses:

### Required Courses

BIS 311	Managing Information Systems Analysis and Design	3
BIS 324	Business Data Management	3
Select one of the following:		3
BIS 335	Web Application Development for Business	
BIS 342	e-Business Enterprise Applications	
BIS 333	Enterprise Security and Risk Management	
Total Credits		9

### Courses

#### BIS 111 Introduction to Information Systems 3 Credits

This course examines the fundamental role of information systems in supporting and managing all business functions and enabling firms to compete effectively. Both technical and managerial aspects of information systems are introduced. The course integrates technical infrastructure, database concepts, management decision-making, and business process issues critical to the understanding of operational and strategic information systems. It introduces business applications that support accounting, finance, supply chain management, and marketing. Must have Excel competency.

**Prerequisites:** CBEC 1 or ENGR 001

#### BIS 300 Apprentice Teaching 1-4 Credit

#### BIS 311 Managing Information Systems Analysis and Design 3 Credits

This course focuses on managing the requirements analysis and system design methodology and techniques for business information systems. Students learn current methods and techniques for system requirement analysis as well as system design, and apply them to real world projects. It covers cost benefit analysis and risk management of business systems development, JAD and structured walkthroughs, structured and object oriented methodologies, and software package evaluation. It emphasizes the factors for effective communication and integration with users and user systems and encourages interpersonal skill development with client users, team members, and others associated with development, operation, and maintenance of the system. Prerequisites as noted below or consent of instructor.

**Prerequisites:** ACCT 311 or CSB 311 or BIS 111

#### BIS 324 Business Data Management 3 Credits

This course covers the fundamentals of database management systems (DBMS), including database development, processing, logical and physical design, access, implementation and administration. Students will gain extensive experience in developing data models, creating relational databases, and formulating and executing complex queries. The focus in the course will be on analyzing the connections between data and business organizational information needs and decisions, and understanding the principles of managing organizational data. The course includes a project with hands-on experience with a large scale database and SQL. Prerequisites as noted below.

**Prerequisites:** BIS 311

#### BIS 331 Electronic Commerce 3 Credits

This course covers how businesses and consumers use the Internet to exchange information and complete transactions. Both theoretical concepts and practical skills will be addressed with the scope of the class. Topics include advertising and marketing, ecommerce business and revenue models, online consumer behavior, web-site design issues, Internet security, electronic payments, infrastructure issues, privacy issues, and overall electronic commerce strategy. Students will get hands-on experience designing ecommerce web-sites using web authoring software. Prerequisite: BIS 111, MKT 111 or consent of instructor.

**Prerequisites:** (BIS 211 or BIS 111 or CSB 311 or ACCT 311) and (MKT 111 or MKT 211)

#### BIS 333 Enterprise Security and Risk Management 3 Credits

This course covers modern data communication technologies and how they are used in business. It provides an exposure to current and emerging networking and telecommunications technologies, introduces software and hardware fundamentals for various computer/network architectures, and provides an understanding of the business context of these technologies. Students will learn how to evaluate, select, and implement different communication options within an organization. The course emphasizes the business context of data communication technologies. Prerequisites as noted below.

**Prerequisites:** BIS 111

#### BIS 335 Web Application Development for Business 3 Credits

This course provides an introduction to planning, designing, developing and maintaining web-delivered content and applications by creating and publishing interactive and dynamic web sites. Students will learn basic systems development and computer programming concepts by designing, coding, and testing using client side and server side scripting. Emphasis will be placed on developing professional, customer-focused web sites for commercial purposes, including forms to obtain and validate information from the user, input/output functions to read and write files, and connections to databases to read, create and update records. Students will learn data types and control statements common to all programming languages and the use of basic SQL to handle data from databases. Some previous experience with programming helpful but not required. Hands on exercises will be included, taught in the computer lab. Prerequisites as noted below.

**Prerequisites:** BIS 111

#### BIS 342 e-Business Enterprise Applications 3 Credits

Introduction to the implications of key information technologies used within and across businesses to conduct e-business. The course covers the functionality of various enterprise applications and their integration: customer relationship management, enterprise resource planning, supply chain management, supplier relationship management, data warehousing and mining, business intelligence, and product lifecycle management. Prerequisites as noted below or consent of instructor.

**Prerequisites:** BIS 111

**BIS 350 Project Management 3 Credits**

Key processes and tenets of project management including scope, time, cost, quality, human resources, communications, risk, procurement, and integration management. Both technical and behavioral aspects of project management are applied within the context of either IS management, HR management, Supply Chain Process Management, Small Business Management. Topics include: expectations management, change management and consulting engagement management. Introduces both software project monitoring tools and project team collaboration techniques and tools. Must have completion of all other courses in either BIS or Management major.

**Prerequisites:** BIS 120 or BIS 015 or CSE 017 or BIS 335 and BIS 324

**BIS 360 Business Information Systems Practicum 3 Credits**

The business information systems practicum provides an opportunity for students to work on an intensive consulting engagement with a business. Students work with client firms on individual or team projects, which focus on information systems activities such as developing requirements, designing, and implementing systems. Students complete written reports and make formal presentations to clients. May not be taken concurrently with MGT 311. Course cannot be used to satisfy BIS major or minor requirements. Must have junior standing in the College of Business and Economics.

**BIS 371 Directed Readings 1-3 Credit**

Readings and research information systems; designed for superior students who have special interest in some topic(s) not covered by the regularly scheduled courses. Written term paper(s) required. May be repeated. Must have preparation in information systems acceptable to program coordinator.

**Repeat Status:** Course may be repeated.

**BIS 372 Special Topics in Information Systems 1-3 Credit**

Special problems and issues in information systems for which no regularly scheduled course work exists. When offered as group study, coverage varies according to interests of the instructor and students. May be repeated. Must have preparation in information systems acceptable to program coordinator.

**Repeat Status:** Course may be repeated.

**BIS 373 Business Information Systems Internship 1-3 Credit**

Based on a student's work experience, a sponsoring faculty member shall direct readings, projects, and other assignments-including a "capstone report." It should be noted that the work experience (at least 80 hours per credit), by itself, is not the basis for academic credit. The faculty directed activity must be provided concurrent with the work. Course registration and related arrangements, including designating a sponsoring faculty member, must be made in advance of the work engagement. This course must be taken Pass/Fail, is not repeatable and cannot be used to satisfy BIS major or minor requirements. Declaration of a BIS major or minor, junior standing, and consent of department required. Prerequisites as noted below.

**Prerequisites:** BIS 311

**Business and Economics Graduate Courses**

Graduate degree programs (p. 245) offered by the college include the Master of Business Administration, the Master of Science in Accounting and Information Analysis, the Master of Science in Economics, and the Ph.D. in Business and Economics. Interdisciplinary degree programs (p. 380) are offered through partnerships with other colleges: P.C. Rossin College of Engineering and Applied Science - Master of Business Administration and Engineering; P.C. Rossin College of Engineering and Applied Science and the College of Arts and Sciences-Master of Science in Analytical Finance; College of Education-Master of Business Administration and Educational Leadership. Graduate certificate programs (p. 245) offered include Corporate Entrepreneurship, Project Management and Supply Chain Management.

Courses for the programs are taught by faculty from the Accounting (p. ), Economics (p. ), Finance (p. ), Management (p. ), and Marketing (p. ) departments.

**Professors.** J. Richard Aronson, PhD (Clark University); Shin-Yi Chou, PhD (Duke University); James A. Dearden, PhD (The Pennsylvania State University); Mary E. Deily, PhD (Harvard University); Thomas J. Hyclak, PhD (University of Notre Dame); Arthur E. King, PhD (Ohio State University); Judith A. McDonald, PhD (Princeton University); Vincent G. Munley, PhD (State University of NY, Binghamton University); Larry W Taylor, PhD (University of North Carolina Chapel Hill); Robert J. Thornton, PhD (University of Illinois Upper Chicago); Todd A. Watkins, PhD (Harvard University)

**Associate Professors.** Frank R. Gunter, PhD (Johns Hopkins University); Chad Meyerhoefer, PhD (Cornell University)

**Assistant Professors.** Ernest Kong-Wah Lai, PhD (University of Pittsburgh); Alberto Lamadrid, PhD (Cornell University); Oleksandr Nikolsko Rzhevskyy, PhD (University of Houston University Park); Irina Panovska, PhD (Washington University); Muzhe Yang, PhD (University of California Berkeley)

**Professor Of Practice.** Maria Augusta Figueroa Armijos, PhD (University of Missouri Columbia)

**Emeriti.** Nicholas W. Balabkins, PhD (Rutgers University); Alvin Cohen, PhD (University of Florida); Jon T. Innes, PhD (University of Oregon); John R. Mc Namara, PhD (Rensselaer Polytechnic Institute); Anthony Patrick O'Brien, PhD (University of California Berkeley)

**Economics Courses****ECO 401 Basic Statistics for Business and Economics 3 Credits**

Descriptive statistics, probability and probability distributions, estimation, hypothesis testing, correlation and regression, chi-square analysis, and analysis of variance. Computer applications.

**ECO 402 Managerial Economics 3 Credits**

Application of economic and statistical analysis to managerial decision-making. Business and economic forecasting. Empirical estimation of demand, production, and cost functions. Resource allocation and pricing strategies in various market structures. Decisions under risk and uncertainty. Government regulation of business. Cases. Prerequisites as noted below.

**Prerequisites:** MATH 021 and MATH 022 and ECO 401

**ECO 412 Mathematical Economics 3 Credits**

Applications of various mathematical techniques in the formation and development of economic concepts and theories. Consent of instructor required.

**ECO 413 Advanced Microeconomics Analysis 3 Credits**

A survey of methods of decision-making at the microeconomic level; price theory and econometric applications. Prerequisites as noted below.

**Prerequisites:** ECO 402

**ECO 414 Advanced Topics in Microeconomics 3 Credits**

Resource allocation and price determination. Theories of choice of consumers, firms, and resource owners under various market forms. Prerequisites as noted below.

**Prerequisites:** ECO 413

**ECO 415 Econometrics I 3 Credits**

Computer applications of standard econometric techniques using regression analysis in a single-equation context. Discussion of problems of multicollinearity, heteroscedasticity and autocorrelation. An introduction to simultaneous equation models, identification and estimation problems. Prerequisites as noted below.

**Prerequisites:** ECO 401

**ECO 416 Econometrics II 3 Credits**

Mathematical and statistical specification of economic models. Statistical estimation and tests of parameters in single and multiple equation models. Prediction and tests of structural change. Prerequisites as noted below.

**Prerequisites:** ECO 415

**ECO 417 Advanced Macroeconomic Analysis 3 Credits**

Macroeconomic theory and policy. Emphasis on theoretical models and policy implications.



**ECO 418 Advanced Topics in Macroeconomics 3 Credits**

Models of employment, income and growth in monetary economies. Policies for economic stability and growth. Prerequisites as noted below.  
**Prerequisites:** ECO 417

**ECO 423 Real Options 3 Credits**

This is an introductory graduate level course in financial economics. It is intended for students with strong technical backgrounds who are comfortable with mathematical arguments. The course is divided into three major parts: deterministic finance, single-period uncertainty finance, and options theory and its applications. Prerequisite as noted below.

**Prerequisites:** GBUS 420

**ECO 425 Cost-Benefit Analysis 3 Credits**

Theory and methods of cost-benefit analysis; efficiency and equity as criteria in program evaluation; proper measurement of market and non-market costs and benefits; consideration of risk, uncertainty, appropriate discounting techniques, and distributional consequences; applications to the evaluation of health care policies and therapies. Prerequisites as noted below or consent of instructor.

**Prerequisites:** ECO 402 and (ECO 357 or ECO 415)

**ECO 429 Monetary Theory 3 Credits**

The role of money in the economy from theoretical and empirical perspectives. The influence of money and prices, interest rates, output, and employment.

**ECO 430 Public Finance 3 Credits**

The economics of public spending and taxation; principles of government debt management; theories of budgeting and cost-benefit analysis and public choice.

**ECO 440 Labor Economics I 3 Credits**

The economics of labor markets and various labor-market institutions with emphasis on current theoretical and empirical research. Topics include labor supply and demand, human capital, the structure of labor markets, labor market regulation, information and job search, labor mobility, unionism, and labor market discrimination. Prerequisites as noted below.

**Prerequisites:** ECO 401 and ECO 402

**ECO 441 Labor Economics II 3 Credits**

An examination of empirical research in labor economics, focusing on topics such as human resource management and internal labor market outcomes, wage and income inequality and poverty, unemployment, and other issues current in the literature. Prerequisites as noted below.

**Prerequisites:** ECO 402 and ECO 415

**ECO 447 Economic Analysis of Market Competition 3 Credits**

Mathematical models based on game theory and industrial organization. Cases are used to analyze the strategic interaction of firms and governments as competitors and partners. Prerequisites as noted below or consent of instructor.

**Prerequisites:** ECO 402

**ECO 454 Economics of Environmental Management 3 Credits**

Economic theory of natural resources. Optimal policies for the development of renewable and nonrenewable resources and environmental quality. Prerequisites as noted below.

**Prerequisites:** ECO 402

**ECO 455 Health Economics I 3 Credits**

Economic theory and empirical analysis of health production, the demand for health services, and health insurance. Implications for the current institutional structure of health care and health delivery systems will also be discussed. Additional topics and extensions will be selected based on developments in the literature. Prerequisites as noted below.

**Prerequisites:** ECO 402 and ECO 415

**ECO 456 Industrial Organization 3 Credits**

The goal of the course is to review theoretical and empirical attempts by economists to understand market structures lying between the extremes of perfect competition and monopoly. The course will focus first on describing the current U.S. industrial structure and reviewing models of imperfect competition. The course then shifts to a closer study of individual firm behavior. The final segment of the course is an overview of two significant relationships between government and industry caused by the existence of imperfect competition.

**ECO 457 Bio-Pharmaceutical Economics 3 Credits**

Characteristics of the market for pharmaceuticals; barriers to entry, competition and innovation; pricing and regulation; physician prescribing behavior; commercialization and financing of biotech startups; international comparisons of public policy. Prerequisites as noted below or consent of instructor.

**Prerequisites:** ECO 401 and ECO 402

**ECO 460 Time Series Analysis 3 Credits**

Classical decomposition of time series, trend analysis, exponential smoothing, spectral analysis and Box-Jenkins autoregressive and moving average methods.

**ECO 461 Forecasting 3 Credits**

Methods of economic and business forecasting.

**ECO 463 Topics in Game Theory 3 Credits**

A mathematical analysis of how people interact in strategic situations. Topics include normal-form and extensive-form representations of games, various types of equilibrium requirements, the existence and characterization of equilibria, and mechanism design. The analysis is applied to micro-economic problems including industrial organization, inter-national trade, and finance. Must have completed two semesters of calculus. Prerequisites as noted below or consent of instructor.

**Prerequisites:** ECO 412 and ECO 413

**ECO 464 Applied Econometrics I 3 Credits**

This course focuses on the identification of causal relationships using cross-sectional and panel data. The objectives are to 1) familiarize students with identification assumptions for causal inference; and 2) enable students to select appropriate econometric tools for empirical economic problems and policy evaluation. Topics include robust inference and bootstrap; instrumental variables and generalized method of moments (GMM); quantile and nonparametric regression methods; treatment effect analysis, and models for discrete choices, panel data, and social interactions. Prerequisites as noted below.

**Prerequisites:** ECO 416

**ECO 465 Applied Econometrics II 3 Credits**

Econometric analysis of skewed and truncated distributions, discrete outcomes, and missing or incomplete data. The first part of this course will involve the functional specification and testing of appropriate estimators in these situations, while the second part of the course will focus on conducting causal inference using nonlinear models in the presence of unobserved heterogeneity. Emphasis will be given to common applications in health and labor economics. Prerequisites as noted below.

**Prerequisites:** ECO 416

**ECO 466 Health Economics II 3 Credits**

Selected topics in the literature on health economics with an emphasis on the application and evaluation of econometric techniques and identification strategies. Both demand and supply side issues will be addressed. Examples of the former include the demand for health, health insurance and health care services, while examples of the latter include the regulation of supplier behavior and industrial organization issues. Prerequisites as noted below.

**Prerequisites:** ECO 402 and ECO 416

**ECO 472 International Trade Theory 3 Credits**

Theories of comparative advantage, factor price equalization, trade and welfare, tariffs, trade and factor movements. Prerequisites as noted below or consent of department chair.

**Prerequisites:** ECO 413

**ECO 473 International Monetary Economics 3 Credits**

Theory of the balance of payments, the microeconomics of international finance, various approaches to balance-of-payments adjustments, theories of foreign exchange-rate determination, and macroeconomic policy under fixed and flexible exchange rates. Prerequisites as noted below or consent of department chair.

**Prerequisites:** ECO 417

**ECO 490 Master's Thesis 6 Credits****ECO 492 Special Topics in Economics 1-3 Credit**

Extended study of an approved topic not covered in scheduled courses. May be repeated for credit.

**Repeat Status:** Course may be repeated.

**ECO 493 Doctoral Pre-Dissertation Research Project - Independent Study 1-9 Credit**

Independent study on a topic that is being pursued to fulfill the third year paper requirement, and has been approved by the student's interim advisor.

**ECO 499 Dissertation 1-15 Credit**

**Repeat Status:** Course may be repeated.

**Grad Business Entrepreneurship Courses****GBEN 401 The Business Plan I: Strategic Considerations 2 Credits**

This course is first of a two-part sequence that focuses on the initial steps necessary to design and build a high-impact business plan for the startup company or new enterprise within an existing firm. The development process is integrative, complex, and time-consuming for the entrepreneur. Foundation or strategic-level issues that impact the formation and growth of the new enterprise are addressed. The goal in this first phase is to complete various sections of the business plan that deal with market opportunity, industry trends and developments, company positioning, competitive advantage, and core competencies. This course is project-oriented and makes extensive use of one-on-one instruction between class meetings. Students identify a market opportunity, develop the product/service offering, target potential customers and users, assess market demand, analyze market penetration, and determine the revenue potential of the new venture.

**GBEN 402 The Business Plan II: Operating Strategies and Implementation 2 Credits**

This course is the second of a two-part sequence that focuses on the final steps necessary to complete the business plan. This phase concentrates on designing the appropriate operational framework and business processes, including technology and infrastructure, which are required to successfully launch the new enterprise. The business plan must also demonstrate that the venture will have strong leadership and a capable management team to deal with uncertainty and drive results. Finally, the business plan must incorporate detailed financial forecasts and financing methods, and should address equity valuation and investor exit strategies. Like its predecessor, this course is project-oriented and makes extensive use of one-on-one instruction between class meetings. Additional emphasis is placed on developing an effective format and packaging of the written document.

**Prerequisites:** GBEN 401

**GBEN 403 Anatomy of Entrepreneurship: Startups and Established Companies 1 Credit**

This interactive seminar focuses on understanding the true meaning of entrepreneurship. The new venture opportunity is profiled from the perspective of the individual entrepreneur who is starting a business and embarking on a new career path involving high risk and reward. Different entrepreneurial management styles are analyzed and highlighted. Course emphasis is also placed on managing innovation and creativity in a corporate environment. Successful implementation of entrepreneurial activities for the large company makes special demands on management to promote discovery and create internal stakeholders. Both startups and established companies are placed under the microscope through guest speakers, panel discussion, selected readings, and case analysis.

**GBEN 404 Market Opportunity: Targeting Strategies and Selling Tactics 1 Credit**

The focal point of any business plan is identifying and understanding the target customer that will be served. The product/service offering must have strong buyer appeal and capture immediate attention in the marketplace. The need to rapidly penetrate a market demands that a marketing mix be designed, built, and implemented in a manner that leads to differentiation and superior positioning. Maximizing marketing firepower with severely limited financial and organizational resources is a major challenge that confronts today's entrepreneurs. Market segmentation strategies, the target marketing process, forming market alliances, and managing the selling process are viewed from the perspective of seed and early stage ventures.

**GBEN 405 Intellectual Property: Management and Valuation 1 Credit**

New technologies create new markets and new venture possibilities. Their discovery and success rate, along with the ability of an enterprise to leverage these assets in markets, depends on how the firm views and manages its investment in intellectual property. Obtaining the necessary legal protection of intellectual property can also serve as an effective barrier to entry and may be a source of competitive advantage. This seminar focuses on the strategic management of intellectual property as a commercial enterprise, covers methods of valuation, and examines various accounting and legal issues that must be considered in strategic-level decision making.

**GBEN 406 Performing a Business Enterprise Audit: Developing an Industry Perspective 1 Credit**

New ventures must position themselves for long-term growth and market development. Entrepreneurs create enterprises, define their organizations, and build business models based on changes in technology, government regulation, demographics, and shifts in other exogenous variables. A strategy must be crafted that is sustainable over the long run. Success or failure is often predicated on market cycles, market saturation, supply/demand imbalances and other forces that are not controllable. This seminar places emphasis on assessing the market potential and valuation of startups from an industry or macro-perspective, particularly from the view of an outside investor. It also focuses on how to gather and make effective use of competitive intelligence.

**GBEN 407 Processes and Infrastructure: Creating Production and Delivery 1 Credit**

This course provides an overview of the internal capabilities and the process and technology platform required to fully operationalize the business plan. Critical business activities and functions are dissected, such as establishing needed backend procurement, production, and distribution services that focus on supply chain dynamics and management; determining the scope of frontend call center and e-commerce activities; managing logistics; and utilizing information systems and web-based solutions that effectively link customers, elements of the supply chain, and employees. These topics are explored from the perspective of the startup and emerging company as well as the large corporation engaged in new venture creation.

**GBEN 408 The New Venture Organization: Management, Design, and Governance 1 Credit**

Managing a new enterprise presents unique and difficult challenges for its leadership. Expanding workloads and the increased complexity of tasks resulting from the rapid and sustained growth of the business create the need for a smooth transition from entrepreneurial-style management to professional management. Timing is critical, and for many startups it is not an easy bridge to cross. This course dissects the design and characteristics of small organizations, and the need to correctly align structure with strategy. It also considers how entrepreneurial activities should be seeded, managed, organized, and executed within the context of an established company. Under scrutiny are the heavy demands placed upon entrepreneurs and corporate managers to effectively lead and manage under highly uncertain conditions where change is a constant. Additional course emphasis is placed on comprehending the critical role that boards of directors play for startup companies.

**GBEN 409 Financial Forecasting: Developing Pro Forma Financial Statements 1 Credit**

No business plan would be complete without providing detailed financial projections and identifying the key assumptions that help shape the numbers. The financial translation of business models is expressed through pro forma income statements, balance sheets, and sources and uses of funds. Having this information allows management, investors, and lenders to measure and evaluate future financial performance. This exercise also establishes the capitalization required to launch the venture, support operations, and meet interim goals as the enterprise progresses through the beginning stages of its development. Course emphasis is placed on the use of forecasting methods and breakeven analysis, working capital and cash flow management, and identification of accounting and financial issues that impact on profit measurement and financial risk.

**GBEN 410 Financing StartUps: Seeking Outside Venture Capital 1 Credit**

This course provides an overview of the venture capital market, examines the nature and role of the venture capitalist, and analyzes whether and how venture capital financing may be the preferred approach in raising outside capital. Venture deals are closely examined in terms of types of equity instrument, methods of valuation, milestones and staged release of funds, special provisions that may include anti-dilution measures and other protective arrangements, and developing term sheets. Emphasis is also given to dissecting the process and criteria used to seek and attract venture capitalists, including angel investors. Various scenarios and tradeoffs are covered in this intensive course.

**GBEN 411 Establishing Credit Facilities: Asset-Based and Cash Flow Financing 1 Credit**

Borrowing from a commercial bank or a credit intermediary can provide outside funding for working capital and equipment purchases in many situations. For seed and early stage firms, attention is often given to asset-based lending programs that make use of first liens on accounts receivable and inventory or fixed assets to provide added legal protection to creditors. For later stage firms, traditional line-of-credit financing may be feasible and desirable from a cash flow standpoint. Various borrowing alternatives, including leasing, are covered in this course along with covenants and restrictions that often apply. Government loan programs, especially those of the Small Business Administration, are also given emphasis.

**GBEN 412 Developing Exit Strategies: Concepts and Approaches 1 Credit**

Sophisticated equity investors require that an exit or harvest plan be developed and that it be viable and capable of being executed within the foreseeable future. Venture capitalists and angel investors anticipate their future departure and a positive financial outcome at the very point the deal is struck in the present. Various planned and unplanned exit strategies are analyzed in this course which include: an initial public offering, offering the business for sale, merging with another company, franchising, acquisition of shares by some investors, or liquidation of the business. Valuation methods, financial and tax implications, and due diligence are also examined.

**GBEN 413 Integrative Experience/New Venture Internship 1-4 Credit**

Only students enrolled in the Entrepreneurial concentration may elect one of these hands-on, project-orientated courses. Integrative Experience must meet the requirements of formal independent study and involve a new venture situation with a startup or existing company. Students employed in a New Venture Internship may also qualify for course credit if the same requirements are satisfied.

**GBEN 415 LehighSiliconValley 1-3 Credit**

Immersion study-abroad-like program focused on venture capital-backed companies and the paths taken to start, build, and exit an enterprise. Offered in the hub of entrepreneurship, Silicon Valley, live cases draw on seasoned practitioners from all reaches of the venture community. Students strategically analyze and evaluate startups, lead discussion, and assess team performance in recommending go-forward strategies. Emphasis on real companies, real players, and real situations in real time create a highly charged learning environment. Winter term. Includes pre-trip sessions. Competitive admission. Program fees.

**GBEN 424 Entrepreneurship & Innovation: From Idea to Opportunity 3 Credits**

Thought about starting a business but wonder where to begin? Course focuses on the idea stage of new venture creation where discovery plants seeds of future enterprises. Student projects, case studies and speakers introduce personal, interpersonal, financial, and legal challenges startups encounter. Drawing on research on entrepreneurial decision-making, students learn to think and behave entrepreneurially. Participants "kick the tires" on their own and others' just-emerging ideas and improve them. For those interested in starting a business sometime in their lives.

**GBEN 492 Special Topics 1-3 Credit****Graduate Business Courses****GBUS 401 Financial Reporting for Managers and Investors 3 Credits**

Corporate financial reporting under Generally Accepted Accounting Principles. Analysis and interpretation of financial statements: accrual accounting, balance sheet valuation, income determination and cash flow analysis. Profit manipulation, window dressing and "creative accounting" through accounting policy choices. Fraudulent financial reporting, uses and limitations of accounting information. Accounting information as a tool for strategic decision making.

**GBUS 413 Advanced Management Accounting 3 Credits**

Issues in management accounting including activity-based costing, activity-based management, strategic cost management, theory of constraints, advanced manufacturing technologies, cost of quality and lifecycle costing. Readings and cases. Prerequisites as noted below.

**Prerequisites:** MBA 403

**GBUS 414 Financial Statement Analysis and Interpretation 3 Credits**

This course focuses on analysis of financial statements. It develops the skills necessary to interpret and use financial statement information effectively to assess profitability and risk and is intended for individuals likely to become intensive users of financial accounting information. Requirements include readings, case studies, presentations, and written analysis of actual financial statements. Prerequisites as noted below or consent of instructor.

**Prerequisites:** (MBA 402) or (ACCT 151 and FIN 125 or FIN 225)

**GBUS 419 Financial Management 3 Credits**

An intermediate level course in corporate finance. Coverage includes capital budgeting techniques including real options, decision tree analysis, risk analysis, advanced cost of capital theories, capital structure theory, dividend policy, working capital management, mergers and acquisitions, restructuring, and bankruptcies. The course emphasizes both theory and practice through lectures, cases, and financial modeling exercises. Students not possessing the relevant prerequisites must obtain waivers from the designated finance faculty representative. Prerequisites as noted below.

**Prerequisites:** (MBA 402) or (ACCT 151 and FIN 125)

**GBUS 420 Investments 3 Credits**

A survey course in investments. Overview of financial institutions and markets involved in the issuance and trading of securities. Emphasis on valuation and risk assessment of fixed income and equity securities. Construction of optimal portfolios and examination of performance measures. Students not possessing the relevant prerequisites must obtain waivers from the designated finance faculty representative. Prerequisites as noted below.

**Prerequisites:** (MBA 402) or (ACCT 151 and FIN 125)

**GBUS 421 Advanced Investments 3 Credits**

Advanced topics relating to specific areas within investment finance such as valuation/security analysis; portfolio/risk management; fixed investment securities; mutual funds; hedge funds; microstructure; and trading. May be repeated. Prerequisites as noted below or consent of designated finance faculty representative required.

**Repeat Status:** Course may be repeated.

**Prerequisites:** GBUS 420

**GBUS 422 Derivatives and Risk Management 3 Credits**

The theory and application of a variety of derivative instruments (options, futures contracts, etc.) used in corporation finance and the financial services industry. The focus is on the risk management application vs. a rigorous development of option pricing theory and similar topics. Prerequisites as noted below or consent of designated finance faculty representative required.

**Prerequisites:** GBUS 420

**GBUS 424 Advanced Topics in Financial Management 3 Credits**

Advanced topics relating to specific areas of corporate finance such as: theoretical and empirical examination of recent developments in financial management, asset valuation and capital budgeting including the role of uncertainty, imprecise forecasts, risk preferences, inflation, market conditions, and the global marketplace, working capital management, leasing, mergers, and financing. The course content may vary between instructors or each time the course is offered. May be repeated. Prerequisites as noted below or consent of designated finance representative.

**Repeat Status:** Course may be repeated.

**Prerequisites:** GBUS 419

**GBUS 425 Real Estate Financing and Investing 3 Credits**

An upper-level course in modern real estate financing techniques from the perspectives of both the borrower and the lender. Subject matter encompasses the following areas: The principles of financing decisions; financing methods and techniques; institutional sources of funds for real estate; and real estate financing decisions. Prerequisites as noted below or consent of designated finance faculty representative required.

**Prerequisites:** (MBA 402 and GBUS 420)

**GBUS 426 Financial Markets and Institutions 3 Credits**

Functions and portfolios of financial intermediaries. Sectional demand and supply of funds, nature and role of interest rates, term structure and forecasting, impact of inflation and regulations on financial intermediaries and markets, and current developments in the financial system. Management of assets and liabilities within the U.S. financial institution's legal and economic constraints. Prerequisites as noted below or consent of designated finance faculty representative.

**Prerequisites:** (GBUS 420)

**GBUS 431 Quantitative Finance 3 Credits**

Relationship of quantitative models to financial theory and applications. Capital budgeting, portfolio selection, security evaluation, cash management, inventory policy and credit analysis. Prerequisites as noted below or consent of designated finance faculty.

**Prerequisites:** MBA 402

**GBUS 432 Demand and Supply Chain Planning 3 Credits**

Students will learn how businesses work together to build relationships and integrate demand and supply planning activities across the supply chain to deliver superior value to customers. They will also learn about tools and technologies that enable integration as well as the critical drivers and the key metrics that support supply chain performance. Current readings and case studies, simulations and written assignments will be used.

**GBUS 437 Federal Taxation and Business Decisions 3 Credits**

Impact of federal taxation on the structure and timing of business decisions. Problem-solving methods and research techniques from a managerial perspective. Prerequisites as noted below.

**Prerequisites:** ACCT 307

**GBUS 440 Human Resource Management 3 Credits**

A survey of personnel management activities in organizations. Topics include human resource planning, recruitment, selection, equal employment opportunity, performance appraisal, compensation, career planning, safety and health, and quality of work life issues. Course consists of lectures, discussion, and case analysis.

**GBUS 442 Seminar in Management Consulting 3 Credits**

A study of consulting practices in general and their application to small business. Processes include a field study/counseling service to a local business. Emphasis is on the identification and analysis of multidisciplinary problems and opportunities and the implementation of recommendations. Must have completion of MBA background courses (or equivalent). Consent of instructor required.

**GBUS 444 Managerial Communication Skills 3 Credits**

Organization, style and strategy of language to inform, direct and persuade. Application of writing, reading, speaking and listening skills to managerial problems. Case studies.

**GBUS 445 Labor-Management Administration 3 Credits**

A study of the U.S. system of industrial relations, including the evolution and present status of labor law; union organizing efforts; the strategy of negotiations; the substantive provisions of collective bargaining and the administration of collective agreements. Also considered is the role of unions in the implementation of programs for employee self-management and other workplace innovations.

**GBUS 446 Commercial Potential Assessment 3 Credits**

A study of the process of bringing an invention to market with emphasis on commercial potential. Industrial analysis, competitor intelligence and strategic issues will be emphasized along with the development of market strategy and an overall business plan. Extensive research including data base searches will be included. Instructor permission required.

**GBUS 447 Negotiation 3 Credits**

The class examines the behavioral foundations of the negotiation process. Topics include: The negotiation process, negotiation planning, power in negotiations, communications in negotiations, tactics, concepts of win-win and win-lose, social styles, individual and team negotiations, ethical considerations, cultural differences, negotiating in sole source (customer) situations, using third parties. The concepts will be exposed through both lectures and simulations.

**GBUS 448 Leadership 3 Credits**

This course is an examination of leadership at the organization and group/team levels, and aims to develop and build a student's leadership skills and the ability to diagnose leadership needs in different situations. In identifying and building these leadership skills, the course will focus on the decisions leaders need to make, and the appropriate leadership decision-making processes required in various contexts and at different stages of an organization's existence. Cases and developmental exercises including in-depth decision-making exercises are utilized and cover diverse situations and cross-cultural dimensions including specific situations such as a crisis or ethically difficult decisions.

**GBUS 450 Strategic Supply Management 3 Credits**

A survey course designed to introduce the MBA/MSE student to the vital role played by supply management in achieving overall effectiveness for the firm in today's global economy. The course starts by examining the traditional purchasing process and then moves on to an examination of the evolution of purchasing into supply management and, finally, to the role purchasing plays in improving effectiveness of the entire value chain. Course consists of lectures, discussion and case analysis.

**GBUS 453 Transportation and Logistics Management 3 Credits**

The control of physical distribution and inventories; the flow of information, products and cash through the integrated supply chain.

**GBUS 455 E-Business Enterprise Applications 3 Credits**

Implications of key information technologies used within and across businesses to conduct e-business, including customer relationship management, enterprise resource planning, online ordering and inventory management, supply chain management, and e-procurement systems, data warehousing, data mining, intra-extranets, and knowledge management.

**GBUS 456 Applied Supply Chain Models 3 Credits**

This course will present applied and analytic approaches for developing inventory and forecasting models, supplier selection, supply chain quality management, and production planning and supply chain network design.

**GBUS 458 Strategic Information Systems 3 Credits**

Understanding the various types of computer based information systems and developing an ability to identify and exploit information technologies to gain competitive advantage, at the individual, group and organizational levels. Prerequisites as noted below.

**Prerequisites:** MBA 403

**GBUS 459 Survey of Project Management 3 Credits**

This course provides an overview of the project management framework and knowledge areas. Covers the day-to-day, hands-on problems of managing a project (defined as a temporary structure within a permanent organization, set up to achieve a specific objective). Areas covered will include: project integration, project scope, project planning and implementation, project control and evaluation, project cost and risk management, project resource management and organization, and project communication. Cases will be used to illustrate problems and the techniques to solve them. A basic project management software tool will be introduced and utilized in this course. This course is designed for MBA students who want a general exposure to project management concepts. This course may not be used in the Project Management Certificate Program.

**GBUS 460 Strategic Marketing Management 3 Credits**

The course studies the management of contemporary organizations from the perspective of a marketing manager. While the course content addresses the activities required to maintain a strategic fit between an organization's environment and its particular set of objectives and resources, the central focus is on designing strategic marketing actions for various types of organizations. The course pedagogy emphasizes the application of marketing and other business principles through seminars, simulations, or case discussion.

**Prerequisites:** MBA 404

**GBUS 462 Pharmaceutical Marketing 3 Credits**

The course provides an introduction and overview of the various healthcare system components as they relate to the pharmaceutical industry. This course will (1) focus on product decisions of the firm, requiring an occasional shift in focus from that of corporate management to that of operating managers of new product activities or established brands; (2) recognize the importance of marketing research as input to product decisions; (3) take a managerial orientation; (4) recognize the need to tailor product policy approaches to the characteristics of the decision-maker and the firm. The course will be a mixture of lectures, discussions, case analyses, and group exercises. Graduate students only.

**Prerequisites:** MBA 404

**GBUS 464 Business-to-Business Marketing 3 Credits**

This course focuses on marketing strategies and tactics in firms whose customers are other institutions, not individuals. Topics covered include organizational buying behavior, managing strategic buyer-seller relationships, sales force deployment, communication strategies, and so on. Specific attention is given to the impact of information technology and globalization in the business to business context.

**GBUS 465 Creating Breakthrough Innovations 3 Credits**

Most products and services either fail or do average business, but some are phenomenally successful. Such products and services that provide phenomenal financial returns and become market leaders can be called "Breakthrough Products and Services". The main objective of the course is to improve our understanding of the process of creating breakthrough products and services. It is accomplished by in-class discussions of cases, assignments, and the state-of-the-art research work in academia and industry. The course concludes with a term paper that integrates the concepts learned from class discussions, reference books, and research papers and applies them to a real product. Must have graduate student status plus two years of postgraduate work experience.

**GBUS 466 Marketing Research and Analysis 3 Credits**

This course focuses on procedures for collecting and analyzing relevant information for informed decision making by managers. The process of identifying research questions, developing instruments for collecting information, appropriate interpretation of information, and appropriateness of research methods are some of the topics discussed in this course. The course focuses on the process of doing marketing research as well as the techniques for analyzing information. Discussion of concepts and cases, developing data collection instruments, and doing actual marketing research projects will form the key elements of this course.

**Prerequisites:** (ECO 401 or BUEC 1)

**GBUS 470 Marketing Communications Strategies 3 Credits**

This course focuses on how various elements of communications are integrated to achieve various organizational objectives. In addition to the traditional communication media such as advertising and point of purchase media, emphasis will also be placed on new media and strategies made possible due to the advances in technology. The course will involve discussion of concepts, case analysis and discussion, insights from practitioners, and group projects.

**GBUS 471 Strategic Brand Management 3 Credits**

This course will focus on theories, models, and other tools to manage brands, products, and product lines. Specific attention will be focused on building, measuring, and managing brand equity. The course will be a mixture of lectures, discussions, case analyses, and group exercises.

**GBUS 472 Strategies for Services Marketing 3 Credits**

The course focuses on the challenges of marketing and managing services (whether in a manufacturing or service business) and discusses the development of strategies for addressing these challenges. The need for cross-functional integration to provide effective service is stressed. Illustrative topics include service quality gap analysis, relationship between superior service and profitability, service encounter analysis, customer lifetime value analysis, services guarantees, and service demand and capacity management.

**GBUS 473 International Finance 3 Credits**

Consideration of problems arising from the risks associated with international investing and multinational corporation finance (currency, political, etc.). Focus is on (a) investing in international market given the institutional constraints and differences between domestic markets, and (b) managerial issues relating to corporations, investors, and financial institutions. Prerequisites as noted below or consent of designated finance faculty representative.

**Prerequisites:** GBUS 419

**GBUS 474 Legal Aspects of International Business 3 Credits**

Various legal problems of engaging in business abroad, including contracts, technology transfer, property ownership, business organizations and labor, using a case and problem-solving approach.

**GBUS 475 Global Marketing Strategies 3 Credits**

The course is designed to provide a framework within which global marketing operation can be analyzed, understood, and undertaken. The course focuses on the issues that are being faced by firms in today's global marketplace, particularly those that are related to strategy formulation and implementation. The learning experience in this course is placed on global business decision-making, through the use of case studies, projects, and lectures.

**Prerequisites:** MBA 404

**GBUS 481 Technology, Operations and Competitive Strategy 3 Credits**

Develops an understanding and appreciation of the interrelationships among technology, operations and the competitive strategy of the firm. Industry analysis and competitiveness; competitive strategy formulation and implementation; value chain analysis; operations strategy and technology strategy; operation's contributions to competitive advantages in cost, quality and variety and new product introduction.

**GBUS 486 Qualitative Research Methodology 3 Credits**

Study of techniques that describe, decode and translate social phenomena. Explores how interpretive researchers plan and conduct studies and present findings. Studies investigators' roles, data sources, observation methods, dataanalysis methods and trustworthiness of findings. A field research project is required.

**GBUS 490 Thesis 6 Credits****GBUS 492 Special Topics 1-4 Credit**

**Repeat Status:** Course may be repeated.

**GBUS 494 Field Projects 1-4 Credit**

The field projects course will provide MBA students with an opportunity to apply MBA concepts with an employer, corporate partner or other suitable organization. Students will work with a supervising professor and a corporate representative on a project designed by the student. Students must prepare a written proposal for the project including the expected outcomes and an estimate of the hours required for completion. Students will present their proposal to a faculty member of their choice for approval. The academic rigor and time required to complete the project will determine the number of credits earned.

**GBUS 499 Dissertation 1-12 Credit****Graduate MBA Core Courses****MBA 401 Introduction to the Organization and its Environment 2 Credits**

An MBA core course designed to provide a thorough understanding of business organizations by examining strategies middle and senior managers use to create and sustain organizational competitive advantage. The course examines the organization from an overall perspective within the context of the firm's internal and external environment. The second aspect of this course deals with the ability to communicate effectively in today's business and professional environment. Students will examine and practice the written and verbal communications strategies and skills that are essential to their success in business.

**MBA 402 Managing Financial and Physical Resources 4 Credits**

An MBA core course designed to integrate financial and managerial concepts into operations decisions. Disciplines of accounting, finance and economics are combined to provide substantive foundations for discussing and analyzing data. Implications of analysis are applied to facilitate decision-making in other areas such as marketing, operations (manufacturing, logistics and engineering), human resources, information technology and general management. The major learning objectives will be applied through a series of "living" cases that are centered on analyzing historical financial performance, preparing a business plan, and valuing a business.

**Prerequisites:** (MBA 401 and GBUS 401 or BUAC 1)

**Can be taken Concurrently:** MBA 401

**MBA 403 Managing Information 4 Credits**

An MBA core course dealing with concepts and methods involved in the collection, organization and dissemination of information that helps managers make operational and strategic decisions. The course also deals with attributes of information and examines enterprise-wide impacts of local decisions. Revenue, cost, time and quality-based information are accorded equal emphasis, while students are exposed to alternative evaluation methods for decisions related to different parts of the value chain. Topics include: activity-based costing; activity-based management; transaction analysis; operational and strategic decisions such as outsourcing, design partnerships, etc; investment analysis for short lifecycle investments; evaluation of uncertainty, risk and ambiguity; metrics development; compensation policies; segment evaluation methods; target costing and functional analysis; quality function deployment; total cost of ownership; and transfer pricing. In addition, the course deals with: information technology enablers which allow firms to improve value delivered to customers; and evaluation and management of emerging forms of Cooperation, such as joint ventures and project based strategic alliances.

**Prerequisites:** (ECO 401 or BUAC 1) and (GBUS 401 or BUAC 1 and MBA 401)

**Can be taken Concurrently:** MBA 401

**MBA 404 Managing Products and Services 4 Credits**

An MBA core course focusing on the management of products and services within a firm's value chain. The course addresses exceeding customer expectations, establishing total quality as the core foundation, developing a strong customer focus, creating value through supply chain management, developing new products for competitive advantage, matching aggregate supply with customer demand, and designing market channels and influencing customers. Prerequisites as noted below.

**Prerequisites:** MBA 401

**Can be taken Concurrently:** MBA 401

**MBA 405 Managing People 4 Credits**

An MBA core course that examines how effective organizations are created, maintained, and improved. The course will focus on how good people are attracted to an organization and how to make them productive. Topics include: organizational design, job design, staffing, training and development, performance, teams, influence, diversity, change, ethical decision-making and current people issues facing today's organizations. Prerequisites as noted below.

**Prerequisites:** MBA 401

**Can be taken Concurrently:** MBA 401

**MBA 406 Integrative Experience 3 Credits**

An MBA course where students apply the body of knowledge acquired in MBA 401 through 405 through a simulation, case presentations and the cross core project. This course places an emphasis on strategic management and takes the point of view of the general manager to view the organization from an overall perspective in the context of the firm's internal and external environment. In doing so, students examine historical perspectives, contemporary theories, and practical applications all in the spirit of helping them develop a broad understanding of strategic management issues and solutions. By combining high-level class discussions, case analyses, a computer simulation competition and the crosscore project this course exposes students to rigorous theoretical analysis while providing hands-on, simulated real world business experiences. Prerequisites as noted below.

**Prerequisites:** (MBA 401 and MBA 402 and MBA 403 and MBA 404 and MBA 405)

**Can be taken Concurrently:** MBA 403

**Masters Accounting Courses****MACC 401 Professional Issues in Accounting - Negotiation 1 Credit**

This course examines the behavioral foundations of the negotiation process. Topics include planning, tactics, power, integrative and distributive bargaining, behavioral styles and individual and team negotiations. Open only to MSAIA students.

**MACC 402 Professional Issues in Accounting - Case Analysis 1 Credit**

Introduces business case analysis. Cases will be dissected, analyzed and discussed. A range of business topics will be used to demonstrate the case method. Open only to MSAIA students.

**MACC 403 Professional Issues in Accounting – Ethics 1 Credit**

Explores the fundamentals of making ethical business decisions in both domestic and international engagements. Students learn to identify ethical dilemmas and are trained to utilize a framework for making decisions. The course also examines the impact poor ethical standards and fraud has on the sustainability and growth of the free market economic system. The course format consists of team and class discussions as well as written individual exercises. Open only to MSAIA students.

**MACC 412 IT Auditing 3 Credits**

Addresses internal control and audit issues in an Information Technology (IT) environment. Course structured around the COSO internal control framework. Audit procedures for the review of IT general and application controls are examined. Students perform substantive tests on financial databases using audit software. Topics covered: Internal controls in centralized and distributed IT environments, IT outsourcing, IT governance, Data modeling, network and database security ACL software, SAP process and control issues.

**MACC 413 The Corporate Financial Reporting Environment 3 Credits**

This course addresses the nature of corporate financial reporting, its role in providing decision-useful information to capital market participants, standard-setting and the FASB conceptual framework, and theoretical and empirical assessments of its performance.

**MACC 420 Forensic Accounting and Auditing 3 Credits**

This course focuses on forensic skills to enhance audits and other services rendered by accounting professionals. Materials derived primarily from SEC cases to help students understand more complex financial reporting issues such as earnings management and fraud, apply auditing requirements of SAS 99 and Sarbanes-Oxley dealing with fraud, comprehend services beyond the audit which rely on forensic skills, and demonstrate knowledge through role plays in real world scenarios.

**Prerequisites:** ACCT 320 or BUA2 1 and MACC 401 and MACC 402 and MACC 403

**MACC 424 Governance, Risk and Control 3 Credits**

This course focuses on developing in students an understanding of corporate governance, risk oversight and internal control monitoring from an accounting professional's perspective. Topics include agency theory, fundamentals of corporate governance, risk and internal control, functions of the board of directors and the audit committee, independent auditor and impediments to audit quality, internal auditor's role, and SEC regulations and laws impacting governance, risk and control. Class discussions, interactive group exercises, role plays, field projects, and real-life cases are used.

**Prerequisites:** ACCT 320 or BUA2 1 and MACC 401 and MACC 402 and MACC 403

**MACC 427 Accounting for Financial Instruments & Advanced Financial Statement Analysis 3 Credits**

This course provides an introduction to accounting for financial instruments. Topics include, accounting for stock options, fair value accounting for financial instruments, accounting for fair value hedges, cash flow hedges, foreign exchange hedges, tests for assessing effectiveness of hedges and constructing accounting entries associated with hedges, interest rate swaps, and accounting for securitization. The second half focuses on analysis and interpretation of financial and non-financial information to evaluate firm performance and valuation.

**Project Management Courses****PMGT 401 Project Management: Course Framework & Project Leader Assessment 1 Credit**

This course serves as the introduction to the Project Management Certification Program. Students will become acquainted with: the terminology, nine knowledge areas, relationships to other disciplines, project management context and processes. This course also provides an introduction to the logistical vehicles for course delivery and the tools to be used. Students will also assess themselves as project leaders and explore project leader competencies, roles, responsibilities and stakeholder relationships.

**PMGT 402 Project Management: Skills and Abilities for Effective Leadership of Teams 1 Credit**

Students will enhance project team leadership skills, define the work environment of project teams, team selection, develop a team charter, clearly define the roles and responsibilities of all project team members, set team guidelines, learn methods to promote teamwork, understand the stages of development, and manage team dynamics. Additional skills covered: delegation, managing accountability without direct authority over project team members, managing dysfunctional teams, performance improvement, input to performance appraisals, rewards, recognitions, celebrations. Prerequisites as noted below.

**Prerequisites:** PMGT 401

**Can be taken Concurrently:** PMGT 401

**PMGT 403 Project Management: Initiating the Project and Planning Scope and Schedule 2 Credits**

Students will learn techniques for deciding whether to undertake a project and for planning project outcomes and schedules. The relationship of projects to organizational planning and budgeting, information and performance appraisals systems will be discussed. Approaches will be shared for identifying and classifying project stakeholders and designing and conducting a cost benefit analysis. How to define desired project outcomes clearly and completely and how to determine project work to be performed using decomposition and templates will be addressed. Students will learn how to develop a project charter, a scope statement, a Work Breakdown Structure, a WBS dictionary and a Linear Responsibility Chart. How to create a network diagram and analyze schedule possibilities using the Critical Path Method (CPM) and the Program Evaluation and Review Technique (PERT) will be explained. Fast tracking and crashing a schedule will also be explored. Displaying a schedule with a Gantt Chart, key events list and activities will be illustrated. How to support these activities using MS Project will be demonstrated. Prerequisites as noted below.

**Prerequisites:** PMGT 401 and PMGT 402

**Can be taken Concurrently:** PMGT 401, PMGT 402

**PMGT 404 Project Management: Planning Resources, Communication, Quality and Risk Management 2 Credits**

In this course, students will learn how to estimate the needs for personnel and other types of projects resources, to develop a project budget and to plan for additional project support activities. Determining the type, amount and timing of resource needs will be emphasized. Approaches to resource leveling will be discussed. The different types of project costs will be explained. The use of analogous estimating, parametric modeling, bottom-up estimating and computerized tools to estimate costs will be explored. Planning to ensure project quality and coordinate project communications will be will be addressed. Identifying, assessing, and preparing a plan to manage project risks will also be discussed. Planning for project procurement and associated solicitations will be explained. Students will learn how to develop resource matrices, loading charts and grafts and a project budget. How to support these activities using MS Project will be demonstrated. Prerequisites as noted below.

**Prerequisites:** PMGT 401 and PMGT 403

**Can be taken Concurrently:** PMGT 401, PMGT 403

**PMGT 405 Project Management: Project Leader Communications Expertise and Evaluating Team Performance 1 Credit**

The purpose of this weekend seminar is to strengthen the project leader's communication skills, change-management skills, conflict resolutions skills, and team evaluation skills. Focus areas will also include the following: understanding the art and science of effective listening, managing multiple expectations, communicating "bad news," and learning tools and techniques for project team evaluation. Prerequisites as noted below.

**Prerequisites:** PMGT 401 and PMGT 402 and PMGT 403 and PMGT 404

**Can be taken Concurrently:** PMGT 401, PMGT 402, PMGT 403, PMGT 404

**PMGT 406 Project Management: Implementing and Managing Projects 2 Credits**

Students will learn techniques and processes to start and perform the actual project work. Suggestions for working successfully in a matrix management environment will be discussed. Information systems to track schedule performance, labor charges and project expenditures will be expressed. Developing escalation procedures to address project conflicts issues will be emphasized. Procedures for controlling labor and fund charges to a project will be introduced. Key project review and decision meetings will be identified. Planning and implementing quality assurance activities will be addressed. Planning for, awarding and administering contracts will be discussed. How to support these activities using MS Project will be demonstrated. Prerequisites as noted below.

**Prerequisites:** PMGT 401 and PMGT 402 and PMGT 403 and PMGT 404 and PMGT 405

**Can be taken Concurrently:** PMGT 401, PMGT 402, PMGT 403, PMGT 404, PMGT 405

**PMGT 407 Project Management: Controlling Performance and Assessing Outcomes 2 Credits**

Students will learn how to monitor and control project activities in progress and how to bring a project to closure. Approaches for assessing project products and services produced will be explored. Techniques for evaluating schedule and cost performance will be introduced. Variance analysis and earned value analysis will be explained. Quality control and risk monitoring and control will be discussed. Change control systems and procedures will be explained. How to prepare focused progress reports and conduct effective project meetings will be discussed. Requirements for closing out contracts and procurements will be detailed. Obtaining user acceptance, closing labor and fund charge accounts and other administrative activities will be discussed. Designing and conducting a post-project review will be explored. How to support these activities using MS Project will be demonstrated. Prerequisites as noted below.

**Prerequisites:** PMGT 401 and PMGT 402 and PMGT 403 and PMGT 404 and PMGT 405 and PMGT 406

**Can be taken Concurrently:** PMGT 401, PMGT 402, PMGT 403, PMGT 404, PMGT 405, PMGT 406

**PMGT 408 Project Management: Problem Solving, Decision Making and Ethics 1 Credit**

This 2 day seminar focuses on developing problem solving and ethical decision-making skills. Students will learn to recognize project problems, frame the problem, assess risk, manage risk, plan contingencies, recognize the escalation points, and apply alternate methods. Students will also participate in ethical exercises to strengthen their ability to recognize ethical dilemmas and evaluate decisions. Prerequisites as noted below.

**Prerequisites:** PMGT 401 and PMGT 402 and PMGT 403 and PMGT 404 and PMGT 405 and PMGT 406 and PMGT 407

**Can be taken Concurrently:** PMGT 401, PMGT 402, PMGT 403, PMGT 404, PMGT 405, PMGT 406, PMGT 407

**Economics**

Though economics is variously defined, modern-day definitions generally suggest that it is the study of the principles that govern the efficient allocation of resources. One of the greatest of the 19th century economists who did much to uncover these principles suggested a broader definition. Alfred Marshall described economics as "a study of mankind in the ordinary business of life and a part of the study of man." This dual nature of economics, technical and humanistic, is reflected in the fact that at Lehigh the economics major is available to students in the College of Arts and Sciences as well as in the College of Business and Economics.

**Professors.** J. Richard Aronson, PhD (Clark University); Shin-Yi Chou, PhD (Duke University); James A. Dearden, PhD (The Pennsylvania State University); Mary E. Deily, PhD (Harvard University); Thomas J. Hyclak, PhD (University of Notre Dame); Arthur E. King, PhD (Ohio State University); Judith A. McDonald, PhD (Princeton University); Vincent G. Munley, PhD (State University of NY, Binghamton University); Larry W Taylor, PhD (University of North Carolina Chapel Hill); Robert J. Thornton, PhD (University of Illinois Upper Chicago); Todd A. Watkins, PhD (Harvard University)

**Associate Professors.** Frank R. Gunter, PhD (Johns Hopkins University); Chad Meyerhoefer, PhD (Cornell University)

**Assistant Professors.** Ernest Kong-Wah Lai, PhD (University of Pittsburgh); Alberto Lamadrid, PhD (Cornell University); Oleksandr Nikolsko Rzhnevskyy, PhD (University of Houston University Park); Irina Panovska, PhD (Washington University); Muzhe Yang, PhD (University of California Berkeley)

**Professor Of Practice.** Maria Augusta Figueroa Armijos, PhD (University of Missouri Columbia)

**Emeriti.** Nicholas W. Balabkins, PhD (Rutgers University); Alvin Cohen, PhD (University of Florida); Jon T. Innes, PhD (University of Oregon); John R. Mc Namara, PhD (Rensselaer Polytechnic Institute); Anthony Patrick O'Brien, PhD (University of California Berkeley)

**College of Business and Economics****Major in Economics**

Students in the College of Business and Economics electing to major in economics must take the college core courses listed in the College of Business and Economics section of this catalog. They must also take ECO 119 and at least 12 credit hours of 200- and 300-level economics courses beyond the core requirements. These courses may be chosen so as to form an area of specialization or to provide a broad exposure to the various aspects of the discipline. In any case, students should consult with the major advisor in forming their programs.

**Major in Business Economics**

The business economics major prepares students for careers as business consultants or analysts by teaching the application of microeconomic theory to the analysis of critical business issues. The emphasis is on rigorous, quantitative business analysis through the use of theoretical and mathematical models and econometric analysis of data. Students electing the major in business economics must take the college core courses, ECO 245, ECO 322, ECO 333, two elective courses from an approved list, and a course involving student research on a problem identified by an external client. Students should consult with the major advisor in forming their program.

**Minor in International Economics**

The minor in International Economics aims to prepare non-economics majors in the CBE, as a complement to their major programs, with a fundamental understanding of international trade, finance and economic development, and to develop skills in applying economic analysis to international economic issues and social problems. This minor is open to any CBE undergraduate student not majoring in economics or business economics.

**International Economics Minor Requirements**

ECO 119	Intermediate Macroeconomic Analysis	3
ECO 339	International Trade	3
or ECO 340	International Finance	
Select two of the following (at least one at the 300 level):		6
ECO 203	Microfinance: Financial Inclusion for the Poor	
ECO 209	Comparative Economic Systems	
ECO 303	Economic Development	
ECO 339	International Trade	
ECO 340	International Finance	
ECO 345	Political-Economy of Iraq	
<b>Total Credits</b>		<b>12</b>

**Minor in Public Policy Economics**

The minor in Public Policy Economics aims to prepare non-economics majors in the CBE, as a complement to their major programs, with a fundamental understanding of the main economic policy issues and the role of government in markets, and to develop skills in applying economic analysis to the development of public policies and potential solutions to social problems. This minor is open to any CBE undergraduate student not majoring in economics or business economics.

**Public Policy Minor Requirements**

ECO 119	Intermediate Macroeconomic Analysis	3
ECO 353	Public Finance: Federal	3
Select two of the following:		6
ECO 235	Labor Economics	
ECO 311	Environmental Economics	
ECO 336	Business and Government	
ECO 354	Public Finance: State and Local	
ECO 365	Business, Government, and Macroeconomic Policy	
ECO 368	Health Economics	
Or approval by Minor Advisor		
<b>Total Credits</b>		<b>12</b>



**College of Arts and Sciences****Major in Economics**

The B.A. major in economics is designed to prepare students for graduate study in economics or law, and for entry into careers in business, government or service organizations. The requirements for the economics major are:

**Economic Core**

ECO 001	Principles of Economics	4
ECO 105 or ECO 146	Intermediate Microeconomic Analysis Applied Microeconomic Analysis	3
ECO 119	Intermediate Macroeconomic Analysis	3
ECO 029	Money, Banking, and Financial Markets	3
ECO 045	Statistical Methods	3

**Collateral Calculus Courses**

Select one of the following:		7-8
MATH 081 or MATH 051 & MATH 052	Calculus with Business Applications Survey of Calculus I and Survey of Calculus II	4
MATH 021 & MATH 022	Calculus I and Calculus II <sup>2</sup>	

**Electives**

Select five courses in economics at the 200- or 300- level. <sup>3</sup> 15

**CBE's Excel competency exam <sup>4</sup>**

Total Credits 42-43

- 1 MATH 051 and MATH 052 are terminal math classes for students planning on careers in fields that are primarily non-quantitative.
- 2 MATH 021 and MATH 022 are for students considering careers or graduate programs that require a stronger math background.
- 3 Students may count only two 200-level courses toward the completion of the economics major.
- 4 To take economics courses numbered 100 or above, students must pass the CBE's Excel competency exam; contact the Rauch Center for Business Communications for more information.

Students are free to select any five economics courses to meet their elective requirements. However, the faculty of the economics department has developed recommended course clusters to meet the differing needs of students. These include course recommendations for those interested in:

- Graduate study in economics
- Careers in consulting and financial services
- International economics and global markets
- Political economy and public policy

Interested students are encouraged to consult with the major advisors in the economics department to select elective courses that match their needs and interests.

**Honors in Economics**

Economics majors who wish to be considered for departmental honors must consult with their major advisor and request such consideration by the beginning of their senior year. The criteria for departmental honors are:

1. Completion of the major program with at least 33 credits of economics and a grade point average in those courses of 3.5 or better.
2. Submission of an acceptable research paper to the Departmental Honors committee. This paper must report on original research conducted by the student. An economics faculty member will direct the honors paper. Students who successfully complete the paper will receive independent study credit, which can be applied to economics major requirements. The committee will notify students of submission deadlines and other requirements for satisfying this criterion.

**Minor in Economics**

A minor in economics consists of 12 credit hours beyond ECO 001. Required courses in the minor are:

ECO 105 or ECO 146	Intermediate Microeconomic Analysis Applied Microeconomic Analysis	3
ECO 119 or ECO 029	Intermediate Macroeconomic Analysis Money, Banking, and Financial Markets	3
Two elective courses <sup>1</sup>		6
<b>Total Credits</b>		<b>12</b>

<sup>1</sup> Elective courses must be chosen from among the 200- and 300-level economics offerings with at least one 300-level elective. ECO 371 does not count towards the minor.

This minor is available only to students in the College of Arts and Sciences and in the College of Engineering and Applied Science. Interested students should contact the minor advisor.

**Courses****ECO 001 Principles of Economics 4 Credits**

A one-semester course in the principles of economics. General topics covered are: supply and demand; pricing and production decisions of firms; the role of government in the economy; the determination of national income; money and banking; monetary and fiscal policy; and government finance.

**Attribute/Distribution:** SS

**ECO 029 Money, Banking, and Financial Markets 3 Credits**

The nature and functions of money. Global money and financial markets. The role of commercial and central banks. Effects of the interest rate, exchange rate, and the money supply on the economy. Examination and evaluation of current and past monetary policies. Prerequisites as noted below.

**Prerequisites:** ECO 001

**Attribute/Distribution:** SS

**ECO 045 Statistical Methods 3 Credits**

Descriptive statistics, probability and probability distributions, sampling, estimation, hypothesis testing, chi-square tests, simple regression and correlation. Note: CBE students may not take MATH 012 as a replacement for ECO 045.

**Prerequisites:** CBEC 1

**ECO 105 Intermediate Microeconomic Analysis 3 Credits**

Determination of prices in terms of the equilibrium of the business enterprise and consumer choice in markets of varying degrees of competition; analysis of market structures; determination of wages, rent, interest and profits. Not available for credit to students who have taken ECO 146. Prerequisites as noted below.

**Prerequisites:** ECO 001 and (MATH 021 or MATH 051 or MATH 081 or MATH 076)

**Attribute/Distribution:** SS

**ECO 111 Introduction to Environmental Economics 4 Credits**

An examination of the interactions between our economic systems and the environment. Pollution as a consequence of human activity within a framework for analyzing the relationships between environmental quality, scarcity of resources and economic growth. How to develop appropriate policies to deal with these issues. Prerequisites as noted below.

**Prerequisites:** ECO 001

**Attribute/Distribution:** SS

**ECO 119 Intermediate Macroeconomic Analysis 3 Credits**

Macroeconomic measurement, theory and policy. The use of alternative macroeconomic models to analyze the level of national income, inflation, unemployment, economic growth; the balance of payments, and exchange rate determination. Prerequisites as noted below.

**Prerequisites:** ECO 001

**Attribute/Distribution:** SS

**ECO 146 Applied Microeconomic Analysis 3 Credits**

The application of economic analysis to managerial and public policy decision-making. Not available for credit to students who have taken ECO 105. Note: MATH 12 does not serve as a pre-requisite for ECO 146. Prerequisites as noted below.

**Prerequisites:** (ECO 145 or ECO 045 or PSYC 110 or IE 111 or CEE 012 or MATH 231) and (ECO 001) and (MATH 021 or MATH 031 or MATH 051 or MATH 076 or MATH 097 or MATH 081)

**Attribute/Distribution:** SS

**ECO 203 Microfinance: Financial Inclusion for the Poor 3 Credits**

Non-technical survey of the global microfinance industry, which provides financial services to the poor on a large scale, mostly in developing nations. Historical origins and industry evolution. Nature and developmental role of microenterprises and informal finance. Methods and technologies used by microfinance institutions (MFIs). Case studies of leading MFIs and the lives of their clients. Policy and regulatory environments. Debates over profiting from the poor, and over health and environmental goals. Conflicting evidence on economic and social impact. Meetings with practitioners. Prerequisites as noted below.

**Prerequisites:** ECO 001

**Attribute/Distribution:** SS

**ECO 209 Comparative Economic Systems 3 Credits**

An analysis of the micro- and macro-economic, institution and political dimensions of various economic systems, with particular emphasis on former centrally planned economies in their transition to a market orientation. Prerequisites as noted below.

**Prerequisites:** ECO 001 or ECO 011 or ECO 012

**Attribute/Distribution:** SS

**ECO 235 Labor Economics 3 Credits**

The economic analysis of labor markets, with emphasis on labor supply and demand, wage and employment theory, and the economics of unionism and other labor market institutions. Prerequisites as noted below.

**Prerequisites:** ECO 001 or (ECO 011 and ECO 012) or (ECO 011 and ECO 022) or (ECO 012 and ECO 021)

**Attribute/Distribution:** SS

**ECO 245 Statistical Methods II 3 Credits**

This course is a continuation of Economics 045, and gives broader coverage of linear regression and the construction of empirical models. Topics include the analysis of variance, simple and multiple regression, index numbers, forecasting, nonparametric methods, and statistical methods for quality control. Prerequisites as noted below.

**Prerequisites:** MATH 012 or MATH 231 or ECO 145 or ECO 045

**Attribute/Distribution:** ND

**ECO 246 Business Cycles and Forecasting 3 Credits**

A study of short-term business fluctuations, growth, forecasting and stabilization. Prerequisites as noted below.

**Prerequisites:** (ECO 001 or ECO 011 or ECO 012) and (ECO 145 or MATH 012 or ECO 045 or MATH 231 or SR 111 or PSYC 110) and (ECO 145 or MATH 012 or MATH 231 or IE 111 or SR 111)

**Attribute/Distribution:** ND

**ECO 259 Athletic Complex Design 3 Credits**

This course is for students to participate in cross discipline Integrated Learning Experience (ILE) research projects. The twin purposes of the course are to provide real-world, team-oriented learning experiences and to apply economic analysis in evaluating the costs and benefits of newly proposed, or renovations and expansions of, existing athletic facilities. Prerequisites as noted below.

**Prerequisites:** ECO 105 or ECO 146

**ECO 273 Community Consulting Practicum 3 Credits**

This course involves teams of students in community-oriented research projects. The twin purposes of the course are to provide real-world, team-oriented learning experiences and to provide a resource for local governments and community organizations that would allow them to draw upon the expertise of our students as consultants in analyzing problems and formulating policy. Prerequisites as noted below.

**Prerequisites:** ECO 001

**ECO 300 Apprentice Teaching 1-3 Credit****ECO 303 Economic Development 3 Credits**

Economic development, economic growth and their political environment are discussed in detail. The principal economic development theories are examined. These theories are used to examine a variety of development issues including planning, poverty, rural-urban relationships, physical and human capital accumulation, international trade, and the environment. Emphasis on institutions and development policy. Prerequisites as noted below.

**Prerequisites:** ECO 105 or ECO 115 or ECO 146

**Attribute/Distribution:** SS

**ECO 311 Environmental Economics 3 Credits**

Resource allocation implications of environmental degradation. Analysis of the benefits and costs associated with alternative pollution control programs and strategies. Prerequisites as noted below.

**Prerequisites:** ECO 105 or ECO 115 or ECO 146

**Attribute/Distribution:** SS

**ECO 314 Energy Economics 3 Credits**

The economic theory of natural resource allocation over time. Economics of exhaustible and renewable resources. Environmental effects of energy production and consumption. Government regulation of the energy industry. Computer models for energy system forecasting and planning. Prerequisites as noted below.

**Prerequisites:** ECO 105 or ECO 146

**Attribute/Distribution:** SS

**ECO 315 Industrial Organization 3 Credits**

Structure of American industry. Development of economic models to describe behavior in markets with varying degrees of competition. Technological innovation, relationship between industry concentration and rates of return on capital, role of information and advertising, dynamics of monopoly and oligopoly pricing. Prerequisites as noted below.

**Prerequisites:** ECO 105 or ECO 146

**Attribute/Distribution:** SS

**ECO 322 Competitor and Market Analysis 3 Credits**

Competitors, partners, and firms and governments strategically interact. This course uses game theory to analyze issues like pricing by competitors, vertical integration and contracting issues in supplier-buyer relationships, collective actions and joint ventures, and research and development programs. Students use both mathematical models and cases to analyze these interactions. Prerequisites as noted below.

**Prerequisites:** (ECO 105 or ECO 115 or ECO 146) and (ECO 145 or ECO 045 or MATH 012 or MATH 231 or IE 111 or SR 111) and (MATH 021 or MATH 031 or MATH 051 or MATH 081 or MATH 076)

**Attribute/Distribution:** SS

**ECO 323 Evolution of Business Strategy 3 Credits**

Analyzes how business firms have adapted to changes in technology, relative factor prices, globalization, and the extent of government intervention in the market. Material will be presented through discussion of case studies from the nineteenth and twentieth centuries. Prerequisites as noted below.

**Prerequisites:** (ECO 001)

**Attribute/Distribution:** SS

**ECO 324 The Economics of the Sports Industry 3 Credits**

This course analyzes the role of basic economic forces in shaping today's sports industry. Topics include: competition in the market for professional franchises; public subsidies for stadiums and arenas; compensation of professional athletes; the NCAA as an economic enterprise; and the impact of athletics on a university's budget. Prerequisites as noted below.

**Prerequisites:** ECO 105 or ECO 146

**Attribute/Distribution:** SS

**ECO 325 Quantitative Marketing Analysis 3 Credits**

This course explores economics and management science approaches to improve marketing decision making and marketing interactions in such areas as strategic marketing, e-marketing, advertising, pricing, sales force management, sales promotions, new products, and direct marketing. The development, implementation, and use of quantitative models are emphasized. Cases are used to illustrate how these models can be applied. Students have the opportunity to learn how to use and evaluate models through spreadsheet-based assignments. Prerequisites as noted below.

**Prerequisites:** (MKT 111 or MKT 211) and (ECO 146 or ECO 105) and (ECO 145 or ECO 045 or MATH 231 or MATH 012 or SR 111 or IE 111) and (MATH 021 or MATH 031 or MATH 051 or MATH 081 or MATH 076)

**Attribute/Distribution:** SS

**ECO 327 Real Options and Investment Strategy 3 Credits**

This is an introductory course in financial economics. It focuses on the principles underlying financial decision-making, with applications to stocks, bonds, and real estate. It is intended for students with strong technical backgrounds who are comfortable with mathematical arguments. The course is divided into three main parts: deterministic finance, single-period uncertainty finance, and options theory. Prerequisites as noted below.

**Prerequisites:** FIN 323

**Attribute/Distribution:** ND

**ECO 332 Monetary-Fiscal Policy 3 Credits**

Monetary, credit and fiscal policies of governments and central banks with particular reference to the policies of the United States Treasury and the Federal Reserve System. Prerequisites as noted below.

**Prerequisites:** ECO 119 or ECO 129 or ECO 029

**Attribute/Distribution:** SS

**ECO 333 The Economics of Business Decisions 3 Credits**

Students analyze business problems using economic logic and techniques like mathematical programming, marginal analysis, and decision making under risk and uncertainty. New topics like asymmetric information and the analysis of organizations are introduced. Case studies are emphasized. Prerequisites as noted below.

**Prerequisites:** (ECO 105 or ECO 115 or ECO 146) and (ECO 145 or ECO 045 or MATH 012 or MATH 231 or IE 111 or SR 111) and (MATH 021 or MATH 031 or MATH 051 or MATH 081 or MATH 076) and ECO 245

**Attribute/Distribution:** SS

**ECO 336 Business and Government 3 Credits**

Analysis of government involvement in the private sector. The problems of monopoly, oligopoly, and externalities in production and consumption. Optimum responses to market failure and analysis of the performance of actual government policies. Prerequisites as noted below.

**Prerequisites:** ECO 105 or ECO 146

**Attribute/Distribution:** SS

**ECO 339 International Trade 3 Credits**

The theory of international trade; the theory of tariffs; United States commercial policies; the impact of growth and development of the world economy. Prerequisites as noted below.

**Prerequisites:** ECO 105 or ECO 146 or ECO 115

**Attribute/Distribution:** SS

**ECO 340 International Finance 3 Credits**

Analysis of balance of payments and disturbances and adjustment in the international economy; international monetary policies. Prerequisites as noted below.

**Prerequisites:** ECO 129 or ECO 119 or ECO 029

**Attribute/Distribution:** SS

**ECO 342 Economic Development in China 3 Credits**

An examination of the economic, political and social forces at work in the development process in China since 1949. Special emphasis on post-1978 market reforms, the rural-urban divergence, the role of foreign trade and investment, the accumulation of human capital, and the deterioration of the physical environment. Course concludes with a detailed discussion of possible futures of the Chinese economy.

**Prerequisites:** ECO 303

**Attribute/Distribution:** SS

**ECO 343 European Economic Integration 3 Credits**

Study of the problems of economic integration throughout Europe, especially in the Post-Cold War era among Western, Central and Eastern European nations. Prerequisites as noted below.

**Prerequisites:** ECO 209

**Attribute/Distribution:** SS

**ECO 345 Political-Economy of Iraq 3 Credits**

An examination of the economic, political and social forces at work in Iraq with emphasis on the post-2002 period. Major topics include petroleum production and transport, corruption, education and other forms of human capital accumulation in an Islamic state, the agricultural transition, the rural-urban divergence, the economic impact of the ongoing conflict, unemployment and underemployment, poverty and population, the economic and political role of the state owned enterprises, entrepreneurship and the informal economy, traditional banking and micro-finance, and the inconsistencies between current political and economic development policies. Course concludes with a discussion of the possible futures for the Iraqi economy. Prerequisites as noted below or consent of instructor.

**Prerequisites:** ECO 303 or (ECO 105 and ECO 119)

**ECO 346 Numerical Methods for Business Decisions 3 Credits**

This course provides a connection between textbook economics/finance and the problems of real world business. It emphasizes practical numerical methods rather than mathematical proofs. Problems in finance are emphasized. The course teaches students how to use EXCEL macros and advanced VBA (the industry standard) programming techniques to model and manipulate financial data. Prerequisites as noted below.

**Prerequisites:** FIN 323

**Attribute/Distribution:** ND

**ECO 353 Public Finance: Federal 3 Credits**

A course dealing with the expenditures and revenues of the federal government. Major topics include public choice theory, benefit-cost analysis, the theory of public goods, the economics of taxation, and the design of tax structures. Prerequisites as noted below.

**Prerequisites:** ECO 105 or ECO 115 or ECO 146

**Attribute/Distribution:** SS

**ECO 354 Public Finance: State and Local 3 Credits**

A course dealing with the expenditures and revenues of state and local governments. Major topics include the theory of fiscal federalism, intergovernmental fiscal transfers, the design of state and local tax structures, capital budgeting and debt finance, pension funds, and school finance. Prerequisites as noted below.

**Prerequisites:** ECO 105 or ECO 115 or ECO 146

**Attribute/Distribution:** SS

**ECO 357 Econometrics 3 Credits**

Problems in construction, evaluation and use of econometric models. Applications based on research and case studies. Prerequisites as noted below.

**Prerequisites:** (ECO 105 or ECO 115 or ECO 119 or ECO 146 or MATH 012 or MATH 231 or IE 111 or SR 111) and (ECO 245)

**Attribute/Distribution:** ND

**ECO 358 Game Theory 3 Credits**

A mathematical analysis of how people interact in strategic situations. Applications include strategic pricing, negotiations, voting, contracts and economic incentives, and environmental issues. Prerequisites as noted below.

**Prerequisites:** (ECO 105 or ECO 115 or ECO 146) and (MATH 021 or MATH 031 or MATH 051 or MATH 081 or MATH 076)

**Attribute/Distribution:** SS

**ECO 362 Martindale Research Seminar 1-3 Credit**

This course prepares students to undertake research on various topics in business and/or economics. Admission to this course is limited to student associates of the Martindale Center for the Study of Private Enterprise. Consent of the instructor is required. Course may be repeated for credit up to a maximum total number of 3 hours credit. This course does not count towards an Economics major or minor.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** ND

**ECO 365 Business, Government, and Macroeconomic Policy 3 Credits**

This course analyzes particular domestic and foreign macroeconomic policy episodes. Through the case study method, the course provides both an historical and an international context for understanding current macroeconomic policy issues. Prerequisites as noted below or consent of instructor.

**Prerequisites:** ECO 029 or ECO 119

**Attribute/Distribution:** SS

**ECO 368 Health Economics 3 Credits**

Supply and demand in the health service markets for the U.S. and Canada. Unique features of health care which interfere with competitive market allocation and pricing. Overview of insurance systems and other payment methods. Prerequisites as noted below.

**Prerequisites:** ECO 145 or ECO 045 or MATH 012 or MATH 231 and (ECO 105 or ECO 146)

**Attribute/Distribution:** SS

**ECO 371 Special Topics in Economics 1-3 Credit**

Study in various fields of economics, designed for the student who has a special interest in a subject not included in the regular course schedule or for the student interested in pursuing a significant supervised research project in economics. Students interested in enrolling in this course must submit a written proposal to a member of the faculty with expertise in the proposed subject area and to the department chair prior to the registration period for the relevant semester. This course may count towards the ECO major only once; it does not count towards the ECO minor. Prerequisites as noted below.

**Repeat Status:** Course may be repeated.

**Prerequisites:** (ECO 105 or ECO 146 or ECO 119)

**Attribute/Distribution:** ND

**ECO 389 Honors Project 1-6 Credit**

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** ND

**ECO 401 Basic Statistics for Business and Economics 3 Credits**

Descriptive statistics, probability and probability distributions, estimation, hypothesis testing, correlation and regression, chi-square analysis, and analysis of variance. Computer applications.

**ECO 402 Managerial Economics 3 Credits**

Application of economic and statistical analysis to managerial decision-making. Business and economic forecasting. Empirical estimation of demand, production, and cost functions. Resource allocation and pricing strategies in various market structures. Decisions under risk and uncertainty. Government regulation of business. Cases. Prerequisites as noted below.

**Prerequisites:** MATH 021 and MATH 022 and ECO 401

**ECO 412 Mathematical Economics 3 Credits**

Applications of various mathematical techniques in the formation and development of economic concepts and theories. Consent of instructor required.

**ECO 413 Advanced Microeconomics Analysis 3 Credits**

A survey of methods of decision-making at the microeconomic level; price theory and econometric applications. Prerequisites as noted below.

**Prerequisites:** ECO 402

**ECO 414 Advanced Topics in Microeconomics 3 Credits**

Resource allocation and price determination. Theories of choice of consumers, firms, and resource owners under various market forms. Prerequisites as noted below.

**Prerequisites:** ECO 413

**ECO 415 Econometrics I 3 Credits**

Computer applications of standard econometric techniques using regression analysis in a single-equation context. Discussion of problems of multicollinearity, heteroscedasticity and autocorrelation. An introduction to simultaneous equation models, identification and estimation problems. Prerequisites as noted below.

**Prerequisites:** ECO 401

**ECO 416 Econometrics II 3 Credits**

Mathematical and statistical specification of economic models. Statistical estimation and tests of parameters in single and multiple equation models. Prediction and tests of structural change. Prerequisites as noted below.

**Prerequisites:** ECO 415

**ECO 417 Advanced Macroeconomic Analysis 3 Credits**

Macroeconomic theory and policy. Emphasis on theoretical models and policy implications.

**ECO 418 Advanced Topics in Macroeconomics 3 Credits**

Models of employment, income and growth in monetary economies. Policies for economic stability and growth. Prerequisites as noted below.

**Prerequisites:** ECO 417

**ECO 423 Real Options 3 Credits**

This is an introductory graduate level course in financial economics. It is intended for students with strong technical backgrounds who are comfortable with mathematical arguments. The course is divided into three major parts: deterministic finance, single-period uncertainty finance, and options theory and its applications. Prerequisite as noted below.

**Prerequisites:** GBUS 420

**ECO 425 Cost-Benefit Analysis 3 Credits**

Theory and methods of cost-benefit analysis; efficiency and equity as criteria in program evaluation; proper measurement of market and non-market costs and benefits; consideration of risk, uncertainty, appropriate discounting techniques, and distributional consequences; applications to the evaluation of health care policies and therapies. Prerequisites as noted below or consent of instructor.

**Prerequisites:** ECO 402 and (ECO 357 or ECO 415)

**ECO 429 Monetary Theory 3 Credits**

The role of money in the economy from theoretical and empirical perspectives. The influence of money and prices, interest rates, output, and employment.

**ECO 430 Public Finance 3 Credits**

The economics of public spending and taxation; principles of government debt management; theories of budgeting and cost-benefit analysis and public choice.

**ECO 440 Labor Economics I 3 Credits**

The economics of labor markets and various labor-market institutions with emphasis on current theoretical and empirical research. Topics include labor supply and demand, human capital, the structure of labor markets, labor market regulation, information and job search, labor mobility, unionism, and labor market discrimination. Prerequisites as noted below.

**Prerequisites:** ECO 401 and ECO 402

**ECO 441 Labor Economics II 3 Credits**

An examination of empirical research in labor economics, focusing on topics such as human resource management and internal labor market outcomes, wage and income inequality and poverty, unemployment, and other issues current in the literature. Prerequisites as noted below.

**Prerequisites:** ECO 402 and ECO 415

**ECO 447 Economic Analysis of Market Competition 3 Credits**

Mathematical models based on game theory and industrial organization. Cases are used to analyze the strategic interaction of firms and governments as competitors and partners. Prerequisites as noted below or consent of instructor.

**Prerequisites:** ECO 402

**ECO 454 Economics of Environmental Management 3 Credits**

Economic theory of natural resources. Optimal policies for the development of renewable and nonrenewable resources and environmental quality. Prerequisites as noted below.

**Prerequisites:** ECO 402

**ECO 455 Health Economics I 3 Credits**

Economic theory and empirical analysis of health production, the demand for health services, and health insurance. Implications for the current institutional structure of health care and health delivery systems will also be discussed. Additional topics and extensions will be selected based on developments in the literature. Prerequisites as noted below.

**Prerequisites:** ECO 402 and ECO 415

**ECO 456 Industrial Organization 3 Credits**

The goal of the course is to review theoretical and empirical attempts by economists to understand market structures lying between the extremes of perfect competition and monopoly. The course will focus first on describing the current U.S. industrial structure and reviewing models of imperfect competition. The course then shifts to a closer study of individual firm behavior. The final segment of the course is an overview of two significant relationships between government and industry caused by the existence of imperfect competition.

**ECO 457 Bio-Pharmaceutical Economics 3 Credits**

Characteristics of the market for pharmaceuticals; barriers to entry, competition and innovation; pricing and regulation; physician prescribing behavior; commercialization and financing of biotech startups; international comparisons of public policy. Prerequisites as noted below or consent of instructor.

**Prerequisites:** ECO 401 and ECO 402

**ECO 460 Time Series Analysis 3 Credits**

Classical decomposition of time series, trend analysis, exponential smoothing, spectral analysis and Box-Jenkins autoregressive and moving average methods.

**ECO 461 Forecasting 3 Credits**

Methods of economic and business forecasting.

**ECO 463 Topics in Game Theory 3 Credits**

A mathematical analysis of how people interact in strategic situations. Topics include normal-form and extensive-form representations of games, various types of equilibrium requirements, the existence and characterization of equilibria, and mechanism design. The analysis is applied to micro-economic problems including industrial organization, inter-national trade, and finance. Must have completed two semesters of calculus. Prerequisites as noted below or consent of instructor.

**Prerequisites:** ECO 412 and ECO 413

**ECO 464 Applied Econometrics I 3 Credits**

This course focuses on the identification of causal relationships using cross-sectional and panel data. The objectives are to 1) familiarize students with identification assumptions for causal inference; and 2) enable students to select appropriate econometric tools for empirical economic problems and policy evaluation. Topics include robust inference and bootstrap; instrumental variables and generalized method of moments (GMM); quantile and nonparametric regression methods; treatment effect analysis, and models for discrete choices, panel data, and social interactions. Prerequisites as noted below.

**Prerequisites:** ECO 416

**ECO 465 Applied Econometrics II 3 Credits**

Econometric analysis of skewed and truncated distributions, discrete outcomes, and missing or incomplete data. The first part of this course will involve the functional specification and testing of appropriate estimators in these situations, while the second part of the course will focus on conducting causal inference using nonlinear models in the presence of unobserved heterogeneity. Emphasis will be given to common applications in health and labor economics. Prerequisites as noted below.

**Prerequisites:** ECO 416

**ECO 466 Health Economics II 3 Credits**

Selected topics in the literature on health economics with an emphasis on the application and evaluation of econometric techniques and identification strategies. Both demand and supply side issues will be addressed. Examples of the former include the demand for health, health insurance and health care services, while examples of the latter include the regulation of supplier behavior and industrial organization issues. Prerequisites as noted below.

**Prerequisites:** ECO 402 and ECO 416

**ECO 472 International Trade Theory 3 Credits**

Theories of comparative advantage, factor price equalization, trade and welfare, tariffs, trade and factor movements. Prerequisites as noted below or consent of department chair.

**Prerequisites:** ECO 413

**ECO 473 International Monetary Economics 3 Credits**

Theory of the balance of payments, the microeconomics of international finance, various approaches to balance-of-payments adjustments, theories of foreign exchange-rate determination, and macroeconomic policy under fixed and flexible exchange rates. Prerequisites as noted below or consent of department chair.

**Prerequisites:** ECO 417

**ECO 490 Master's Thesis 6 Credits****ECO 492 Special Topics in Economics 1-3 Credit**

Extended study of an approved topic not covered in scheduled courses. May be repeated for credit.

**Repeat Status:** Course may be repeated.

**ECO 493 Doctoral Pre-Dissertation Research Project - Independent Study 1-9 Credit**

Independent study on a topic that is being pursued to fulfill the third year paper requirement, and has been approved by the student's interim advisor.

**ECO 499 Dissertation 1-15 Credit**

**Repeat Status:** Course may be repeated.

**Entrepreneurship**

Entrepreneurship-related programs and activities are university-wide, and coordinated by the Baker Institute for Entrepreneurship, Creativity and Innovation. Entrepreneurship curriculum is overseen by a joint committee of faculty from CBE, CAS and RCEAS.

**MINOR IN ENTREPRENEURSHIP**

Open to all undergraduate students, from any major.

The purpose is to enable students in any major to supplement their major with a creative entrepreneurial mindset and skills that increase their ability to identify opportunities for innovation, to challenge the status quo in any field, and to implement sustainable change, whether in emerging or established companies or non-profit enterprises. The program is designed to be accessible to students from all disciplines with an emphasis upon innovation, entrepreneurial thinking and creative processes, cross-functional integration, and hands-on experiential practice. The minor leverages the resources and support of the Baker Institute for Entrepreneurship, Creativity, and Innovation, as well as a broad array of related programs and infrastructure across the university.

We encourage participation by those interested in all types of entrepreneurship, including business and technical entrepreneurship but also not-for-profit contexts aiming for social, cultural and environmental change. Throughout the multi-disciplinary, team-based curriculum, students are encouraged to work either on their own entrepreneurial projects, projects related to Lehigh University intellectual property, or on ideas brought in by outside entrepreneurs.

**Recommended Tracks**

Students may select any set of courses that fulfill the minor requirements. However students are encouraged consult with the minor director to design a focused track, such as Technology Entrepreneurship, Social & Non-profit Entrepreneurship, Arts Entrepreneurship, Green Entrepreneurship, Health & Biomedical Entrepreneurship, Service-sector Entrepreneurship, or others. The recommended approach for a focused track begins with the introductory

ENTP 101 and closes with in-depth hands-on capstone entrepreneurial experiences, sandwiched around a flexible package of courses selected by each student as needed to foster their particular entrepreneurial interests and goals.

#### Requirements

The minor has a prerequisite of ECO 001 (4 credit hours) and then requires at least 14 credit hours of ENTP and capstone courses.

#### Prerequisite Course

ECO 001	Principles of Economics <sup>1</sup>
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#### Required Courses

ENTP 101	Introduction to Entrepreneurship	3
Select at least 6 additional credit hours in other ENTP courses <sup>2</sup>		6
Select at least two (minimum 5 credit hours) of the following experiential Capstone courses: <sup>3</sup>		5
ENTP 311	The Garage: Launching Entrepreneurial Ventures I	
ENTP 312	The Garage: Launching Entrepreneurial Ventures II	
ENTP/IR 307	International Social Entrepreneurship	
ENTP/POLS 310	Social Entrepreneurship: How to Change the World	
IBE 380	Integrated Business and Engineering Capstone Project I	
IBE 385	Integrated Business and Engineering Capstone Project II	
MGT 311	Small Business Consulting	
CSB 312	Design of Integrated Business Applications I	
CSB 313	Design of Integrated Business Applications II	
BUS/ENGR 211	Integrated Product Development (IPD) I	
BUS/ENGR 212	Integrated Product Development (IPD) II	
Other independent experiential project approved by the minor director		
<b>Total Credits</b>		<b>14</b>

<sup>1</sup> ECO 001 Principles of Economics (4 credit hours) must be completed prior to enrolling in the minor. Students may enroll in ENTP 101 without ECO 001, but may not sign up for the minor until completing ECO 001.

<sup>2</sup> Or alternatives approved by the minor director in consultation with the student.

<sup>3</sup> Or alternatives approved by the minor director.

Students must complete the minor with an average GPA of at least 2.0 in those courses to qualify.

#### Courses

##### ENTP 101 Introduction to Entrepreneurship 3 Credits

Introduction to the nature of entrepreneurship and the entrepreneurial mindset. Emphasis on identifying opportunities, generating creative ideas, and the process of scaling up sustainable organizations.

Topics include: alternative concepts of entrepreneurship and social entrepreneurship; personal attributes of entrepreneurs; steps in new venture creation; introduction to entrepreneurial finance and marketing; new venture planning for both emerging and existing enterprises. Uses case studies, hands-on experiential teams, and exposure through guest speakers to successful entrepreneurs and to Lehigh and community resources for entrepreneurs.

**Attribute/Distribution:** ND

##### ENTP 201 Entrepreneurship & Enterprise 3 Credits

Investigates skills & steps for entrepreneurial success: mindset; opportunity scanning; informal networking; finding resources; managing risk; marketing plans; investors; debt & venture capital; horizontal management; developing a leadership team & creative culture; technology cycles; structuring; managing change; ethics; exit strategies. Case studies & projects. Guest entrepreneurs. Prerequisites as noted below or consent of minor director.

**Prerequisites:** ENTP 101

##### ENTP 232 Gender Issues in Entrepreneurship 4 Credits

Explores role of women entrepreneurs in society & economic development; impacts of women's entrepreneurship in different economic and cultural contexts; research on why women still represent a minority or entrepreneurs; gender differences in patterns of entrepreneurship; related policy challenges. Also addresses pragmatic and personal life choices facing women entrepreneurs, including identifying key characteristics of entrepreneurial opportunities and mapping those against values, skills, ethics and definitions of success; and planning for professional and personal development.

**Attribute/Distribution:** SS

##### ENTP 306 Decision Making in Small Business and Non-Profit Enterprise 3 Credits

Formulation of strategies, policies and decisions unique to family owned businesses, nonprofit organizations, startup ventures and organizations experiencing rapid growth. Lectures and case studies. Prerequisites as noted below.

**Prerequisites:** FIN 125 and MKT 111

##### ENTP 307 International Social Entrepreneurship 4 Credits

International social entrepreneurship aims to change the world through innovation in solving social problems. Focus on the nexus between social entrepreneurship and development practice, especially in relation to NGOs. Emphasis on acquiring the tools and conceptual framework to launch a new social venture through real world hands-on field work and team-oriented learning by doing. Exposure to best practices in field methods with respect to development projects, to how to affect meaningful social change in poor countries, to generate and evaluate innovative ideas for poverty reduction, to develop those ideas into concrete on-the-ground start-up plans, and to take initial steps to implement them. It is recommended, but not required, that students have some previous experience with development or entrepreneurship, such as through enrollment in ENTP 101 or IR 322 or Eco 303 or CEE 205.

**Attribute/Distribution:** SS

##### ENTP 309 Nonprofit Administration 4 Credits

Key questions in nonprofit sector research, policy, & management and factors that make the nonprofit sector distinct. Scope & character of nonprofit activity in the U.S. & abroad. Current debates in nonprofit policy and critical challenges facing management.

**Attribute/Distribution:** SS

##### ENTP 310 Social Entrepreneurship: How to Change the World 4 Credits

The marketplace does not always have to be harsh. Social entrepreneurship uses market-based approaches to address needs and solve problems in our society. Students in this seminar-style course will learn how to identify community problems, convince the community that it is a problem worth solving, design the response, and implement it. Hands-on projects. Must have junior standing or higher, or consent of the minor director. Prerequisites as noted below, or consent of the minor director.

**Prerequisites:** ECO 001

**Attribute/Distribution:** SS

**ENTP 311 The Garage: Launching Entrepreneurial Ventures I 3 Credits**

Students work in cross-disciplinary teams with faculty advisors and alumni mentors on marketing, financial planning, and economic and technical feasibility of entrepreneurial product- or service-based new ventures, commercial or non-profit. Students may elect to work either on their own entrepreneurial projects, on projects related to Lehigh University intellectual property, or on ideas brought in by outside entrepreneurs. Oral presentations, written new venture plans and discussions with guest speakers are integral parts of the course. Prerequisites as noted below or consent of minor director.

**Prerequisites:** ENTP 101

**Attribute/Distribution:** ND

**ENTP 312 The Garage: Launching Entrepreneurial Ventures II 3 Credits**

Continuation of ENTP 311. Investigates and pursues in detail the critical steps and activities necessary when entrepreneurs seriously pursue launching new ventures. Prerequisites as noted below or consent of minor director.

**Prerequisites:** ENTP 311

**ENTP 320 The Business of Life Science 3 Credits**

An examination of business process in startup, early stage and developing bioscience companies. Technology assessment, business plan and proposal preparation, financial strategies, resource management, intellectual property, and legal as well as regulatory issues. Cannot be used to fulfill major requirements in BIOS. Prerequisites as noted below or consent of instructor.

**Prerequisites:** BIOS 120

**ENTP 371 Independent Study in Entrepreneurship or Social Ventures 1-4 Credit**

Study and projects in entrepreneurship or social ventures; designed for the student who has a special interest in a subject not included in the regular course schedule or interested in pursuing a significant supervised project in entrepreneurship. Interested students should seek agreement from a willing faculty adviser prior to enrolling. Consent of minor director required. Repeatable, but this course may count towards the ENTP minor only once.

**Repeat Status:** Course may be repeated.

**ENTP 372 Special Topics in Entrepreneurship or Social Ventures 1-4 Credit**

Special problems and issues in entrepreneurship or social ventures for which no regularly scheduled course exists. Coverage will vary according to the interests of the instructor and students. Consent of minor director required. Course may be repeated, with permission.

**Repeat Status:** Course may be repeated.

**ENTP 389 Honors Project 1-4 Credit**

Opportunity for Eckardt Scholars to pursue an extended project for senior honors. Transcript will identify department in which project was completed. Consent of department required.

**Finance**

In the era of a growing competitive global economy, finance has become increasingly important and complex. This has led to an expansion of career opportunities within corporations, investment firms, and financial institutions worldwide. These opportunities are varied and often overlap with other disciplines such as accounting, information systems, and marketing. It is also important that students engage in extracurricular activities that might complement their academic studies.

The domestic financial services industry has been at the forefront of global finance and will remain as one of our relative strengths within a global economy. Lehigh, in turn, enjoys a relative advantage in this regard as Lehigh alumni are well respected in all areas of finance. Our program has also been able to take advantage of our proximity to many financial institutions.

**Professors.** Paul Brockman, PhD (Louisiana State University); Stephen G. Buell, PhD (Lehigh University); Richard J. Kish, PhD (University of Florida); Matthew A. Melone, JD (University of Pennsylvania); Nandkumar Nayar, PhD (University of Iowa); Ajai K. Singh, PhD (University of Iowa)

**Associate Professors.** Anne-Marie Anderson, PhD (University of Arizona); George A. Nation, III, JD (Villanova University); Stephen F. Thode, DBA (Indiana University Bloomington)

**Assistant Professors.** Allen M. Carrion, PhD (University of Utah); Michael B Imerman, PhD (Rutgers University); Yung-Yu Ma, PhD (University of Utah); Steven McKay Price, PhD (Florida State University); Jesus M. Salas, PhD (University of Oklahoma); Ke Yang, PhD (University of Iowa)

**Professors Of Practice.** Daniel A. Bayak, MBA (University of Scranton); David H. Myers, PhD (University of Washington); Samuel C. Weaver, Ph.D., PhD (Lehigh University)

**Emeriti.** Carl R. Beidleman, PhD (University of Pennsylvania); James A. Greenleaf, PhD (New York University)

The finance major offered by the Perella Department of Finance requires at least 18 credit hours beyond the core requirements. Each finance major must successfully complete the 2-course foundation requirement; the 3-course depth requirement; and a minimum 2-course breadth requirement as outlined below.

**2-Course Foundation Requirement**

FIN 323	Investments	3
FIN 328	Corporate Financial Policy	3

**3-Course Depth Requirement**

Select three of the following: 9

FIN 324	Security Analysis and Portfolio Management	
FIN 330	Financial Markets and Institutions	
FIN 333	Global Finance	
FIN 334	Derivatives and Management of Risk	
FIN 335	Advanced Topics – Financial Management (Various Topics can be offered under this course listing)	
FIN 336	Real Estate Finance	
FIN 377	Advanced Topics--Investments (Various topics can be offered under this course listing)	

**2-Course Breadth Requirement**

Select at least 2 breadth electives within one of the following six breadth tracks. 6-7

**Track 1: Financial Analysis**

ACCT 315	Financial Accounting I	
ACCT 316	Financial Accounting II	

**Track 2: Financial Marketing**

MKT 312	Marketing Research	
MKT 319	Development and Marketing of New Products	
MKT 320	Global Marketing	
MKT/ECO 325	Quantitative Marketing Analysis	
MKT 332	Sales Management	

**Track 3: Analytical Finance**

IE 316	Optimization Models and Applications	
IE 339 or MATH 310	Stochastic Models and Applications Random Processes and Applications	
MATH 205 or MATH 242	Linear Methods Linear Algebra	
MATH 231 or MATH 309	Probability and Statistics Theory of Probability	

**Track 4: Financial Economics**

ECO 322 or ECO 333	Competitor and Market Analysis The Economics of Business Decisions	
ECO 339 or ECO 340 or ECO 203	International Trade International Finance Microfinance: Financial Inclusion for the Poor	

**Track 5: Real Estate Valuation (Must take all 3 courses)**

IPRE 301	Case Studies in Real Estate Value Creation
IPRE 347	Practicum in Real Estate I
IPRE 348	Practicum in Real Estate II

**Track 6: Expanded Finance**

FIN 324	Security Analysis and Portfolio Management
FIN 330	Financial Markets and Institutions
FIN 333	Global Finance
FIN 334	Derivatives and Management of Risk
FIN 335	Advanced Topics – Financial Management (various topics can be offered under this course listing)
FIN 336	Real Estate Finance
FIN 377	Advanced Topics--Investments (various topics can be offered under this course listing)

Total Credits	21-22
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**Undergraduate Courses****For Advanced Undergraduates and Graduate Students**

*Courses numbered 200 and above in the College of Business and Economics are open to sophomores only on petition.*

**Graduate Courses**

Course descriptions for the College of Business and Economics graduate courses can be found under the heading of Business and Economics Graduate Courses.

**Courses****FIN 125 Introduction to Finance 3 Credits**

An introductory finance course stressing the links between corporate finance and investments. Major topic areas will include financial statement analysis, time value of money, risk and return valuation of stocks and bonds, capital budgeting, and cost of capital. Prerequisites as noted below.

**Prerequisites:** (ECO 129 or ECO 029 and ACCT 151) and (ECO 145 or ECO 045 or MATH 231 or IE 111 or SR 111) and (MATH 021 or MATH 031 or MATH 076 or MATH 097 or MATH 081)

**FIN 273 Finance Internship I 1-3 Credit**

Based on a student's work experience, a sponsoring faculty member shall direct readings, projects, and other assignments—including a "capstone report." It should be noted that the work experience (at least 80 hours), by itself, is not the basis for academic credit. The faculty directed activity must be provided concurrent with the work. Course registration and related arrangements must be made in advance of the work engagement. This course must be taken Pass/Fail and cannot be used to satisfy finance major requirements. Declaration of a finance major. Consent of department required. Prerequisites as noted below.

**Prerequisites:** (ECO 129 or ECO 029 and ACCT 151) and (ECO 145 or ECO 045 or MATH 231 or IE 111 or SR 111) and (MATH 021 or MATH 031 or MATH 076 or MATH 097 or MATH 081)

**FIN 300 Apprentice Teaching 1-3 Credit**

**Repeat Status:** Course may be repeated.

**FIN 323 Investments 3 Credits**

The nature of risk and the form of returns on financial assets from the viewpoint of various constituents. Investor objectives, attitudes, and constraints are considered within the risk-return matrix within the context of valuation. Prerequisites as noted below.

**Prerequisites:** (FIN 125 or FIN 225) and ECO 146

**FIN 324 Security Analysis and Portfolio Management 3 Credits**

Valuation of equity and debt instruments factoring in the influence earnings forecasts and expectations, uncertainty, required returns, supply and demand for securities and funds, and investor attitudes. Portfolio management concepts include the implications of market factors, technical analysis, timing, and screening of securities. Prerequisites as noted below.

**Prerequisites:** FIN 323 and FIN 328

**FIN 328 Corporate Financial Policy 3 Credits**

The study of management issues related to capital budgeting, working capital, leasing, mergers, and financing. Prerequisites as noted below.

**Prerequisites:** (FIN 125 or FIN 225) and (ECO 146)

**FIN 330 Financial Markets and Institutions 3 Credits**

Functions and portfolios of financial intermediaries. Sectional demand and supply of funds, nature and role of interest rates, term structure and forecasting, impact of inflation and regulation on financial intermediaries and markets, and current developments in the financial system.

Management of assets and liabilities within the U.S. financial institution's legal and economic constraints. Prerequisites as noted below.

**Prerequisites:** (FIN 323 and FIN 328)

**FIN 333 Global Finance 3 Credits**

Issues that underlie the investment, financing, and dividend decisions of multinational firms from both the buyer's and seller's viewpoints. Current transactions in foreign currencies, direct and portfolio investment and associated risk management when dealing in foreign countries.

Prerequisites as noted below.

**Prerequisites:** (FIN 328 and FIN 323)

**FIN 334 Derivatives and Management of Risk 3 Credits**

Theoretical and practical aspects of various instruments and markets that involve financial derivative instruments. Emphasis on the management of risk for corporate managers and portfolio managers.

Prerequisites as noted below.

**Prerequisites:** (FIN 323 and FIN 328)

**FIN 335 Advanced Topics – Financial Management 3 Credits**

Advanced topics relating to specific areas of corporate finance such as: bond refunding, asset valuation and capital budgeting including the role of uncertainty, imprecise forecasts, risk preferences, inflation, market conditions, and the global marketplace; working capital management, leasing, mergers, and financing. The course content may vary between instructors and over time, therefore, the course descriptor is subject to change each time the course is offered. May be repeated as topics vary. Prerequisites as noted below.

**Repeat Status:** Course may be repeated.

**Prerequisites:** (FIN 328 and FIN 323)

**FIN 336 Real Estate Finance 3 Credits**

An advanced survey of modern residential and commercial real estate financing techniques from the perspective of the borrower and the lender. Topics include: the principles of financing decisions; financing methods and techniques, institutional sources of funds for real estate, and real estate financing decision-making. The course includes lectures, demonstrations, spreadsheet software exercises, and guest speakers. Prerequisites as noted below.

**Prerequisites:** (FIN 328 and FIN 323)

**FIN 371 Directed Readings 1-3 Credit**

Readings in various fields of finance designed for the student with a special interest in some field of finance not covered in scheduled courses. May be repeated. Consent of sponsoring instructor required.

**Repeat Status:** Course may be repeated.

**FIN 372 Special Topics 1-3 Credit**

Special problems and issues in finance for which no regularly scheduled course work exists. When offered as group study, coverage varies according to interests of instructor and students. May be repeated. Consent of sponsoring instructor required.

**Repeat Status:** Course may be repeated.



**FIN 373 Finance Internship II 1-3 Credit**

Based on a student's work experience, a sponsoring faculty member shall direct readings, projects, and other assignments—including a "capstone report." It should be noted that the work experience (at least 80 hours), by itself, is not the basis for academic credit. The faculty directed activity must be provided concurrent with the work. Course content and work experience should have added rigor from Finance Internship I due to the satisfactory completion of the finance core (FIN 323 and FIN 328). Course registration and related arrangements must be made in advance of the work engagement. This course must be taken Pass/Fail and cannot be used to satisfy finance major requirements. Declaration of a finance major. Consent of department required. Prerequisites as noted below.

**Prerequisites:** (FIN 323 and FIN 328)

**FIN 374 Portfolio Management Practicum 1-3 Credit**

Readings, projects and papers designed to complement the leadership and analytical activities associated with the management of the Student Investment Club or Thompson portfolios and similar activities. May be repeated. Consent of instructor required. Prerequisites as noted below.

**Repeat Status:** Course may be repeated.

**Prerequisites:** FIN 323

**FIN 377 Advanced Topics--Investments 3 Credits**

Advanced topics to specific areas of Investments such as: valuation/security analysis; portfolio/risk management; fixed income securities; mutual funds; hedge funds; microstructure; and trading. May be repeated as topics vary. Prerequisites as noted below.

**Repeat Status:** Course may be repeated.

**Prerequisites:** FIN 323 and FIN 328

**FIN 382 Guest Speaker Seminar Series 1 Credit**

This course is designed to help prepare students for 'real' world problems by exposing them to a variety of career opportunities. The purpose of this seminar is to give students the opportunity to network with successful professionals in the Financial Services industry, connecting students and practitioners across places and generations to build community around shared work-as-service interests. For future professionals, this seminar advances co-curricular programming to the "pro-curricular" level – linking classroom study of finance to the dynamic world of the practicing financial professionals. May be repeated for credit.

**Repeat Status:** Course may be repeated.

**FIN 389 Honors Project 1-8 Credit**

**Repeat Status:** Course may be repeated.

**Integrated Real Estate at Lehigh Program**

Integrated Real Estate At Lehigh (*ire@l*) is a three or four year course of study designed to complement a wide range of majors, from art and architecture to civil engineering to environmental science to finance to marketing to economics. The mission of the *ire@l* program is to prepare the next generation of real estate leaders. Students completing the *ire@l* program will earn a minor in real estate.

The director of the Goodman Center for Real Estate Studies and the *ire@l* program is Associate Professor Stephen Thode ([ire@lehigh.edu](mailto:ire@lehigh.edu)).

**ire@l minor****Required Courses**

IPRE 001	Introductory Seminar in Real Estate	3
IPRE 002	Field Laboratory	2
IPRE 301	Case Studies in Real Estate Value Creation	3
IPRE 302	IPRE Internship	1
IPRE 347	Practicum in Real Estate I	2
IPRE 348	Practicum in Real Estate II	2

**Recommended Courses**

IPRE 101	Real Estate Practicum Clerkship I
IPRE 102	Real Estate Practicum Clerkship II

Total Credits

13

**Courses****IPRE 001 Introductory Seminar in Real Estate 3 Credits**

Required of all entering *ire@l* students, this seminar explores a variety of issues related to real estate, entrepreneurship and leadership.

Topics include: the relationship of real estate to finance, architecture, environmental issues, government, engineering, urban planning and economic development; the role of the entrepreneur in real estate and real estate development; ethical considerations in real estate; and, models of leadership. The seminar will consist of lectures and presentations by a variety of Lehigh faculty, entrepreneurs, and real estate professionals. Must have freshman OR sophomore standing. Consent of instructor required.

**IPRE 002 Field Laboratory 2 Credits**

An introduction to the real estate development process. Using an actual, planned commercial real estate development, the class will engage in an extensive inquiry into the breadth and depth of the real estate development process. Topics include: the sequence of events in the development process; parallel and sequential activities; impediments to highest and best use; strategies for overcoming impediments; managing relationships with various constituents; sources of capital; and, market analysis. Each class member will submit a final report detailing his or her findings with respect to these topics. Consent of instructor required. Prerequisites as noted below.

**Prerequisites:** IPRE 001

**IPRE 101 Real Estate Practicum Clerkship I 1 Credit**

Just as medical school and law school students serve clerkships as a key part of their academic preparation, *ire@l* students may serve clerkships in the Real Estate Practicum. Clerkship students will rotate among all of the groups engaged in the Real Estate Practicum - accompanying Practicum groups on site visits, observing those groups' interactions with various faculty and real estate professionals, and assisting those groups in the completion of numerous tasks. During the fall semester, the focus of these rotations be on the physical characteristics of the Practicum properties including design considerations, structural integrity, floor plans, building systems and tenant improvements. Students will also develop an understanding of the property's location, and how that location affects the use(s) of the property. Finally, students will gauge the area in which the property is located. Concurrent with these rotations, these students will reference their Field Laboratory property that is in an earlier stage of development, drawing a contrast between a completed property and a property under development. Consent of instructor required.

**Prerequisites:** (IPRE 001 and IPRE 002)

**IPRE 102 Real Estate Practicum Clerkship II 1 Credit**

A continuation of the fall semester, the spring semester rotations focus on the real estate markets in which the Practicum properties are located, and on the financial analysis (valuation) of the Practicum properties. As in the fall, at the conclusion of each rotation, the clerkship student will receive evaluations from faculty, practitioners and Practicum group members on their performance. Likewise, clerkship students will reference their Field Laboratory property to contrast the difference between the demonstrated value created (in a completed property) and the value that is expected to be created (in a property under development). Consent of instructor required.

**IPRE 300 Apprentice Teaching 1-4 Credit**

**Repeat Status:** Course may be repeated.

**IPRE 301 Case Studies in Real Estate Value Creation 3 Credits**

An investigation into ways in which the entrepreneur is able to create value through the development or redevelopment of real estate. Issues: establishing a real property's highest and best use; the entrepreneurial thought process; zoning, planning and land use regulations and their effects on real estate development; real and potential environmental impacts and their effects on real estate development; the role of government in stimulating (or destimulating) real estate development; overcoming barriers to real estate development; negotiation techniques; and, application of alternative strategies in the development process. The course is taught using the case method with the majority of the cases from previous Real Estate Practica. The course is a combination of lectures, presentations by entrepreneurs, and site visits to (re)developed properties as well as properties in the planning phase. Consent of instructor required.

**IPRE 302 IPRE Internship 1 Credit**

Open to students in the Integrated Real Estate At Lehigh (ire@l) Program. The student will be evaluated on a directed writing assignment of no fewer than 9 pages and on a detailed evaluation provided by his or her work supervisor. A minimum of 150 hours of work must be completed in the internship, and verified by work supervisor. It should be noted that the work experience itself is not the basis for academic credit. Course registration and related arrangements must be made in advance of the work experience. This course cannot be used to satisfy any major requirements. Consent of program director required. In extraordinary circumstances and with the consent of the program director this requirement can be altered according to the director's stipulations.

**Prerequisites:** (IPRE 001 and IPRE 002)

**IPRE 347 Practicum in Real Estate I 2 Credits**

Organized into teams, with each team assigned a different subject commercial real property, the class engages in the study of the physical and locational characteristics of commercial real estate as they relate to value including: property history; architecture; physical attributes that add to or detract from value; tenant mix; the immediate neighborhood environment; and, the specific market in which the real property competes for tenants. Each team meets with the property owner and conducts a thorough review of the property's development process including, where applicable, previous attempts to develop the property, prior uses for the property, and significant phase points in the development process (for example, "deal killing" impediments that were overcome). Each team submits a written report of their findings and produces a 10-minute video documentary on their subject property. Permission of the instructor required.

**IPRE 348 Practicum in Real Estate II 2 Credits**

A continuation of the study of the creation of value in commercial real estate begun in the Practicum in Real Estate I. Each student team continues with the subject commercial real property assigned to them in Practicum I. The class engages in the study of the market and financial characteristics of commercial real estate as they relate to value through: a financial analysis of the market in which their property is located to include market rents, market vacancy rates and market absorption rates; and, financial analysis of the subject property to include both historical results, and pro forma estimates of revenues, expenses, cash flow and residual value. Each team also studies the financial characteristics of comparable properties. The grand finale of the Real Estate Practicum (and the IPRE curriculum) is the Collins Family Scholarship Competition. Held at the conclusion of the spring semester, this competition is the public vehicle for the Practicum teams to present the results of their property studies. Consent of instructor required. Prerequisites as noted below.

**Prerequisites:** IPRE 347

**Law**

Every CBE student is required to take Law 201 as part of the CBE Core.

The following undergraduate law courses are offered through the Perella Department of Finance:

Course descriptions for the College of Business and Economics graduate courses can be found in the Courses tab. Prerequisite: consent of sponsoring instructor.

**Courses****LAW 101 Introduction to Law 3 Credits**

A study of the nature and function of law and the legal system, the study of legal reasoning through the use of the case method.

**LAW 201 Legal Environment of Business 3 Credits**

The study of the legal relationships of business and government, business and society and the individual and society. The case method is used to develop analytical skills. Introduction to contract law and the law of sales underlying the free market system. Must have junior standing. Prerequisites as noted below.

**Prerequisites:** (ECO 001)

**LAW 202 Business Law 3 Credits**

The law of agency, business organizations, secured transactions, bankruptcy and negotiable instruments. Prerequisites as noted below.

**Prerequisites:** (LAW 201)

**LAW 300 Apprentice Teaching 1-3 Credit**

**Repeat Status:** Course may be repeated.

**LAW 371 Directed Readings 1-3 Credit**

Readings in various fields of law, designed for students who have a special interest in a field of law. Consent of sponsoring instructor required.

**LAW 372 Special Topics 1-3 Credit**

Special problems and issues in commercial law.

**Management**

The Management major introduces management practices to students who wish to work in human resource management, management consulting, or in small business and non-profit organizations. There are two distinct tracks to the major.

- **Managing Human Resources:** This track prepares students to work as human resource professionals or in management consulting organizations or to broaden their interpersonal skills.
- **Small Business and Non Profit Management:** This track prepares students specifically to work in small businesses including family owned businesses, nonprofit organizations, startups, and in rapid growth environments.

**Professors.** Nada R. Sanders, PhD (Ohio State University); Michael D. Santoro, PhD (Rutgers University); Susan A. Sherer, PhD (University of Pennsylvania); Robert J. Trent, PhD (Michigan State University)

**Associate Professors.** Corinne A. Post, PhD (Rutgers University Newark); Catherine M. Ridings, PhD (Drexel University); Andrew John Ward, PhD (University of Pennsylvania); Yuliang Yao, PhD (University of Maryland College Park); Zach G. Zacharia, PhD (University of Tennessee Knoxville)

**Assistant Professors.** Liuba Y. Belkin, PhD (Rutgers University); William Forster, PhD (University of Virginia); Douglas M. Mahony, PhD (Rutgers University); Serge Pires da Motta Veiga, PhD (University of Missouri Columbia); Naomi B. Rothman, PhD (New York University); Charles E. Stevens, PhD (Ohio State University)

**Lecturer.** Chitra S. Nayar, MBA (University of Iowa)

**Professors Of Practice.** Dale F. Falcinelli, MS (Lehigh University); Robert Kuchta, MS (New Jersey Institute of Technology)

**Emeriti.** Richard W Barsness, PhD (University of Minnesota Minneapolis); John W. Bonge, PhD (Northwestern University); Michael G. Kolchin, DBA (Indiana State Univer); Peter P. Poole, PhD (The Pennsylvania State University); Theodore W. Schlie, PhD (Northwestern University); John E. Stevens, PhD (University of Cincinnati)

Each track of the Management Major is comprised of 5 courses (15 credits). All Management Majors are required to take MGT 342 Managing in the International Organization.

**Managing Human Resources****Required**

MGT 333	Human Resource Management	3
MGT/SCM 328	Negotiations and Conflict Management	3
MGT 342	Managing in the International Organization <sup>1</sup>	3
MGT 363	Diversity and Inclusion in the Workplace	3
<b>Plus 1 from the following courses:</b>		3
MGT 311	Small Business Consulting	
ECO 235	Labor Economics	
Total Credits		15

**Small Business and Non-Profit Management****Required**

MGT 342	Managing in the International Organization <sup>1</sup>	3
MGT 311	Small Business Consulting	3
MGT 306	Decision Making in Small Business and Non-profit Enterprise	3
<b>Plus 2 from the following courses:</b>		6
MGT/SCM 328	Negotiations and Conflict Management	
MGT 333	Human Resource Management	
FIN 328	Corporate Financial Policy	
BIS 335	Web Application Development for Business	
MKT 319	Development and Marketing of New Products	
Total Credits		15

<sup>1</sup> MGT 342 Management in the International Organization fulfills the CBE Global Requirement

<sup>2</sup> MGT 363 Diversity and Inclusion in the Workplace fulfills the CBE Diversity Requirement

Course descriptions for the College of Business and Economics graduate courses can be found in this section under the heading of Business and Economics Graduate Courses.

**Courses****MGT 143 Managing and Leading People in Organizations 3 Credits**

Introduction to human behavior in organizations. Emphasis on conceptual and applied organizational behavior and human resource topics such as: individual differences; perception and judgment; decision making; motivation; teams and groups; leadership; conflict; ethics; diversity; and culture. Must have sophomore or junior standing.

**MGT 243 Managing and Leading People in Organizations 3 Credits**

Introduction to human behavior in organizations. Emphasis on conceptual and applied organizational behavior and human resource topics such as: individual differences; perception and judgment; decision making; motivation; teams and groups; leadership; conflict; ethics; diversity; and culture. Must have junior standing.

**MGT 300 Apprentice Teaching 1-3 Credit****MGT 301 Strategic Management 3 Credits**

The capstone business class, integrating concepts and practices from the core business classes, utilizing an organizationwide strategic perspective and examining the relationship among firm strategy, structure and environment. The course emphasizes strategic analysis strategy formulation, and strategy implementation so as to achieve sustainable competitive advantage. Corporate governance, corporate social responsibility and business ethics are incorporated into the strategic perspective. Case analyses and competitive simulation game are the central learning components. Must have senior standing in the College of Business and Economics, and completion of the college core.

**Prerequisites:** (MKT 111 or MKT 211) and (ECO 115 or ECO 146 or ECO 105) and (LAW 201) and (FIN 125 or FIN 225) and (MGT 186 or SCM 186) and (MGT 243 or CSB 311 or CSB 312) and (BIS 211 or BIS 111 or ACCT 311 or CSB 311) and (ECO 029 or ECO 129) and ACCT 152 and BUS 001 and (BUS 005 or CSB 311)

**MGT 306 Decision Making in Small Business and Non-profit Enterprise 3 Credits**

Formulation of strategies, policies and decisions unique to family owned businesses, non profit organizations, start up ventures, and organizations experiencing rapid growth. Lectures and case studies. Prerequisites as noted below.

**Prerequisites:** (FIN 125 and MKT 111 or MKT 211)

**MGT 311 Small Business Consulting 3 Credits**

A field studies course providing management assistance to small businesses in the Lehigh Valley. Students work in small groups under faculty supervision on a direct basis with owners. Problem solving and experience in applying marketing, accounting, finance, and/or management concepts to business. Must have junior standing in the College of Business and Economics.

**MGT 328 Negotiations and Conflict Management 3 Credits**

This course covers the theory and processes of negotiation in a variety of settings including face-to-face, virtual and crosscultural business environments. Students will learn negotiating skills by preparing and simulating a broad mixture of negotiations, ranging from one-on-one, to three-person, to multiparty and team negotiations. They will learn to analyze outcomes and strategies during the debriefing sessions and will have an opportunity to compare results of their negotiations to the results of other people in class.

**MGT 333 Human Resource Management 3 Credits**

Analysis and resolution of personnel problems in organizations. Human resource planning, recruitment, selection, orientation, training, appraisal, compensation, and development. Prerequisites as noted below or consent of instructor.

**Prerequisites:** MGT 243

**MGT 342 Managing in the International Organization 3 Credits**

This course introduces students to the challenges of managing and leading organizations whose operations and activities span national boundaries. Particular attention will be given to the critical human resource issues confronting managers in the global marketplace. Topics discussed include: contemporary and emerging international organizational structures; fostering a global mindset; managing across cultures; developing global leaders; reward systems; performance management; and managing global careers. Junior standing is required or approval by the instructor.

**MGT 350 Project Management 3 Credits**

Key processes and tenets of project management including scope, time, cost, quality, human resources, communications, risk, procurement, and integration management. Both technical and behavioral aspects of project management are applied within the context of either IS management, HR management, Supply Chain Process Management, Small Business Management. Topics include: expectations management, change management and consulting engagement management. Introduces both software project monitoring tools and project team collaboration techniques and tools. Must have completion of all other courses in either BIS or Management major.

**Prerequisites:** (MGT 321 and MGT 333) or (MGT 321 and MGT 311 and MGT 306) or (MGT 321 and BIS 311 and BIS 324) or (MGT 321 and (SCM 328 or SCM 340 or SCM 342 or SCM 309 or SCM 354), )

**MGT 363 Diversity and Inclusion in the Workplace 3 Credits**

This 3-credit course focuses on the complex dynamics that emerge in diverse groups and environments, explains how diversity and inclusion affect individual and organizational performance, relates diversity and inclusion to career development and success and to the management of human resources. This course also aims to develop skills and competencies for effectively managing diversity and its effects in the workplace. Diversity and Inclusion in the Workplace will be taught with a combination of lectures, self-assessments, class discussions, group exercises, self-reflections, case studies, and current events.

**MGT 371 Directed Readings 1-3 Credit**

Readings in various fields of management designed for the student who has a special interest in some field of management not covered by the regularly scheduled courses. Consent of department chair required. May be repeated.

**Repeat Status:** Course may be repeated.

**MGT 372 Special Topics 1-3 Credit**

Special problems and issues in management for which no regularly scheduled course work exists. When offered as group study, coverage varies according to interests of instructor and students. Consent of department chair required. May be repeated.

**Repeat Status:** Course may be repeated.

**MGT 373 Management Internship 1-3 Credit**

A sponsoring faculty member shall direct readings, projects, and other assignments including a comprehensive final report in conjunction with an industry-sponsored internship. The work experience itself, whether paid or unpaid, is not the basis for academic credit. Intellectual development in the context of a field study learning experience will be the determining factor in awarding academic credit. This course cannot be used to satisfy requirements of the Management major. Consent of department chair. Must have junior standing.

## Marketing

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Marketing Department Web page: [www.lehigh.edu/cbemarketing](http://www.lehigh.edu/cbemarketing)

Marketing is a critical success factor in any business. Marketing is more than just selling or advertising. It is understanding a product. It is focusing on the needs of the consumers. It encompasses new product development, pricing, promotion and distribution considerations. Marketing influences virtually all strategic business plans and decisions and its scope ranges from government and not-for-profit organizations to free enterprise. Marketing plays a major role in the management of any business.

Lehigh's marketing major is a rigorous and highly relevant curriculum of instruction. Students are taught to recognize the strong linkage between theory and practice and to appreciate the need for teamwork, leadership, and communication skills. Activities that encourage students to acquire professional-level competency throughout the curriculum include: developing integrated advertising campaigns, designing and implementing marketing research projects, conducting customer analyses, as well as a wide variety of practice-based projects.

Students are encouraged to explore the potential enhancement of their educational experience through study abroad programs, internships with business, and research projects with faculty members.

Participation in the Marketing Club student organization is an extracurricular activity that offers a professional orientation program and the enjoyment of socializing with other students from across the campus.

**Professors.** David Griffith, PhD (Kent State University); K. Sivakumar, PhD (Syracuse University)

**Associate Professors.** Ravindra Chitturi, PhD (University Texas Austin); Nevena Taneva Koukova, PhD (University of Maryland); James M. Maskulka, PhD (Kent State University)

**Assistant Professors.** Beibei Dong, PhD (University of Missouri Columbia); Taewan Kim, PhD (Syracuse University); Ju-Yeon Lee, PhD (University of Washington)

**Professors Of Practice.** Beth S. Gallant, MA (Columbia University); Steven L. Savino, MBA (Wake Forest University)

**Emeritus.** James Edward Hansz, PhD (University of Cincinnati)

The marketing major offered by the Department of Marketing consists of 18 credit hours from the following courses:

**Required courses**

MKT 311	Consumer Behavior	3
MKT 312	Marketing Research	3
MKT 387	Marketing Strategy	3

**Elective courses**

Select two of the following:		6
MKT 313	Integrated Marketing Communications	
MKT 319	Development and Marketing of New Products	
MKT 320	Global Marketing	
MKT 321	Business-to-Business Marketing	
MKT 325	Quantitative Marketing Analysis	
MKT 331	Electronic Commerce	
MKT 332	Sales Management	
MKT 360	Marketing Practicum	
MKT 366	Marketing of Services	
MKT 371	Directed Readings	
MKT 372	Special Topics	

One additional marketing elective required, either from the above list, or any course approved by the academic advisor

Total Credits		18
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**Graduate Courses**

Course descriptions for the College of Business and Economics graduate courses can be found in this section under the heading of Business and Economics Graduate Courses.

**Courses****MKT 111 Principles of Marketing 3 Credits**

The purpose of this course is to give an overview of the entire marketing function. The objective is to take a broad-based approach to expose students to the meaning of marketing, the terminology of marketing, the activities involved in marketing, how managers make and implement decisions in marketing, and how they evaluate the results. The role of marketing in the broader society will also be discussed. At the end of this course, students will be able to understand the meaning of the marketing concept, various marketing terminologies, how firms develop and evaluate marketing strategies related to product, place, price, and promotions, how marketing strategies are related to other strategies of the firm, and what internal and external factors influence the marketing decisions. The outcome of the course will be assessed by a series of multiple choice and short essay questions, and other suitable assignments decided by the instructor. Prerequisites as noted below.

**Prerequisites:** ECO 001

**MKT 211 Principles of Marketing 3 Credits**

The purpose of this course is to give an overview of the entire marketing function. The objective is to take a broad-based approach to expose students to the meaning of marketing, the terminology of marketing, the activities involved in marketing, how managers make and implement decisions in marketing, and how they evaluate the results. The role of marketing in the broader society will also be discussed. At the end of this course, students will be able to understand the meaning of the marketing concept, various marketing terminologies, how firms develop and evaluate marketing strategies related to product, place, price, and promotions, how marketing strategies are related to other strategies of the firm, and what internal and external factors influence the marketing decisions. The outcome of the course will be assessed by a series of multiple choice and short essay questions, and other suitable assignments decided by the instructor.

**Prerequisites:** ECO 001

**MKT 300 Apprentice Teaching 1-3 Credit**

**Repeat Status:** Course may be repeated.

**MKT 311 Consumer Behavior 3 Credits**

This course focuses on the theory and tools necessary to analyze and understand consumer buyers and business buyers, as well as other organizational and governmental buyers, in the context of the global information age. The topics covered include, but are not limited to, diffusion of innovations; market segmentation and product positioning; the multiattribute model and the theory of reasoned action; group and individual decision making processes of buyers; and buyer conditioning and learning processes. Throughout the course, the relevance of the covered theory and tools will be illustrated by using cutting edge examples of what businesses and consumers are doing today. At the end of this class, students will be able to demonstrate an understanding of the theories and tools of buyer behavior. In addition, they will be able to analyze buyers and develop appropriate marketing strategies. The achievement of course objectives will be measured through the use of examinations, as well as a variety of application level tools, including in-class projects, case analyses, and a term project. Prerequisites as noted below.

**Prerequisites:** MKT 111 or MKT 211

**MKT 312 Marketing Research 3 Credits**

The objective of this course is to offer a managerial approach toward conducting and using research for marketing decisions. The focus will be on the relevance and usefulness of systematic research for decision making, the process and steps involved in conducting effective marketing research, analysis and interpretation of the information for decision making, and the presentation of research results to help managers arrive at sound marketing decisions. Particular emphasis will be placed on the context of technological advances in the collection, dissemination, and use of marketing information, the applicability of marketing research principles for a wide variety of organizations and individuals in the global context, and ethical issues involved in marketing research. At the end of this course, students will have an understanding of the costs and benefits of marketing research, be able to conduct marketing research using a systematic set of procedures, know how to develop research instruments such as questionnaires, have the knowledge to analyze the data, and present the conclusions to other managers. In addition to periodic testing of their knowledge of marketing research by means of examinations (multiple choice, short essay questions, and hands-on problems), the course will involve a marketing research project from problem formulation to presentation of findings. Prerequisites as noted below.

**Prerequisites:** (ECO 145 or ECO 045) and (MKT 111 or MKT 211)

**MKT 313 Integrated Marketing Communications 3 Credits**

This course focuses on the wide range of areas included in marketing communications and the tools and techniques needed to create an integrated approach. Students are introduced to the broad spectrum of communication messages and the sources that produce them, and then showed how they can be used for maximum efficiency through a coordinated planning process. Lectures and assignments develop an understanding for the factors found in all integrated marketing communications plans, their interactions, strengths and weaknesses, and their effect on the overall marketing message. The course concludes with the students creating and presenting an integrated marketing communications plan and its supporting tactics. Prerequisites as noted below.

**Prerequisites:** MKT 111 or MKT 211

**MKT 319 Development and Marketing of New Products 3 Credits**

This course adopts the marketing philosophy that new products and services will be profitable if the extended product provides customers with highly valued benefits. The goal is to help students learn how to use state-of-the-art management techniques to identify markets, develop new product ideas, measure customer benefits, and design profitable new products. The course provides techniques to interface the marketing function with the functions of R&D, design engineering, and manufacturing. Prerequisites as noted below.

**Prerequisites:** MKT 111 or MKT 211

**MKT 320 Global Marketing 3 Credits**

This course focuses on understanding the process of globalization and its impact on the firm's marketing activities. Whether an organization operates in the domestic market or in the global market place, it cannot ignore competitive pressures and market opportunities at the global level. This course will focus on topics such as the changes in global environment (e.g., financial, cultural, political, and legal) and their impact on marketing activities, development of global marketing strategies based on sound marketing research (e.g., global segmentation and positioning, global market entry strategies, developing products for the global market place, pricing, communication, and distribution strategies, and so on), and the role of technology in global marketing strategies. Prerequisites as noted below.

**Prerequisites:** MKT 111 or MKT 211

**MKT 321 Business-to-Business Marketing 3 Credits**

This course introduces students to the elements necessary to market a product, service, idea, event, organization, place, information, property, experience, or personality to another business. Students develop the knowledge and thinking skills needed to create, develop, and present a complete, integrated Business-To-Business (B2B) marketing plan. Lecture and assignments focus on B2B marketing, a process that begins with researching the relevant marketplace to understand its dynamics. Students learn how to identify opportunities to meet existing needs, segment the market, and select those segments that a company can satisfy in a superior way. In addition, students learn how to formulate a broad strategy, refine it into a detailed marketing mix and action plan, carry out the plan, evaluate the results, and make further improvements. Prerequisites as noted below.

**Prerequisites:** MKT 111 or MKT 211

**MKT 325 Quantitative Marketing Analysis 3 Credits**

Explores economics and management science approaches to improve marketing decision making and marketing interactions in such areas as strategic marketing, e-marketing, advertising, pricing, sales force management, sales promotions, new products, and direct marketing. The development, implementation, and use of quantitative models are emphasized. Cases are used to illustrate how these models can be applied. Students have the opportunity to learn how to use and evaluate models through spreadsheet-based assignments. Prerequisites as noted below.

**Prerequisites:** (MKT 111 or MKT 211) and (ECO 146 or ECO 105) and (ECO 145 or ECO 045 or MATH 012 or MATH 231 or SR 111 or IE 111) and (MATH 021 or MATH 031 or MATH 051 or MATH 081 and MATH 076)

**MKT 331 Electronic Commerce 3 Credits**

This course covers how businesses and consumers use the Internet to exchange information and complete transactions. Both theoretical concepts and practical skills will be addressed within the scope of the class. Topics include advertising and marketing, ecommerce business and revenue models, online consumer behavior, web site design issues, Internet security, electronic payments, infrastructure issues, privacy issues, and overall electronic commerce strategy. Students will get hands-on experience designing ecommerce web-sites using web authoring software. Prerequisites as noted below or consent of instructor.

**Prerequisites:** (MKT 111 or MKT 211) and (BIS 111 or BIS 211)

**MKT 332 Sales Management 3 Credits**

This course is an integrative approach to sales management including formulation of strategically sound sales programs, implementation of sales programs, and evaluation and control of the organization's sales activities. Illustrative topics include the role of the sales manager in the divergent demands of multiple constituencies; the development of effective sales organizations; salesperson's motivations and the development of flexible motivational plans; the variety of financial and non-financial rewards used by sales managers; forecasting sales costs and evaluating performance by person, territory, customer, market, and industry; and coordination of the sales activities with other elements in a firm's marketing program. Prerequisites as noted below.

**Prerequisites:** MKT 211 or MKT 111

**MKT 360 Marketing Practicum 3 Credits**

The marketing practicum combines formal class work on marketing problem formulation and business communications with an intensive internship or consulting engagement with a business. Students work with client firms to develop individual or team projects, which focus on marketing activities such as market research, strategy development, sales management, and promotion management. Upon completion of the project, students submit a written report and make a formal presentation to clients. Prerequisites as noted below.

**Prerequisites:** (MKT 111 or MKT 211) and MKT 312 and MKT 311

**MKT 366 Marketing of Services 3 Credits**

This course focuses on service quality issues and strategies from a customer-focused business perspective. The course gives students an appreciation of the challenges of marketing and managing services (whether in a manufacturing or service business) and develops strategies for addressing these challenges. The need for integration across functions to provide effective service is stressed. Illustrative topics include service quality gap analysis; services triangle analysis; 7 P's for services; service-profit chain; service encounter analysis; customer lifetime value analysis; new service development process; service quality dimensions; services guarantees; and demand/ capacity management. Prerequisites as noted below.

**Prerequisites:** MKT 211 or MKT 111

**MKT 371 Directed Readings 1-3 Credit**

Readings in various fields of marketing designed for the student who has a special interest in some field of marketing not covered in regularly scheduled courses. Consent of department chair required. May be repeated.

**Repeat Status:** Course may be repeated.

**MKT 372 Special Topics 1-3 Credit**

Special problems and issues in marketing for which no regularly scheduled course work exists. When offered as group study or internship, coverage will vary according to the interests of the instructor and students. Consent of department chair required. May be repeated.

**Repeat Status:** Course may be repeated.

**MKT 373 Marketing Internship 1-3 Credit**

Based on a student's work experience, a sponsoring faculty member shall direct readings, projects, and other assignments—including a "capstone report." It should be noted that the work experience (at least 80 hours), by itself, is not the basis for academic credit. The faculty directed activity must be provided concurrent with the work. Course registration and related arrangements must be made in advance of the work engagement. This course must be taken Pass/Fail and cannot be used to satisfy marketing major requirements. Must have junior standing. Consent of department required. Prerequisites as noted below. May be repeated once.

**Repeat Status:** Course may be repeated.

**Prerequisites:** MKT 111

**MKT 387 Marketing Strategy 3 Credits**

The objective of this capstone course is to synthesize the marketing principles introduced in other marketing courses and thus provide students an integrative framework to marketing decision-making. Our review indicates that this integrative closure for the marketing coursework is a common practice at some of the better business schools. It will focus on how marketing strategy supports the overall corporate strategy. The course will emphasize that Marketing does not operate in vacuum. What is done in other functional areas will impact marketing strategy profoundly, and vice versa. The course will address traditional strategic issues such as identification of organizational strengths, weaknesses and environmental opportunities in the context of developing marketing strategies, but will also emphasize the importance of embracing a customer centric orientation throughout the organization. Incorporating a customer centric orientation is an essential component of marketing strategy today as it captures the dynamic and evolving nature of marketing. Every company employee is important to the marketing function. Every employee contact with a customer is a form of marketing communication, the increasing number of customer- initiated contacts with the firm are as important as firm-initiated contacts, and customer relationships now take precedence over sales transactions. Specific emphasis will be placed on applying theoretical principles in realistic scenarios by means of case studies of how marketing strategy is impacted by the overall corporate strategy and other functional strategies. Student performance will be evaluated by his/her ability to prepare and present case analyses. Prerequisites as noted below.

**Prerequisites:** MKT 311 and MKT 312

**MKT 389 Honors Project 1-6 Credit****Supply Chain Management**

Success in today's business environment is driven by competitive advantage and profitability. Customer-focus, value added product differentiation and cost management are the elements associated with industry leaders. The Supply Chain Management undergraduate major at Lehigh University prepares students to understand and manage the processes that distinguish the successful company from its competitors.

The Supply Chain Management major equips students with the knowledge, skills and abilities necessary for success in the complex business environment of the 21st Century. This program:

- Provides solid exposure to supply management, logistics, business-to-business, and operations management topics.
- Develops cross-functional team skills by integrating Supply Chain Management students with engineering students in the Integrated Product Development (IPD) program.
- Emphasizes advanced cost analysis, negotiation, quality management and improvement, logistics network modeling and e-business.
- Integrates core business courses with supply chain major courses.
- Provides field study and experiential learning opportunities.

Supply Chain Management graduates will be prepared to enter industry at a level that accelerates their on-the-job learning and development.

Supply Chain Management graduates typically work within four areas, each with its own set of positions and career paths:

- purchasing and supply management
- transportation and logistics
- operations management
- inventory management and control
- supply chain planning

**Supply Chain Management Program****Required Major Courses**

SCM 309	Supply, Cost, and Risk Management	3
SCM 354	Integrated Logistics and Transportation Management	3
BUS 211	Integrated Product Development (IPD)	3

SCM 328	Negotiations and Conflict Management	3
SCM 340	Demand and Supply Chain Planning	3
SCM 342	e-Business Enterprise Applications	3
<b>Optional</b>		
SCM 373	Supply Chain Management Internship	1-3
Total Credits		19-21

### Supply Chain Management Minor

The Supply Chain Management minor is designed to offer students in other disciplines an opportunity to learn about supply chain topics and issues. The College of Business and Economics offers a Supply Chain Management minor to any student that has completed the following:

#### Prerequisites

ECO 001	Principles of Economics
ECO 045	Statistical Methods (or applicable statistics from the student's college)

#### Required

SCM 309	Supply, Cost, and Risk Management	3
SCM 354	Integrated Logistics and Transportation Management	3
Select one of the following:		3
SCM/MGT 328	Negotiations and Conflict Management	
SCM 342	e-Business Enterprise Applications	
SCM 340	Demand and Supply Chain Planning	
Total Credits		9

#### Courses

##### SCM 186 Supply Chain Operations Management 3 Credits

Introduction to managing global supply chains and operations within the context of an integrated value chain. Topics include supply chain management, total quality management, project management, demand forecasting, supply management, lean operations, aggregate planning, capacity planning, inventory management, distribution and transportation management, and performance measurement. Prerequisites as noted below.

**Prerequisites:** (MATH 021 or MATH 076 or MATH 097 or MATH 081) and (ECO 045 or ECO 145 or MATH 231)

**Attribute/Distribution:** ND

##### SCM 300 Apprentice Teaching 1-3 Credit

##### SCM 309 Supply, Cost, and Risk Management 3 Credits

This class presents a framework for achieving sustainable competitive advantage through progressive supply management leadership and approaches. It presents the need for supply leadership, the organizational enablers that must be in place, and the strategies and approaches that leading organizations pursue to achieve competitive advantage in price and cost, quality, delivery, cycle time, technology, flexibility, and end customer responsiveness. Special attention is given to a wide range of price, cost and risk management techniques. Prerequisites as noted below or consent of instructor.

**Prerequisites:** SCM 186 or MGT 186

##### SCM 328 Negotiations and Conflict Management 3 Credits

This course covers the theory and processes of negotiation in a variety of settings including face-to-face, virtual and cross-cultural business environments. Students will learn negotiating skills by preparing and simulating a broad mixture of negotiations, ranging from one-on-one, to three-person, to multiparty and team negotiations. They will learn to analyze outcomes and strategies during the debriefing sessions and will have an opportunity to compare results of their negotiations to the results of other people in class.

##### SCM 340 Demand and Supply Chain Planning 3 Credits

Students will learn how businesses work with other businesses to build relationships and integrate demand and supply planning activities across the supply chain to deliver value to customers. They will learn about tools and technologies enabling integration, and the critical drivers and key metrics of supply chain performance. Current readings, case studies, simulations and written assignments will be used. Prerequisites as noted below or consent of instructor.

**Prerequisites:** (MGT 186 or SCM 186 or MGT 280)

##### SCM 342 e-Business Enterprise Applications 3 Credits

Introduction to the implications of key information technologies used within and across businesses to conduct e-business. The course covers the functionality of various enterprise applications and their integration: customer relationship management, enterprise resource planning, supply chain management, supplier relationship management, data warehousing and mining, business intelligence, and product lifecycle management. Prerequisites as noted below or consent of instructor.

**Prerequisites:** BIS 111

##### SCM 354 Integrated Logistics and Transportation Management 3 Credits

A combined lecture, discussion, and experiential course designed to provide students (1) exposure to the fundamentals of logistics and transportation and (2) the opportunity to work in teams to manage a company's supply chain within a strategic supply chain simulation. Students will gain hands-on-experience integrating supply chain management concepts to optimize business performance outcomes. Topics addressed include integrated logistics, transportation, warehouse management and global logistics. Prerequisites as noted below or consent of instructor.

**Prerequisites:** SCM 340 and SCM 309

##### SCM 371 Directed Readings 1-3 Credit

Readings in various fields of supply chain management designed for the student who has a special interest in some field of supply chain management not covered by the regularly scheduled courses. Consent of the department chair. May be repeated.

**Repeat Status:** Course may be repeated.

##### SCM 372 Special Topics 1-3 Credit

Special problems and issues in supply chain management for which no regularly scheduled course work exists. When offered as group study, coverage varies according to interests of instructor and students. Consent of the department chair. May be repeated.

**Repeat Status:** Course may be repeated.

##### SCM 373 Supply Chain Management Internship 1-3 Credit

A sponsoring faculty member shall direct readings, projects and other assignments including a comprehensive final report in conjunction with an industry sponsored internship. The work experience itself, whether paid or unpaid, is not the basis for academic credit. Intellectual development in the context of a field study learning experience comparable to Bus 211 (Engr 211), Integrated Product Development Projects, and SCM 372, Special Topics, will be the determining factor in awarding academic credit. This course cannot be used to satisfy requirements of the Supply Chain Management major. Consent of the department chair. Must have junior standing in the College of Business and Economics and Supply Chain Management declaration.

**Repeat Status:** Course may be repeated.

## College of Education

The university's College of Education offers opportunities for advanced study in the field of education.

#### Graduate Degrees in Education

Lehigh's College of Education offers primarily graduate degree programs. Additionally, undergraduates may apply to the college's 5-year Bachelor's plus Master of Education (p. 55) and Pennsylvania Teacher Certification program or they can minor in education (p. 55). The five-year program is designed to allow students to earn both a bachelor's degree and a master's degree in elementary or secondary education in five years instead of the traditional six. The Education minor allows upper level undergraduates to take selected coursework that combines practicum activities with theoretical work and is designed to

provide a foundation for further educational studies at the graduate level. Students enrolled in the College of Education should check with their advisers for a list of regulations and requirements governing degree programs.

Financial assistance. Graduate assistantships and research assistantships are available in the college and in various administrative offices on campus. In addition, graduate students may be recommended for a limited number of fellowships and endowed scholarships that are awarded by the college.

Lehigh's Centennial School, a laboratory school for children with emotional/behavior disorders, provides employment for some Lehigh education students. Graduate students may apply for teaching internships, which cover tuition and pay salaries.

#### **Master of Education (M.Ed.)**

This degree is offered in the following professional specializations: elementary education, secondary education, special education, educational leadership, counseling and human services, globalization and educational change, international counseling, elementary school counseling, secondary school counseling, instructional technology and advanced teaching and learning. Degree requirements vary from program to program.

#### **Master of Arts (M.A.)**

The master of arts is available in either teacher education (secondary education or the teaching and learning degree programs) or comparative and international education. The teacher education M.A. focuses on enhancing both pedagogical skill and subject matter expertise of teachers. The comparative and international education M.A. examines educational policy and theory on an international level, preparing its graduates to work in educational research and policy organizations, government offices, ministries of education, and international development organizations.

The teacher education student pursuing an M.A. must take graduate work in education plus 12 credits of graduate work in an academic field related to the area of teacher certification (typically, English, mathematics, political science, sociology, and physical and natural sciences). The comparative and international education student pursuing an M.A. must take graduate work in education plus 12 credits in one of four specific academic disciplines (sociology and anthropology, political science and international relations, economics, or history).

#### **Master of Science (M.S.)**

The master of science degree is awarded in instructional technology. The master's program in instructional technology focuses on the systematic planning and use of technology and is targeted toward individuals from varied backgrounds who wish to learn how to incorporate technology more effectively in diverse educational settings (including K-12, higher education, informal learning, and corporate training) or to learn how to train others to make such more effective use.

#### **Master in Business Administration/Master of Education (MBA/M.Ed.)**

The MBA and master's of education joint degree program offers students the opportunity to acquire a solid foundation in both business and education. Designed to increase the administrative skill required in today's educational systems, the MBA/M.Ed. provides a framework in which excellent education and sound business practices can flourish. The MBA/M.Ed. will provide an additional option for students for business and students of educational leadership. The program should enhance the student's marketability in private and public sector education while providing students with an understanding of the cultures of both business and education.

#### **Educational Specialist (Ed.S.)**

Specialized post-master's degree programs for practitioners are available in school psychology.

#### **Certification Programs**

The college offers programs of study leading to eligibility for Pennsylvania state certifications in various professional specialties including elementary and secondary teacher education, including certification in special education; supervisor of special education, pupil services, or curriculum and instruction; superintendent; and K-12 principal. Certification programs vary in the number of credits required.

#### **Post-Baccalaureate Certificates**

The college also offers post-baccalaureate certificate programs in international counseling, international development in education, project management (jointly offered through the College of Business and Economics and the College of Education), special education, teacher leadership, teaching English as a second language, and technology use in the schools. Post-baccalaureate certificate programs differ from the above-described certifications issued by agencies external to Lehigh (such as the Pennsylvania Department of Education). Lehigh's post-baccalaureate certificate programs are, instead, focused concentrations of 12 to 15 credits that students complete to enhance their professional credentials. Where appropriate, post-baccalaureate certificate programs may be included as part of the coursework of a degree program. [www.lehigh.edu/education/academics/certificates.html](http://www.lehigh.edu/education/academics/certificates.html)

#### **Doctor of Philosophy (Ph.D.)**

The College of Education also offers the Ph.D. degree to students enrolled in the fields of comparative and international education, counseling psychology, learning sciences and technology, school psychology, special education, and teaching, learning and technology. The requirements for this degree are the same as those for the Ph.D. in the other colleges and as described in previous sections.

#### **Doctor of Education (Ed.D.)**

The doctor of education degree program provides specialized study in educational leadership. Successful professional experience is required for admission to candidacy. The requirements for the Ed.D. degree parallel those already stated for the Ph.D. degree.

#### **Non-Degree Options**

The non-degree options are designed for those individuals interested in taking a few courses in the College but not interested in pursuing a graduate degree. For information on the non-degree program, contact Donna Johnson at 610-758-3231 or email [ineduc@lehigh.edu](mailto:ineduc@lehigh.edu). There are two non-degree options as well:

1. Regular non-degree and
2. Non-degree for external certification.

Regular non-degree admission is for students who wish to take up to 12 credits of graduate coursework at Lehigh University without seeking a degree. Any transcript or other record from the University will clearly indicate the student status as non-degree. Non-degree students are not permitted to audit courses. University admissions criteria for non-degree graduate students are (a) a bachelor's degree from an accredited institution with an overall grade point average of at least 3.0 on a four-point scale (Applicants with undergraduate GPAs slightly below 3.0 may be admitted with approval from the department of Education and Human Services) or (b) to have achieved a GPA of 3.0 or higher on a four-point scale for a minimum of 12 graduate credits at another accredited institution. If English is not your first language, you must submit TOEFL scores.

Non-degree for external certification students are admitted to pursue coursework for the purpose of obtaining certification through an external accrediting agency. Applicants are expected to have an undergraduate GPA of 3.0 or higher on a four-point scale or to have achieved a GPA of 3.0 or higher on a four-point scale for a minimum of 12 graduate credits at another accredited institution. Applicants are assigned certification advisers on admissions and must work with the adviser to assure that they complete all requirements for certification satisfactorily. Students complete the coursework and any other required field experiences for the appropriate certification, with the number of credits and field experiences being dictated by the external accrediting agency. Given this external control of credit requirements, the number of credits will vary and will typically exceed the 12-credit limit for regular non-degree students. Certification involves qualitative components as well as credits; a non-degree student seeking such certification must meet the quality standards of the certification program, as well as completing the necessary coursework and field experiences.

#### **Changing from Non-Degree to Degree Status**

Non-degree students of either type may seek admission to a degree program. Non-degree students who seek admission to a degree program must meet all regular admissions criteria, complete all regular procedures, and present all documents normally required of degree-



seeking applicants to that program. Courses taken by a non-degree student who later enters a degree program will count towards the completion of the program to the extent that those courses fall within the normal requirements of the program and to the extent that the student's performance in the course(s) is acceptable for degree program purposes. Any course that is counted towards the completion of a degree must be completed within the established time limits for that degree, whether taken initially as a degree or non-degree course.

## Education and Human Services

The College of Education has one academic department, the Department of Education and Human Services. The department faculty and program offerings are listed on tabs on this page. More details on specific degree requirements and on university graduate school regulations can be found under Graduate Degrees in Education (p. 281).

The department offers master's degrees and/or professional certification in counseling and human services, educational leadership, elementary and secondary education, elementary school counseling, globalization and educational change, instructional technology, international counseling, secondary school counseling, special education, and teaching and learning, as well as the Ed.S. degree in school psychology and professional certification in school psychology and special education. The Ed.D. degree program is offered in educational leadership. Ph.D. degrees are offered in counseling psychology, learning sciences and technology, school psychology, and special education. While general courses are listed separately, the courses pertinent to each program are listed on the Courses tab.

**Professors.** Linda M. Bambara, EdD (Vanderbilt University); George J. DuPaul, PhD (University of Rhode Island); Arpana Govindan Inman, PhD (Temple University); Lee Kern, PhD (University of South Florida); J. Gary Lutz, PhD (Lehigh University); Gary M. Sasso, PhD (University of Kansas); Edward S. Shapiro, PhD (University of Pittsburgh); Arnold R. Spokane, PhD (Ohio State University); George P. White, PhD (Peabody Institute of The Johns Hopkins University); Perry A. Zirkel, LLM (Yale University)

**Associate Professors.** Floyd D. Beachum, PhD (Bowling Green State University); Alec M. Bodzin, PhD (North Carolina State University); Mary Beth Calhoun, PhD (Vanderbilt University); Grace Caskie, PhD (University of North Carolina); Ward M. Cates, EdD (Duke University); Christine L. Cole, PhD (University Wisconsin at Madison); Helen Lynn Columba-Piervallo, EdD (University of Louisville); Robin L. Hojniski, PhD (University of Massachusetts Amherst); Christopher T H Liang, PhD (University of Maryland College Park); Patricia H. Manz, PhD (University of Pennsylvania); Iveta Silova McGurty, PhD (Columbia University); Jill Sperandio, PhD (University of Chicago); Alexander Wayne Wiseman, PhD (The Pennsylvania State University); Susan S Woodhouse, PhD (University of Maryland University College)

**Assistant Professors.** Bridget V. Dever, PhD (University of Michigan Ann Arbor); Thomas Chalmers Hammond, PhD (University of Virginia); Craig Hochbein, PhD (University of Virginia); Peggy A Kong, PhD (Harvard University); Laura Brook E. Sawyer, PhD (University of Virginia); Minyi Shih, PhD (University Texas Austin); Brenna K. Wood, PhD (University of Arizona)

**Professors Of Practice.** Louise E. Donohue, PhD (Lehigh University); Jon Drescher, MS (Brooklyn College); Amanda Gail Eckhardt, PhD (Lehigh University); Sothy Eng, PhD (Texas Tech Univ); Scott Roy Garrigan, PhD (Lehigh University); Christine Novak, PhD (University of Iowa)

**Emeriti.** Raymond Bell, EdD (Lehigh University); Charles W. Guditus, EdD (Lehigh University); Warren R. Heydenberk, PhD (University of Northern Colorado); Joseph P. Kender, EdD (University of Pennsylvania); Alden J. Moe, PhD (University of Minnesota Minneapolis); Leroy J. Tuscher, PhD (Florida State University); Roland K. Yoshida, PhD (University Southern Calif)

## Comparative and Int'l Educ Courses

### CIE 400 Comparative and International Education 3 Credits

The goal of this course is to introduce students to the origins and development of the field of international and comparative education and to explore how both scholars and educational policymakers have engaged some of the debates that characterize policy and research in education around the world. Special attention is devoted to similarities and differences in educational policy and practice between advanced and developing capitalist, socialist and "transitional" societies. At the end of this course, students should be able to think about their school or educational system within a global context, and have some idea how to make meaningful comparisons.

### CIE 401 Globalization & Contextualization 3 Credits

The goal of the course is to clarify what globalization is and to consider the impact of globalizing ideas, structures, and cultures on education, and how educators and other stakeholders respond given their school's or system's unique global context. Through case studies and discussions with real-world school leaders, students explore ways that policies are "borrowed" and both educational cultures and structures are "institutionalized."

### CIE 402 Development and Evaluation of International Educational Projects 3 Credits

This course is an introductory exercise for students new to educational research, program evaluation and related areas (e.g., quality improvement, enhancing organizational performance, methods of social change, management training). Students will develop and conduct a professional on-site project evaluation of existing national and international projects, including initiatives undertaken by different international organizations (e.g., UNICEF, UNESCO, USAID), educational institutions, and schools (both public and private). Students will be accompanied and supervised throughout all stages of the research and evaluation process. No previous experience with evaluation research and empirical or qualitative data analysis is required.

### CIE 403 Globalization and Curriculum Implications 3 Credits

This course investigates the impact of globalization on curriculum. In particular, it discusses how curriculum has historically been utilized in nation building; how tensions between the global and the local are inherent in curriculum; and how curriculum is a site of construction of national as well as global/cosmopolitan identities. Global citizenship is one of the major curricula themes spanning this dynamic intersection between the global and the local. This course will present several theoretical perspectives on this phenomenon and compare curricula across nations to understand how globalizing the curricula differs according to culture and language.

### CIE 404 Issues and Institutions in International Educational Development 3 Credits

Explores theoretical approaches to understanding the role of education in international development by introducing students to institutions involved in international educational development in diverse global settings (e.g., United Nations, World Bank, NGOs, and state agencies). Discussions are framed by current debates in the fields of international and comparative education.

### CIE 405 Experiencing the United Nations: NGOs in Education Policy and Practice 3 Credits

Building on the Lehigh University/United Nations partnership initiative, this course provides a structured practical experience for students to learn about the dynamics of NGO/UN relationships by representing one of the underrepresented international NGOs at the United Nations. Equips students with necessary experience, understanding, and skills in international education development such as policy brief writing and education sector analysis.

### CIE 406 International Education Policy 3 Credits

Focuses on how policy is created, implemented, and evaluated in schools and educational systems from a comparative and international perspective. Provides a framework for a comprehensive analysis of the education "sector" in order to inform regional, national, or multinational educational policymaking. Students will apply this understanding to an analysis of education policy in a specific region or district (e.g., Pennsylvania) from a global policymaking perspective.

**CIE 407 Grant Writing and Fund Raising in International Education Development 3 Credits**

Addresses NGO issues and needs and will develop leadership, problem solving, and practical grant writing skills focused on international education development. The course is designed for individuals working in international NGOs and schools and is designed to work in conjunction with a local or international NGO. Teams of students will develop a project proposal related to the agency's primary service mission, articulate a fund-raising strategy, and raise capital on the basis of proposals developed in class.

**CIE 408 Thesis Writing 3 Credits**

Capstone course requiring intensive research and writing with the supervision of Comparative & International Education program faculty. The result is a master's-level thesis reporting the investigation, analysis and results related to a relevant topic in the field of comparative and international education.

**CIE 410 Research in Comparative and International Education I 3 Credits**

(Two-semester-course taught in consecutive semesters with CIE 411.) This course provides an overview of research methodologies used in comparative and international education research. The course will introduce doctoral students to both qualitative and quantitative research methodologies, including participant observation, interviews, ethnography, narrative analysis, survey data collection, and large-scale, cross-national data analysis. The relationship between each methodology and the field of comparative and international education will be discussed using both research and policy examples from a variety of developed and developing country contexts.

**CIE 411 Research in Comparative and International Education II 3 Credits**

(Two-semester-course taught in consecutive semesters with CIE 410) This course provides an overview of research methodologies used in comparative and international education research. The course will introduce doctoral students to both qualitative and quantitative research methodologies, including participant observation, interviews, ethnography, narrative analysis, survey data collection, and large-scale, cross-national data analysis. The relationship between each methodology and the field of comparative and international education will be discussed using both research and policy examples from a variety of developed and developing country contexts.

**CIE 412 Sociocultural Issues in Comparative and International Education 3 Credits**

This course examines social and cultural contexts of teaching and learning in developed and developing country contexts. The course combines theoretical and empirical readings to highlight the dynamic factors that shape the lives of learners inside and outside the classroom. The course is divided into two modules. The first module presents theoretical readings on the social and cultural context of schooling. The second module draws from empirical studies of social and cultural issues in developed and developing country contexts.

**CIE 414 Globalization and Post-Colonialism in Education 3 Credits**

This course focuses on some of the central discussions in the field of comparative and international education and addresses the specific questions about the meaning of education and post-colonialism. Readings examine specific instances of the intersection of European colonialism, global capitalism, and international development in a variety of geographic settings, including Eastern/Central Europe, Africa, and Asia. Assignments focus on post-colonialism in specific countries to develop a historical perspective on the topic and to provide the basis for international comparison.

**CIE 450 Doctoral Seminar in Comparative and International Education I 3 Credits**

[Two-semester sequence] This seminar is a year-long course divided into several modules, each taught by different faculty within the comparative and international education program. The goal is to provide new doctoral students with a strong foundation in comparative education theory and initiate them into the professional and academic field. Students will study a variety of established and evolving theoretical frameworks and explore major research areas in comparative and international education and its sub-disciplines, with an emphasis on Lehigh-specific expertise in the field.

**CIE 451 Doctoral Seminar in Comparative and International Education II 3 Credits**

[Two-semester sequence] This seminar is a year-long course divided into several modules, each taught by different faculty within the comparative and international education program. The goal is to provide new doctoral students with a strong foundation in comparative education theory and initiate them into the professional and academic field. Students will study a variety of established and evolving theoretical frameworks and explore major research areas in comparative and international education and its sub-disciplines, with an emphasis on Lehigh-specific expertise in the field.

**CIE 460 Advanced Research Practicum in Comparative and International Education 3 Credits**

The goal of this course is to provide an opportunity for doctoral students to learn advanced techniques of comparative education research or measurement applied to international and/or cross-national comparative study of education phenomena. Advanced Research Practicum will be closely supervised by a CIE faculty member and will involve elements of collaborative academic research and professional mentoring.

**CIE 470 Doctoral Proposal Seminar in Comparative and International Education 3 Credits**

This course guides students through the initial stages of the dissertation proposal writing. Must have official standing as a doctoral student in comparative and international education.

**CIE 471 Globalization and Education Equity 3 Credits**

This course investigates how globalization affects education equity by examining group differences that result from race, ethnicity, culture, language, class, and gender. It critically analyzes existing systems of power and privilege that maintain the social constructions of cultural differences in the United States and globally. Through readings and class discussion, students are empowered to clarify and ground their own beliefs about education equity, while articulating a vision for equitable educational development as thoughtful, critical, and humane education researchers and practitioners.

**CIE 491 Special Topics in Comparative and International Education 3 Credits**

Intensive study and discussion of a specialized area in comparative and international education. Subtitle will vary. May be repeated for credit as topic varies.

**Repeat Status:** Course may be repeated.

**CIE 499 Dissertation 1-15 Credit****Counseling Psychology Courses****CPSY 407 Crisis Management in the Schools 3 Credits**

This course is designed to provide students with knowledge and skills related to crisis preparedness and intervention in the schools. Relevant theories and research literature will be explored as well as practical elements of crisis response that are applicable to all school systems. In addition, intervention strategies and protocols will be examined and discussed.

**CPSY 427 Assessment and Appraisal in Counseling 3 Credits**

Principles of psychological measurement (e.g., tests construction, technology, validity, reliability, functional utility). Ethical, legal, and cultural issues in the administration and interpretation of psychological tests. Case conceptualization, reporting and presentation.

**CPSY 430 Professional Seminar 3 Credits**

Professional, ethical, and legal issues in counseling. Management and delivery of counseling services in a culturally diverse society. Professional development, certification, licensure, and role identification.

**CPSY 436 Culture-Centered Career Intervention 3 Credits**

Examination of the career development process and interventions for children, adolescents, and adults with a culture-centered perspective. Study of theorists, vocational assessment process, and occupational and psychological information systems.

**CPSY 439 Theory and Practice of Group Counseling 3 Credits**

Introduction to the process of group counseling and therapy. Selection of group members; group rules; group procedures with children, adolescents and adults; ethical considerations with groups. Study of research on group processes, group therapy, and group leadership. Consent of program director required.

**CPSY 440 Introduction to Family Counseling 3 Credits**

Research and current trends in the practice of family counseling. Overview and analysis of major theoretical approaches of family therapy.

**CPSY 442 Counseling and Therapeutic Approaches 3 Credits**

Theory, research, and technique of counseling within a cultural context. Must have admission to CPSY master's program or consent of counseling psychology program director.

**CPSY 445 Elementary & Secondary School Counseling I 4 Credits**

Overview of the history, philosophy and current trends in elementary and secondary school counseling. Emphasis is placed on (a) professional, ethical, and legal issues in counseling; (b) management and delivery of counseling services in a school setting and culturally diverse society; (c) professional development, certification and role identification; (d) collaboration and consultation with teachers, parents, and administrators. Students will be involved in a pre-practicum observation of school counselors in a K-12 setting.

**CPSY 448 Elementary & Secondary School Counseling II 4 Credits**

Emphasis on the social and cultural context of elementary and secondary school counseling. Includes ethical, legal, and cultural issues in the administration and interpretation of psychological tests used in K-12 settings. Focus on a special topic such as school violence or substance abuse prevention, school and community interaction, and the social and cultural context of school counseling, etc. The course will also include observations in schools.

**CPSY 449 Elementary & Secondary School Counseling III 4 Credits**

Theory and methods of consultation; development and implementation of student assistance programs; intra-and inter-agency collaborations. The course will also include observations in schools.

**CPSY 451 Helping Skills 3 Credits**

Helping Skills is a course designed to provide counselor trainees with didactic and experiential learning opportunities to facilitate and enhance beginning counseling skills. Counselor trainees will begin to develop an understanding of the counselor's role in assisting or inhibiting client change. This course utilizes such techniques as modeling, role-playing, audiotape feedback, as well as other learning modalities. Particular emphasis is given to theoretical frameworks, cultural competency, and self-understanding.

**CPSY 452 Counseling Issues and Skills: Facilitating Healthy Adjustment 3 Credits**

Course assists counselors in developing proficiency in helping skills and an understanding of the counselor's role in facilitating or inhibiting client change. Focus is on gaining knowledge related to mental health issues for third culture children and adolescents that include (a) cultural adjustment, (b) eating disorders, (c) depression and suicidality, (d) substance abuse, (e) anxiety, (f) family dysfunction, and (h) career development.

**CPSY 453 Counseling Issues and Skills: Building Healthy Communities 3 Credits**

The objectives of this course are for students to develop proficiency in counseling skills and gaining knowledge related to constructing prevention programs for children and adolescents that include (a) substance abuse, (b) sexually transmitted disease and teen pregnancy, (c) eating disorders, (d) violence prevention, and (e) resiliency and competency promotion programs. Special focus will be paid to understanding the components of an effective crisis management plan.

**CPSY 455 Counseling Issues and Skills: Advanced Techniques in Counseling 3 Credits**

The objectives of this course are to help students expand knowledge of traditional counseling theories and facilitate the development of basic counseling and assessment skills. Specifically, the course is designed to: (1) Enhance students' understanding of the intersection of characteristics of effective helping, stages of the helping relationship, and the uses of counseling techniques; (2) Expand students' understanding of the difference between foundational skills, commonly used helping skills and techniques that require specialized training; and (3) Provide students with training experiences that expand conceptual understanding of the counseling process from a multicultural perspective (i.e., from initial intake interviews to integrating assessment information to formulating and carrying out intervention plans to termination).

**CPSY 460 Foundations of Counseling Psychology 3 Credits**

Knowledge in the core foundations of Counseling Psychology, including the history of Counseling Psychology, multicultural issues, career and vocational counseling, counseling/psychotherapy process and outcome, ethics, prevention and health promotion, social justice and disaster intervention. Must have admission to the Ph.D. program in counseling psychology or consent of the counseling psychology program director required.

**CPSY 461 Assessment of Adult Intellectual Functioning 3 Credits**

Administration and interpretation of individual tests/batteries of adult intelligence and neuropsychological functioning. Consideration of psychological and cross-cultural issues in intellectual assessment. Preparation of psychological reports. Consent of instructor required. Prerequisites as noted below.

**Prerequisites:** CPSY 427

**CPSY 462 Assessment of Personality 3 Credits**

Consideration of issues and methods of personality assessment, including ethical and legal issues, and cross-cultural issues. Practice in the administration of instruments used for personality assessment. Supervised experience and report writing. Must have admission to the Ph.D. program in counseling psychology. Prerequisites as noted below.

**Prerequisites:** CPSY 427

**CPSY 466 Current Issues in Counseling and Therapy 1-6 Credit**

Examination of an area of counseling or therapy that is of topical interest to students and faculty. May be repeated for credit.

**Repeat Status:** Course may be repeated.

**CPSY 470 Independent Study and Research 1-6 Credit**

Individual or small group study in the field of counseling. Approved and supervised by the major adviser. May be repeated for credit.

**Repeat Status:** Course may be repeated.

**CPSY 471 Diversity and Multicultural Perspectives 3 Credits**

Examination of the influence of culture, gender, and disabilities on behavior and attitudes. Historical and current perspectives on race, culture, gender, and Lehigh minority group issues in education and psychology. Lecture/small group discussion. Course is restricted to graduate students in the College of Education only.

**CPSY 472 Human Development Across the Lifespan 3 Credits**

An examination of prevailing theories of human growth and development across the lifespan. Examination of the interactive effect of various age groups upon one another. Particular emphasis on the helping relationships.

**CPSY 473 Advanced Research Methods in Applied Psychology 1-3 Credit**

For doctoral students in applied psychology. Issues and methods of research design, data collection and data analysis. Advanced discussion of quantitative, qualitative and single-case research design. Admission to the Ph.D. program in counseling psychology or school psychology or permission of the instructor.

**CPSY 476 Supervision and Consultation in Counseling 1-6 Credit**

Examination of supervision and consultation theory, research and practice within a multicultural framework. Observation and supervision of counseling practicum students. Consultation in clinical settings. For candidates for supervisor's certificate or doctorate in counseling. Consent of instructor required. Prerequisites as noted below.

**Prerequisites:** CPSY 480

**CPSY 480 Masters Internship I 1-4 Credit**

Twenty hours of weekly supervised practicum training for advanced graduate students in individual, group, and family counseling and therapy. May be repeated for credit. Consent of instructor required. Prerequisites as noted below.

**Repeat Status:** Course may be repeated.

**Prerequisites:** CPSY 442

**CPSY 481 Advanced Multicultural Counseling 3 Credits**

This seminar covers models and theories of multicultural counseling and intervention. Students should be actively engaging in practice with multicultural clients in a practicum or field site, and these cases will form part of the basis of course discussions. Must have admission to the doctoral program in counseling psychology. Consent of counseling psychology program director required. Prerequisites as noted below.

**Prerequisites:** CPSY 471

**CPSY 483 Masters Internship II 3-6 Credits**

Twenty hours of weekly supervised professional practice in a school or agency setting as an extension of CPSY 480, Practicum. Onsite supervision, audio and/or video recordings and case presentations required. Consent of counseling psychology practicum coordinator required. Prerequisites as noted below.

**Prerequisites:** CPSY 480

**CPSY 484 History and Systems of Psychology 3 Credits**

This doctoral level course is designed as an overview of the history of psychology in the Western world. The historical approaches to this task will include a historical developmental approach to the origins and changes of ideas over time, the study of great persons and schools of thought, and a look at the Zeitgeist of each. This course will examine the nature of psychology as a whole, and the influence of philosophical worldviews in areas such as epistemology, ontology, teleology, and axiology. Part of this study regards the nature of science, and its power and limitations as applied to the understanding of human beings.

**CPSY 485 Advanced Psychopathology 3 Credits**

This class will cover etiology, assessment, interviewing techniques, establishing a therapeutic alliance, and treatment planning in adult mental disorders. In depth coverage will be given to Axis II disorders. The diagnosis and classification of abnormal behavior using DSM-IV-R medical model will be emphasized. Alternate theories of abnormal psychology will also be discussed.

**CPSY 486 Family Counseling Clinic 3-6 Credits**

Supervised practicum training for advanced graduate students in family counseling and therapy. Techniques and methods of conducting family counseling and therapy. Prerequisites as noted below.

**Prerequisites:** CPSY 480 and CPSY 440

**CPSY 487 Advanced Doctoral Practicum I 3 Credits**

Supervised clinical experience for entry-level doctoral students with emphasis on the development of intake skills, assessment procedures and intervention skills. Audio and video recording, individual and group supervision. Must have admission to the doctoral program in counseling psychology. Consent of the counseling psychology practicum coordinator required.

**CPSY 488 Advanced Doctoral Practicum II 3 Credits**

Supervised clinical experience with emphasis on advanced skills in interpretation, case conceptualization from a theoretical perspective, termination and referral, and in the broad array of professional activities normally conducted by a counseling psychologist. Audio and video recording, individual and group supervision. Consent of counseling psychology practicum coordinator required. Prerequisites as noted below.

**Prerequisites:** CPSY 487

**CPSY 489 Advanced Doctoral Practicum III 1 Credit**

Supervised field experience in counseling and therapeutic settings for doctoral students with specific populations. In consultation with on-site supervisor, the student will develop an area of focus for this practicum that will include therapy experience, training and additional assessment skills as needed. Repeatable for a total of 3 credits. Consent of counseling psychology practicum coordinator required. Prerequisites as noted below.

**Repeat Status:** Course may be repeated.

**Prerequisites:** CPSY 488

**CPSY 491 Advanced Doctoral Practicum IV 1 Credit**

Supervised field experience in counseling and therapeutic settings for doctoral students with specific populations. In consultation with on-site supervisor, the student will develop an area of focus for this practicum that will include therapy experience, training and additional assessment skills as needed. Repeatable for a total of 3 credits. Consent of counseling psychology practicum coordinator required. Prerequisites as noted below.

**Repeat Status:** Course may be repeated.

**Prerequisites:** CPSY 489

**CPSY 492 Advanced Field Placement 1-3 Credit**

Students perform counseling in university and community agencies under the supervision of the Ph.D. psychologists at the field placement. Open only to students in counseling psychology. Course may be repeated for up to 6 credits. Consent of counseling psychology practicum coordinator required. Prerequisites as noted below.

**Repeat Status:** Course may be repeated.

**Prerequisites:** CPSY 491

**CPSY 498 Counseling Psychology Doctoral Internship 1 Credit**

A one year full-time or two year half-time supervised internship in professional psychology. Student functions as regular staff member. Regular contact with academic advisor required in addition to end-of-semester evaluation by the internship site and the student. Consent of program director required. (Repeatable for a total of 3 credits). Prerequisites as noted below.

**Repeat Status:** Course may be repeated.

**Prerequisites:** CPSY 491

**CPSY 499 Dissertation 1-15 Credit**

**Repeat Status:** Course may be repeated.

**Education Leadership Courses****EDL 400 Organizational Leadership and Change Management 3 Credits**

Theory development relating to individuals and organizations emphasizing leadership, decision-making, motivation, and change. Analysis of existing leadership approaches focusing on demonstrating the application theories to administrative practice.

**EDL 404 The Principalship I 3 Credits**

Roles, responsibilities, and operational tasks of principals in the first half of the school year; engagement in practical application of the knowledge, theories, systems, and processes with an emphasis on fall semester responsibilities. Focus on applying the skills and knowledge of the course using problem based learning experiences drawn directly from internship. Must be completed during Principal Internship I (EDL 414).

**EDL 405 The Principalship II 3 Credits**

Roles, responsibilities, and operational tasks of principals in the second half of the school year; engagement in practical application of the knowledge, theories, systems, and processes with an emphasis on budgeting, state testing requirements and closing the school down in the summer. Focus on applying the skills and knowledge of the course using problem-based learning experiences drawn directly from internship. Must be completed during Principal Internship II (EDL 415).

**Prerequisites:** EDL 400

**EDL 408 Central Office Internship I 2 Credits**

Practical experiences in meeting the challenges inherent in the Superintendent and associated central office positions. Emphasis on the five basic functional office roles of the superintendent: CEO of the school board, human resource manager, instructional leader, financial manager, and director of community relations.

**EDL 409 Central Office Internship II 2 Credits**

Practical experiences in meeting the challenges inherent in the Superintendent and associated central office positions. Emphasis on the budgeting process, state testing requirements and other priorities in the second half of a school year. Must have completed Central Office Internship I.

**Prerequisites:** EDL 408

**EDL 414 Principal Internship I 2 Credits**

Practical experiences in meeting the challenges inherent in the principal positions during the first half of the school year. Emphasis on data based decision making, instructional leadership, and day to day operations. Must be completed with EDL 404.

**EDL 415 Principal Internship II 2 Credits**

Practical experiences in meeting the challenges inherent in the principal positions during the second half of the school year. Emphasis on data based decision making, instructional leadership, and day to day operations. Must be completed with EDL 405.

**EDL 420 Data Based Decision Making 3 Credits**

Theory, research, and processes associated with the design and management of school curriculum; implementation of effective instructional and assessment practices enhancing student learning. School leader's role in designing and implementing a comprehensive school improvement process, and using data to guide curriculum, instruction and assessment program.

**EDL 421 Instructional Leadership 3 Credits**

Skills, competencies, and best practices of instructional leadership and student achievement. Includes framing and communicating school goals dealing with student learning, supervising and evaluating instructional practices, coordinating the curriculum to student outcomes, monitoring student progress, creating a professional learning community, and engaging in reflective practice as a school leader.

**EDL 422 Curriculum Management for the School Executive 3 Credits**

A survey of the methods used to facilitate a curriculum development process based on the theories and findings from research and practice. Application of concepts to practical problems in curriculum leadership to acquire skills in the change process for instruction innovation. Emphasis on current theory and research in standards, technology, and curriculum integration.

**EDL 423 Leading Inclusive Learning Systems 3 Credits**

Issues facing school administrators as they develop and implement plans to address the needs of all students in their schools and districts. Addresses administrators' obligations for the development and monitoring of Individualized Education Programs for children and youth with disabilities as well as other duties encumbered by administrators.

**EDL 424 Leadership: Self and Groups 3 Credits**

Exploration of the development and practice of leadership with experiential opportunities for application. Formal and informal authority, the practice of leadership, and individual and organizational dynamics are explored to improve the understanding of adaptive work in organizations.

**EDL 425 Leading and Managing Change 3 Credits**

Practices and theories about reform, change, and decision making look at who you need to communicate with and why each entity needs to be managed differently. Identify the educational stakeholders, the current trends that effect change, and what precipitates the need for change in the educational system. Addresses the process of change as it relates to individuals, the school board, teachers, students, and the administration with special emphasis on leadership, decision-making, motivation, and the dimensions of change.

**EDL 426 Introduction to Relational Leadership: Theory and Practice 3 Credits**

Theory development relating to individuals and organizations with special emphasis on the superintendents prolonged effective working relationship with the board of education, the administration, the professional and support staffs and the community. Implementation, follow through, and maintenance are emphasized relating to the interpersonal savvy a superintendent needs to effectively establish trust, build and mend relationships, guide decision-making, instill motivation, lead stakeholders and manage change.

**EDL 428 Practicum in Supervision of Curriculum and Instruction I 2 Credits**

Supervised field experience in all aspects of district-wide curriculum and instructional activities. Requires monthly seminar meetings.

**EDL 429 Practicum in Supervision of Curriculum and Instruction II 2 Credits**

Advanced supervised field experience in all aspects of district-wide curriculum and instructional activities. Requires monthly seminar meetings. Prerequisites as noted below.

**Prerequisites:** EDL 428

**EDL 430 Development and Administration of Special Education Programs 3 Credits**

Exploration of the research and practice of an effective special education program. Emphasis on curriculum development, field-based research, and data-based decision making program design and evaluation, and the relationship of the special education program to the pupil services program and the regular curriculum.

**EDL 432 Special Education Law 3 Credits**

An overview of the relevant legislation, regulations, and case law concerning the education of students with disabilities in pre-k through secondary school.

**EDL 434 Leadership and Management of Special Education Programs 3 Credits**

Introduction to the management practices related to effective leadership of special education programs including budget development and management, staffing, instructional practices, student assessment practices, and parent involvement.

**EDL 436 School District Governance: Planning Policy, Ethics and Law 3 Credits**

Examines federal and state Department of Education policies, laws, and regulations governing educational practice, policy, ethics and programming at the district level. Topics include a study of policy-making and related policies in a district, the role of the educational community in developing a collaborative decision-making organization, equality of educational opportunity for all students, and how policy efforts are reshaped by federal, state and local systemic reform efforts.

**EDL 437 School District Resource Management 3 Credits**

Theoretical and practical foundation in school resource allocation from the superintendent district wide perspective. Trends in revenue and expenditures, staffing, and operations, including school board issues, are explored. The economics of education and school business administration are discussed in terms of the policies they affect and create.

**EDL 438 Practicum in Supervision of Special Education and Pupil Services Programs I 2 Credits**

Supervised field experience in all aspects of district-wide special education programs. Requires monthly seminar meetings.

**EDL 439 Practicum in Supervision of Special Education and Pupil Services Programs II 2 Credits**

Supervised field experience in all aspects of district-wide special education programs. Requires monthly seminar meetings. Prerequisites as noted below.

**Prerequisites:** EDL 438

**EDL 440 Development and Administration of Pupil Services Programs 3 Credits**

Exploration of the research and practice of an effective comprehensive pupil services program. Emphasis on involvement of community agencies, field-based research, and data-based decision-making, program design and evaluation, and the relationship of the pupil services program to the regular and special education curriculum.

**EDL 442 Leadership and Management of Pupil Services Programs 3 Credits**

Overview of the management practices related to effective leadership of pupil services programs, including budget development and management, staffing, instructional practices, community agency partnerships, student assessment, legal issues, and parent involvement.

**EDL 450 Curriculum Design in a Global Society 3 Credits**

Exploration of global issues and their effects on what is taught in schools, specifically in international schools. Emphasis on the analysis of curriculum and the influence that culture plays in decision making.

**EDL 452 Comparative Education 3 Credits**

Survey of education practices abroad. Systems of articulation, social and legal foundations, and structure in government. Emphasis on the nature and purpose schools in various cultural contexts and the major problems and trends occurring throughout the world.

**EDL 461 Facilitating Organizational Inquiry 2 Credits**

Exploration into the use of reflective practice and inquiry for professional development and school improvement. Development of group facilitation skills for collective inquiry. Reflection and inquiry will serve as the foundation for development of an action research project.

**EDL 462 Transforming the Learner 2 Credits**

Exploration of the integration of social, personal, cognitive, and knowledge-building dimensions to support learning and literacy. Focusing on the metacognitive conversations with self and others essential for developing learning and leadership.

**EDL 463 Designing Systems of Action 3 Credits**

Implementation of action research project. Building understanding of how the project impacts and is influenced by school and community systems. Explores the application of learning theory as related to leadership. Continued development of leadership concept and tools.

**EDL 464 Sustaining Learning Communities 2 Credits**

Completion of action research. Design and facilitation of a symposium of inquiry results. Review the behaviors of leadership that sustain learning in the classroom, school, and community.

**EDL 467 Supervision and Professional Development 3 Credits**

Emphasis on establishing skills in human resource management and supervision, including staff selection, supervision models, assessment and feedback methods, managing a diverse workforce, and adult development related to professional growth options. This course is designed specifically for individuals enrolled in a supervisory certification program.

**EDL 468 Applied Learning Theory for School Leadership 3 Credits**

Overview of the foundations, principles, and theories of curriculum, teaching, and learning. Emphasis on historical perspectives, teaching and learning for understanding, and schools as professional organizations. The purpose is to provide prospective administrators with the background for developing a balanced and challenging school-wide curriculum, for supervising instruction, and for supporting school improvement.

**EDL 470 Special Topics in Educational Leadership: (with subtitle) 1-3 Credit**

Intensive study and discussion of a specialized area. Title will vary. May be repeated for credit as title varies.

**Repeat Status:** Course may be repeated.

**EDL 476 School Resources Management 3 Credits**

Theoretical and practical foundation in school resource allocation. Trends in revenue and expenditures, staffing, and operations are explored. The economics of education and school business administration are discussed in terms of the policies they affect and create.

**EDL 477 Seminar in School-Community Relations 3 Credits**

Analysis and development of the communication and public relations skills needed by educators in dealing with the public.

**EDL 479 School Law and Ethics 3 Credits**

Examination of legal and ethical issues in effective leadership in the public schools, including awareness, analysis and applications of judicial interpretations of the constitutions, statutes, regulations, and common law relating to educational issues.

**EDL 481 Policy and Politics in Public Education 3 Credits**

Analysis of the forces, factors, agencies, formal governmental systems and informal subsystems that influence educational policy in local districts and state and national governments.

**EDL 485 The Superintendency 3 Credits**

A theoretical and historical examination of superintendents' leadership, school board/superintendent relations, and the array of duties and demands upon the superintendency.

**EDL 488 Program Evaluation 3 Credits**

The historical background, theory, methodology, and current practices of program evaluation in the human services area. Emphasis on conducting evaluations of educational programs and gathering data to make effective program decisions. Participants are required to design a program evaluation research plan.

**EDL 489 Doctoral Seminar in School Administration 3 Credits**

Analysis of the theoretical, empirical, and conceptual aspects of contemporary issues in educational administration and their implications for policy formulation and implementation in educational institutions. Must have official standing as a doctoral student in educational leadership.

**EDL 499 Dissertation 1-15 Credit****Education Courses****EDUC 383 Supervised Research in Applied Psychology 1-3 Credit**

Provides undergraduate junior and senior psychology majors a formal supervised research experience in applied psychology. Students are assigned for the semester to a research team led by a participating faculty member in the counseling psychology or school psychology programs in the College of Education. (Repeatable up to 6 credits.).

**Repeat Status:** Course may be repeated.

**EDUC 388 Statistical Computing 3 Credits**

Use of one or more major statistical software packages. Principles of data coding, editing, integrity checking, and management. Emphasis on link between personal computers, mainframes, and other software. Prerequisites as noted below or consent of instructor.

**Prerequisites:** EDUC 408

**EDUC 394 Special Topics In Education 3 Credits**

Course may be repeated for credit as topic varies.

**Repeat Status:** Course may be repeated.

**EDUC 402 Developmental Psychology 3 Credits**

Survey of theories and research concerning perceptual, cognitive, social, and personality development through infancy and childhood. Must have graduate standing or consent of instructor.

**EDUC 403 Research 3 Credits**

Basic principles of research; techniques of gathering and analyzing data; design of studies in education. Emphasis on critical reviews of research reports representing various methodologies. Research report required.

**EDUC 405 Qualitative Research Methods 3 Credits**

Foundations of qualitative design as research methodology for answering questions in education. Topics include history, philosophy, types, methods, applications, and critical reading of qualitative research reports. Emphasis on developing key researcher skills of gaining entrance, collecting, analyzing and interpreting data, establishing credibility, and writing and publishing results.

**EDUC 408 Introduction to Statistics 3 Credits**

Organization and description of data. Principles of statistical inference including hypothesis testing, interval estimation, and inferential error control. Emphasis on application.

**EDUC 409 Analysis of Experimental Data 3 Credits**

Emphasis on analysis of variance designs including one-way, factorial, nested, and repeated measures designs. Introduction to multiple regression and the analysis of covariance. Prerequisites as noted below or consent of instructor.

**Prerequisites:** EDUC 408

**EDUC 410 Univariate Statistical Models 3 Credits**

The univariate general linear model. Principles of expressing models and hypotheses about those models. Emphasis on similarity among the analysis of variance, multiple regression, and the analysis of covariance. Examples of nonstandard models and generalization to complex designs. Prerequisites as noted below or consent of instructor.

**Prerequisites:** EDUC 409

**EDUC 411 Multivariate Statistical Models 3 Credits**

The multivariate general linear model. Principles of expressing multivariate models and hypotheses about those models. Emphasis on similarity among the multivariate analysis of variance, multiple regression, and the analysis of covariance. Examples of non-standard models and generalization to complex designs. Prerequisites as noted below or consent of instructor.

**Prerequisites:** EDUC 410

**EDUC 412 Advanced Applications of Psychometric Principles 3 Credits**

Conceptual examination of exploratory and confirmatory factor analysis, cluster analysis, latent-trait modeling, and other advanced psychometric topics. Prerequisites as noted below.

**Prerequisites:** EDUC 409 or SCHP 427 or CPSY 427

**EDUC 419 Second Language Acquisition (SLA) Theory 3 Credits**

This course introduces theories of second language acquisition, including issues of acquisition of English as a second language as well as other languages. Various theories of communication and language acquisition will be covered.

**EDUC 421 Intercultural Communication 3 Credits**

Language is ambiguous by nature, and discourse is interpreted in cultural and linguistic contexts. This course covers different cultural and linguistic strategies individuals use to communicate, essential concepts for interacting with individuals from other cultural and linguistic backgrounds, and different strategies of communication as defined by specific cultures. Covering the theory and practice of intercultural interaction, the course examines assumptions about language and culture and includes practical advice to help students develop the cultural sensitivity essential for communication today.

**EDUC 422 Theory and Practice for Second Language Learning 3 Credits**

This course presents the application of second language acquisition (SLA) theories in relationship to teaching, and reviews methods and materials needed for ESL instruction in a regular classroom and in a pullout program. This course will demonstrate the knowledge of fundamental concepts and practices of English as a second language (ESL) instruction with an emphasis on instructional materials and strategies. Participants will be able to identify appropriate materials and resources to be used with students at each level of English proficiency.

**EDUC 423 Second Language Assessment 3 Credits**

This is a broad-spectrum course around the use of assessment tools, and other evaluation measurements for diagnosis, prescription, and evaluation of students in English as a second language (ESL) programs. This course will address part three: English Language Learners (ELLs) Language Support Services Knowledge. Participants will learn the effective assessment practices and support services available to ELL students. Participants will examine, explore and understand the purposes for assessment, multiple assessment models, use of evaluation techniques, scaffolding of assessments, and formal/informal assessment tools. Finally, participants will gain hands-on experience in test administration, interpretation and reporting.

**EDUC 451 Applied Principles of Cognitive Psychology 3 Credits**

Basic principles and contemporary theories of cognitive psychology will be covered, especially regarding the application of these principles to education. Experimental research relevant to contemporary theories of cognitive psychology and the application of these theories in educational settings will be reviewed.

**EDUC 461 Single-Subject Research Design 3 Credits**

Experimental designs for use with small N's. Topics include design theory and application, experimental validity (internal, external, statistical conclusions and construct validity) and an overview of data analysis procedures.

**EDUC 471 Diversity and Multicultural Perspectives 3 Credits**

Examination of the influence of culture, gender, and disabilities on behavior and attitudes. Historical and current perspectives on race, culture, gender, and minority group issues in education and psychology. Lecture/small group discussion. Course is restricted to graduate students in the College of Education only.

**EDUC 473 Social Basis of Human Behavior 3 Credits**

Development of human behavior from a social psychological perspective. Emphasis placed on the impact of society upon school-age children and adolescents.

**EDUC 486 Doctoral Qualifying Research Project 1-3 Credit**

Design and implement research project under faculty supervision to meet requirements for doctoral programs. May be repeated for credit.

**Repeat Status:** Course may be repeated.

**EDUC 490 Thesis 1-6 Credit****EDUC 491 Advanced Seminars: (with subtitle) 1-6 Credit**

Intensive study and discussion of a specialized area. Title will vary. May be repeated for credit as title varies.

**Repeat Status:** Course may be repeated.

**EDUC 493 Internship in: (with subtitle) 1-6 Credit**

Opportunity for students to apply theory to practice in a variety of educational settings. Students will be supervised in the field and participate in seminars dedicated to addressing specific concerns and issues encountered during their experience. Consent of program director required.

**EDUC 494 Field Work in: (with subtitle) 3 Credits**

Identification of significant problems in an educational environment, review of the literature, and development of appropriate research plans.

**EDUC 495 Independent Study in: (with subtitle) 1-6 Credit**

Individual or small group study in the field of specialization. Approved and supervised by the major adviser. May be repeated.

**Repeat Status:** Course may be repeated.

**EDUC 496 Doctoral Research Seminar 3 Credits**

For doctoral students. Research design and application to various kinds of educational problems; data collection and analysis. Criticism and evaluation of student proposals. May be repeated for a maximum of nine credits.

**Repeat Status:** Course may be repeated.

**EDUC 499 Dissertation 1-15 Credit****School Psychology Courses****SCHP 402 Applied Behavior Analysis 3 Credits**

Theory and application of behavior modification methods in classroom and clinical settings. Topics include behavior analysis, outcome research, task utilization, and single case research.

**SCHP 404 Historical and Contemporary Issues in School Psychology 3 Credits**

History of psychology, education, and school psychology. Roles and function of school psychologist; legal and ethical aspects of school psychology.

**SCHP 406 Research Methods and Design 3 Credits**

This course is designed to provide skills in the use and application of research methodologies and in the conceptualizing and writing of research proposals. Specifically, the course is focused on developing conceptual knowledge of specific research methods, interpreting data using specific methods of analysis, and developing independent research skills focused around one's own research project. The course is primarily designed for doctoral students in School Psychology and Special Education. Permission of instructor is required.

**SCHP 407 Crisis Management in the Schools 3 Credits**

This course is designed to provide students with knowledge and skills related to crisis preparedness and intervention in the schools. Relevant theories and research literature will be explored as well as practical elements of crisis response that are applicable to all school systems. In addition, intervention strategies and protocols will be examined and discussed. Permission of instructor is required.

**SCHP 408 Dissertation Proposal Seminar 3 Credits**

The primary purpose of this course is to guide students in their independent research endeavors. Students will learn about the complexities of planning and initiating independent research, focusing on the writing process, methodological issues, and the management of time and data. Knowledge and competencies obtained in this seminar will be applied as students prepare their dissertation proposals.

**SCHP 412 Consultation Procedures 2 Credits**

Observational methodology utilized in consultation; rationale, theory and methods of consultation; individual, group and parent consulting. Study of research on the consultation process. Students must also register for one credit of SCHP 431.

**SCHP 422 Assessment of Intelligence 3 Credits**

Administration and interpretation of individual tests of intelligence used in school evaluation and preparation of psychological reports. Consent of instructor required.

**SCHP 423 Behavioral Assessment 3 Credits**

Techniques of behavioral assessment including direct observation, interviews, checklists, rating scales, self-monitoring and role-play tests. Consent of instructor required.

**SCHP 425 Assessment and Intervention in Educational Consultation 3 Credits**

Collection and use of data in designing classroom interventions. Curriculum based assessment, direct behavioral assessment, and structured interviews, and the interrelationship with diagnoses are emphasized within the behavioral consultation model. Utilization of data from actual case studies.

**SCHP 426 Advanced School and Family Interventions 3 Credits**

Overview of school-based and family-based intervention strategies for children and adolescents presenting interpersonal, emotional, developmental or behavioral challenges. Examples of topics covered include crisis intervention, peer-mediated interventions, self-management interventions, behavioral parent training, interventions for child abuse/neglect and computer-assisted instruction. Prerequisites as noted below or consent of instructor.

**Prerequisites:** SCHP 402

**SCHP 427 Assessment and Appraisal in Counseling 3 Credits**

Principles of psychological measurement (e.g., tests construction, technology, validity, reliability, functional utility). Ethical, legal, and cultural issues in the administration and interpretation of psychological tests. Case conceptualization, reporting and presentation.

**SCHP 429 Special Topics in School Psychology 1-3 Credit**

**Repeat Status:** Course may be repeated.

**SCHP 431 Practicum in Consultation Procedures 1-3 Credit**

Supervised experience in conducting school-based consultations. Co-requisite, SCHP 412.

**SCHP 432 Practicum in Assessment of Intelligence 1-3 Credit**

Supervised experience in the administration and interpretation of intelligence tests. Co-requisite, SCHP 422.

**SCHP 433 Practicum in Behavioral Assessment 1-3 Credit**

Supervised experience in conducting behavioral assessments in school settings. Co-requisite, SCHP 423.

**SCHP 434 Applied Research Practicum 1-3 Credit**

Designing and conducting research projects in applied settings.

**SCHP 435 Practicum in Assessment & Intervention in Educational Consultation 1-3 Credit**

Supervised experience in conducting curriculum-based assessments and designing intervention strategies for educational problems. Co-requisite, SCHP 425.

**SCHP 436 Specialized Practicum in School Psychology 1-3 Credit**

Supervised field experience in school psychology with a specific population or setting. May be repeated for credit. Permission of instructor required.

**Repeat Status:** Course may be repeated.

**SCHP 437 Advanced Child Psychopathology 3 Credits**

Advanced training in the definition, classification, etiology, long-term outcome, and treatment of children and adolescents with various psychopathological disorders. Emphasis is placed upon the assessment and treatment of child and adolescent psychopathology in school settings. Must have admission to doctoral program or consent of instructor.

**SCHP 438 Health/Pediatric Psychology 3 Credits**

Introduction to training in the definition, etiology and behavioral/academic characteristics of children and adolescents with medical disorders. Emphasis is placed on the assessment and treatment of educational and behavioral sequelae of medical disorders in both school and health settings. Must have admission to doctoral program in school psychology or consent of instructor.

**SCHP 439 Comprehensive School Health Programs 3 Credits**

Examination of school-wide programs designed to address health care needs of children and adolescents in school settings. Focus is on development of primary prevention and integration of educational, medical, social and community resources. Permission of instructor required.

**SCHP 440 Applications of Pediatric School Psychology 3 Credits**

Focus on further development of students' knowledge and application of pediatric school psychology. The etiology and developmental course of pediatric medical conditions will be examined, emphasizing the impact on school, family and community environments. Prerequisites as noted below or consent of instructor.

**Prerequisites:** SCHP 438 or SCHP 439

**SCHP 442 Doctoral Practicum in School Psychology 1-6 Credit**

Field-based experience in providing psychological services in school and/or clinical settings. Must have admission to doctoral program. May be repeated for credit.

**Repeat Status:** Course may be repeated.

**SCHP 443 Certification Internship 1-6 Credit**

Full-time experience in clinical/educational settings. Student must complete a minimum of 1,200 clock hours under joint supervision of faculty and field supervisor. May be repeated for credit.

**Repeat Status:** Course may be repeated.

**SCHP 444 Doctoral Internship 1-6 Credit**

Full-time experience in clinical/educational settings. Student must complete a minimum of 1,500 clock hours under joint supervision of faculty and field supervisor. May be repeated for credit.

**Repeat Status:** Course may be repeated.

**SCHP 473 Advanced Research Methods in Applied Psychology 1-3 Credit**

For doctoral students in applied psychology. Issues and methods of research design, data collection and data analysis. Advanced discussion of quantitative, qualitative and single-case research design. Admission to the Ph.D. program in counseling psychology or school psychology or permission of the instructor.



**SCHP 484 History and Systems of Psychology 3 Credits**

This doctoral level course is designed as an overview of the history of psychology in the Western world. The historical approaches to this task will include a historical developmental approach to the origins and changes of ideas over time, the study of great persons and schools of thought, and a look at the Zeitgeist of each. This course will examine the nature of psychology as a whole, and the influence of philosophical worldviews in areas such as epistemology, ontology, teleology, and axiology. Part of this study regards the nature of science, and its power and limitations as applied to the understanding of human beings.

**SCHP 496 Doctoral Seminar in School Psychology 3 Credits**

Selected topics in school psychology (titles will vary) including professional issues, assessment and intervention in school settings, and supervision of school psychology services. May be repeated for credit. Must have admission to doctoral program.

**Repeat Status:** Course may be repeated.

**SCHP 499 Dissertation 1-15 Credit**

**Repeat Status:** Course may be repeated.

**Special Education Courses****SPED 330 Special Topics in Special Education 1-3 Credit**

Current issues in the education of individuals with special needs. Titles vary. May be repeated for credit as title varies.

**Repeat Status:** Course may be repeated.

**SPED 332 Education and Inclusion of Individuals with Special Needs in K-12 3 Credits**

Overview of social, developmental, legal, and educational issues and practices related to the special education of individuals with disabilities. Covers social, environmental, and physiological etiology; development; identification; learning characteristics; and needs of individuals identified for special education. Emphasizes meeting diverse needs of students in general education classrooms through evidence-based practices and adaptations matched to learner needs. Addresses legal rights of students and their families, as well as legal responsibilities of teachers as required by IDEIA and other related special legislation.

**SPED 338 Emotional and Behavioral Disorders of Children 3 Credits**

Definition, classification, etiology, treatment, and historical perspective of children and adolescent disorders.

**SPED 402 Applied Behavior Analysis 3 Credits**

Theory and application of behavior modification methods in classroom and clinical settings. Topics include behavior analysis, outcome research, task utilization, and single case research.

**SPED 404 Diversity, Families, and School Collaborations in K-12 3 Credits**

Cultural and linguistic diversity as critical variables in educational equity for all learners, including ELL. Explores home-school partnerships, family and professional collaboration, and teacher self-awareness. Implementing culturally sensitive and responsive classroom practices as well as forming collaborative relationships with families that respect diversity of family contexts. Collaborative, multidisciplinary teaming to support, optimize, and advocate for student's educational needs and connect to community services and resources available to individuals and families. Addresses family mental health issues and wraparound services.

**SPED 405 Principles and Applications of K-12 Assessment 3 Credits**

Assessment applied to learning in classroom learning environments, including universal screening and progress monitoring. Discusses assessment approaches, ways to implement assessment, and use of assessment tools to monitor all students, including ELL and students with disabilities. Use of data-management and grading systems. Addresses diagnostic assessments for student placement and analysis of assessment data to tailor instruction to diverse student needs. Emphasis on research-based practices of assessment to inform instructional decision-making consistent with the RtII framework.

**SPED 409 K-12 Classroom Environment and Management 3 Credits**

Designing inclusive classroom environments that maximize learning. Emphasis on fostering a community of learners using connections among classroom arrangement, classroom management, and cognitive development to create positive learning outcomes for all students, including ELL learners and students with disabilities. Addresses the tiered model of prevention and positive behavior support, including the role of functional assessment and individual positive behavior support plans in classroom management. Highlights the ways a positive climate for learning involves establishing and maintaining partnerships with families.

**SPED 411 Early Childhood Education 3 Credits**

Introduction to development of early childhood education in the U.S. Emphasizes evidence-based methods and materials to assist young children in the learning process, including arrangement of indoor/outdoor space, developmentally appropriate practices, and the design of instruction to foster young children's emotional, social, language, cognitive, physical, and creative development. Includes embedded instruction and adaptations for students with identified disabilities, children at risk for developing disabilities, and children with culturally and linguistically diverse backgrounds, and family collaboration within the instructional planning process.

**SPED 418 Alternative Curricular Approaches 3 Credits**

Curricular and instructional methods for students with pervasive support needs (e.g., intellectual disabilities, autism) who follow an alternative or modified curriculum. Methods for developing an individualized curriculum, embedding instruction and accessing the general education curriculum, systematic instruction, and instruction for full participation in school, home, and community settings are covered. Strategies for facilitating emergent social and communication skills, teaching augmentative and alternative communication, and use of assistive technologies to enhance self-directed learning are included.

**SPED 419 Academic Interventions: PreK-8 3 Credits**

Methods course designed to address the needs of students with disabilities to increase knowledge of instruction of comprehensive pre-literacy and literacy skills and their components. Additionally, pre-reading, reading, language arts, mathematics, and content area reading literacy skills in primary and elementary settings will be addressed. Emphasis on instructional planning, differentiated instructional strategies, appropriate assessments modifications, and adaptations needed for use with individuals with disabilities through a conceptual foundation in the components of reading and the integration of research validated interventions.

**SPED 420 Field Experience: Special Education Certification 1-3 Credit**

Intensive practice in the application of principles of teaching in a supervised experience in the schools for students who already hold another content area certification (e.g., elementary, middle school, secondary). Pre-requisite: Consent of the program.

**SPED 421 Academic Interventions: Secondary Level 3 Credits**

Methods course designed to increase knowledge of core components of reading in secondary settings, language arts, mathematics, and content area literacy skills for students with disabilities and those who are culturally and/or linguistically diverse. Emphasis on instructional planning, differentiated instructional strategies, appropriate assessments, modifications, and adaptations needed for use with individuals with disabilities through a conceptual foundation in the components of reading and the integration of research validated interventions.

**SPED 423 Transition to Post-school Life 3 Credits**

Best instructional practices for preparing students for post-school adult life: employment, post-secondary education, and community participation in inclusive settings. Topics include transition planning, personcentered and work-based assessments, family and interagency collaboration, innovative post-school and inschool transition services, and self-determination. Evidence-based practices to promote positive student outcomes are emphasized.

**SPED 429 Professional Seminar 3 Credits**

Master's seminar on current issues in the area of special education and research design. Must have 18 graduate credits in special education.

**SPED 430 Advanced Seminar in Special Education 3 Credits**

Advanced issues relating to the field of special education. Titles will vary.  
**Repeat Status:** Course may be repeated.

**SPED 432 Positive Behavior Support 3 Credits**

Design of comprehensive, multi-component behavior support plans for individuals with a variety of disabilities who engage in problem behavior. Topics include functional assessment, antecedent and setting event interventions, replacement behaviors, consequence and crisis procedures, lifestyle interventions, and teaming strategies. Assessment focuses on the link between curriculum, academic performance, and behavior problems. Promotes consideration of diverse populations for understanding behavioral differences. Describes strategies for ongoing monitoring and maintenance of behavior reductions.

**SPED 434 Applied Research Practicum 1-3 Credit**

Designing and conducting research projects in applied settings.

**SPED 440 Early Academic Intervention 3 Credits**

Explores the potential effectiveness of interventions to prevent academic failure of children at risk for learning difficulties. Emphasis on research-based interventions in the areas of beginning reading, language and vocabulary, writing and spelling, awareness of print and exposure to print, and mathematics (number sense).

**SPED 442 General Education and Special Education Student Teaching and Seminar 1-6 Credit**

Intensive practice in the application of principles of teaching for both general and special education settings in a supervised internship in the schools (for dual certification). Regular meetings among student teachers for critical analysis and discussion of classroom instructional practices, as illustrated by the student teachers' experiences in the schools. Practical mentoring on professionalism, applying differentiated instructional models in real-world setting, and aligning instruction with standards. Consent of program director required.

**SPED 448 Practicum/Seminar in Positive Behavior Specialist 1 3 Credits**

Introductory supervised field work with emphasis on conducting functional assessments, designing positive behavior support plans, and teaming with families and professionals. Requires one-hour weekly meetings with faculty and other practicum students. This course is restricted to students enrolled in the Positive Behavior Specialist program.

**SPED 450 Practicum/Seminar in Positive Behavior Specialist 2 3 Credits**

Advanced field work with emphasis on resolving difficult case problems in positive behavior support. Requires one-hour weekly meetings with faculty and other practicum students. This course is restricted to students enrolled in the Positive Behavior Specialist program.

**SPED 452 Assessment in Special Education 3 Credits**

Identification, administration and interpretation of a variety of assessments used for planning and to determine special education eligibility and to assess social, emotional, behavioral, and academic functioning. Discusses strengths and limitations of various models and assessment, both formal and informal, instruments used to evaluate the need for special education. Describes strategies to enhance the relationship between assessment and service delivery. Addresses assessment practices to identify curricular needs consistent with the RtII framework.

**SPED 465 Advanced Inclusionary Practices in K-12 3 Credits**

Advanced techniques grounded in current research-based methods and best practice for educating and assessing students with disabilities, students from diverse backgrounds, and English language learners using a standards-aligned system. Accommodations, modifications, planning for physical and instructional inclusion through embedded strategic instruction, adaptations, and curriculum overlapping. Addresses decision hierarchies for level of instructional adaptation and social inclusion methods through social facilitation techniques. Explores critical factors in developing, implementing, and modifying curriculum using evidence-based practices. Explores collaborative co-planning and co-teaching models.

**Prerequisites:** SPED 332

**SPED 490 Doctoral Seminar in Special Education 3 Credits**

Advanced knowledge of issues and research in the education of individuals with special needs. Topics will vary. May be repeated for credit. Must be admitted for doctoral studies.

**Repeat Status:** Course may be repeated.

**SPED 499 Dissertation 1-15 Credit**

**Repeat Status:** Course may be repeated.

**Teaching Learning Technology Courses****TLT 367 Environmental Education 3 Credits**

Introductory environmental education course designed to prepare students to implement environmental education opportunities in formal and non-formal education settings. Topics include history and philosophy of environmental education, environmental laws and regulations, GIS, environmental issues and decision making, curriculum integration and environmental education teaching methodologies. This is a Web enhanced course containing both online and fieldwork components.

**TLT 368 Teaching and Learning with Geospatial Tools 3 Credits**

Exploration of geospatial tools, including but not limited to global positioning systems (GPS), geographic information systems (GIS), and related visualization tools (e.g. Google Earth). Application of these tools and techniques to instructional settings, including appropriate pedagogy and assessment.

**TLT 380 Child Development and Cognition 3 Credits**

Introduction to physical, motor, perceptual, cognitive, language, emotional, social, and gender development of young children and adolescents. Developmental history, theories, and research, as well as the effect of culture, family, peers, media, and schooling on the individual and groups. Students investigate typical and atypical development and explore the implications of individual differences for teaching and learning, with an emphasis on evidence-based instructional practices designed to optimize the growth and development of all learners. Explores mental health issues and at-risk students.

**TLT 391 Workshops 1-3 Credit**

Cooperative study of current educational problems. Provides elementary, secondary, and special education teachers an opportunity to work at their own teaching levels and in their own fields. Limited to six credits during a summer session but the student may register for more than one workshop provided there is no duplication in subject matter.

**Repeat Status:** Course may be repeated.

**TLT 394 Special Topics in Education: 1-3 Credit**

Examination of a topic of research or professional interest in education. Subtitle will vary. May be repeated for credit as subtitle varies.

**Repeat Status:** Course may be repeated.

**TLT 401 Overview of Teaching and Learning 3 Credits**

Foundations and key concepts in learning and instructional theory. Cognition and brain-based research with a focus on innovations in teaching and learning.

**TLT 402 Critical Reading and Writing 3 Credits**

Using literature to build persuasive written arguments. Searching and identifying promising sources, distilling research findings, synthesizing literature to support an argument, and organizing written materials to enhance persuasiveness. Suited to those writing qualifying projects, dissertation proposals, dissertations, funding proposals, conference proposals, and journal articles.

**TLT 403 Instructional Design 3 Credits**

Social, cognitive, and environmental factors in designing for teaching and learning. Systems theory applied to learning settings. Special emphasis on motivational theories and technological affordances. Prerequisites as noted below.

**Prerequisites:** TLT 401

**TLT 404 Diversity, Families, and School Collaborations in K-12 3 Credits**

Cultural and linguistic diversity as critical variables in educational equity for all learners, including ELL. Explores home-school partnerships, family and professional collaboration, and teacher self-awareness. Implementing culturally sensitive and responsive classroom practices as well as forming collaborative relationships with families that respect diversity of family contexts. Collaborative, multidisciplinary teaming to support, optimize, and advocate for student's educational needs and connect to community services and resources available to individuals and families. Addresses family mental health issues and wraparound services.

**TLT 405 Principles and Applications of K-12 Assessment 3 Credits**

Assessment applied to learning in classroom learning environments, including universal screening and progress monitoring. Discusses assessment approaches, ways to implement assessment, and use of assessment tools to monitor all students, including ELL and students with disabilities. Use of data-management and grading systems. Addresses diagnostic assessments for student placement and analysis of assessment data to tailor instruction to diverse student needs. Emphasis on research-based practices of assessment to inform instructional decision-making consistent with the RtII framework.

**TLT 407 Instructional Design for K-12 Classrooms 3 Credits**

Introduces the systematic design of instruction following the Response to Instruction and Intervention (RtII) and Universal Design for Learning models. Explores theories of learning and instructional applications as a part of technology-based and standards-aligned classroom education grounded in the use of a quality, research-based core curriculum and effective instructional practices to meet the needs of all learners. Addresses appropriate use of instructional technologies for universal learning. Students will plan, design, and develop student-centered, standards-aligned, technology-supported instruction and appropriate learner assessments.

**TLT 409 K-12 Classroom Environment and Management 3 Credits**

Designing inclusive classroom environments that maximize learning. Emphasis on fostering a community of learners using connections among classroom arrangement, classroom management, and cognitive development to create positive learning outcomes for all students, including ELL learners and students with disabilities. Addresses the tiered model of prevention and positive behavior support, including the role of functional assessment and individual positive behavior support plans in classroom management. Highlights the ways a positive climate for learning involves establishing and maintaining partnerships with families.

**TLT 410 The Writing Process 3 Credits**

Developmental characteristics of children's writing and relationships among writing, spelling and reading. Predictors of writing achievement, teaching strategies and activities, and evaluation schemes will be emphasized, K-12.

**TLT 411 Early Childhood Education 3 Credits**

Introduction to development of early childhood education in the U.S. Emphasizes evidence-based methods and materials to assist young children in the learning process, including arrangement of indoor/outdoor space, developmentally appropriate practices, and the design of instruction to foster young children's emotional, social, language, cognitive, physical, and creative development. Includes embedded instruction and adaptations for students with identified disabilities, children at risk for developing disabilities, and children with culturally and linguistically diverse backgrounds, and family collaboration within the instructional planning process.

**TLT 412 Social Studies in PreK through 4th Grade 3 Credits**

Overview of Pennsylvania's PreK-4 Standards for social studies, including: Pennsylvania history, United States history, economics, civics and government, citizenship, political science/government, and geography. Development, implementation and evidence-based assessment of preK-grade 4 social studies curricula. Effective teaching techniques such as lesson planning, inclusive practices, integrating instructional technologies into instruction, reflecting on teaching, and the latest research-based teaching and assessment methods. Emphasis on alignment of instruction with standards.

**TLT 420 Reading and Literacy in PreK through 4th Grade 3 Credits**

Methods of teaching reading and literacy in preK-4, including critical components of early literacy. Selection of appropriate materials, instructional strategies, techniques, and formative and summative assessments. Best practices in reading instruction in a standards-aligned curriculum, explicit strategies for teaching vocabulary and comprehension, and using evidence-based practices to teach reading to learners at all levels of proficiency. Helping learners make the transition from learning to read to reading to learn. Working with families and non-school support services to enhance reading development.

**TLT 422 Language Arts in PreK through 4th Grade 3 Credits**

Principles of language learning and the development of communication skills from preK-4. Implications of developmental differences and experiences in non-school settings on student readiness and skills. Helping parents support their children's language skills development. Methods of teaching listening, speaking, and writing, including spelling, punctuation, grammar, and handwriting. Selection of appropriate standards-aligned materials, textbooks, assessments, and evidence-based approaches to teach the language arts to learners from a variety of backgrounds and across a range of abilities.

**TLT 424 Children's Literature in Elementary Education 3 Credits**

Role of literature in the instructional program of the elementary schools. Use of trade books for individualized instruction in reading, language arts, mathematics, science, and social studies.

**TLT 426 Science in PreK through 4th Grade 3 Credits**

Overview of inquiry-based activities and investigations to promote science learning in preK-grade 4 classrooms. Emphasis on Pennsylvania's PreK-4 Standards for Science and Technology and Environment and Ecology standards and aligning instruction with standards. Course activities include planning effective lessons, trying out new methods of teaching, reflective practice, inclusionary methods, and integrating instructional technologies into science learning. Evidence-based assessment types are highlighted within instructional contexts.

**TLT 428 Mathematics and Numeracy in PreK through 4th Grade 3 Credits**

Trends, theories, activities and manipulative materials for teaching early numeracy and elementary mathematics. Pre-school development and in-school skills and concepts, including sets, systems of numeration, experience with numbers, number operations and concepts, numerals, measurement, early algebra, and elements of geometry. Implications of developmental differences and early non-school experiences on learner readiness and skills. Helping parents support their children's mathematics conceptual development. Research-based practices and inclusionary approaches to teach mathematics to learners from a variety of backgrounds and across ability levels.

**TLT 431 Social Studies in Middle Level and High School Education 3 Credits**

Middle and high school curriculum, content, teaching strategies, and instructional materials for the social studies. Emphasis on organizing content, using appropriate methods, testing and evaluation, and appropriate integration of technology. Overview of Pennsylvania's 4-8 and 8-12 standards for social studies and related standards from the National Council for the Social Studies and other national organizations. Explores relevant research, courses of study, textbooks, and teacher-made materials. Addresses inclusive evidence-based and standards-aligned instructional approaches and techniques, including co-teaching.

**TLT 432 Reading and Critical Thinking in Middle Level and High School Education 3 Credits**

Development of reading in the secondary content areas (English/language arts, mathematics, science, social studies). Highlights effective teaching strategies in critical areas, such as higher order reading and study skills. Addresses analysis of evidence based methods and current research for improving the reading development and analytical skills of all students.

**TLT 434 English in Middle Level and High School Education 3 Credits**

Curricula, philosophy, methods, strategies, and materials for the teaching of middle and high school English. Literature, genres, and the nature of text and text differences. Critical analysis and drawing inferences from narrative text and poetry. Techniques for teaching and enhancing writing in various styles. Applications of technology and assessment principles. Addresses inclusive evidence-based and standards-aligned instructional approaches and techniques, including co-teaching.

**TLT 436 Science in Middle Level and High School Education 3 Credits**

Overview of inquiry-based activities and investigations to promote science learning in secondary science classrooms. Emphasis on aligning instruction with Pennsylvania's Standards for Science and Technology and Environment and Ecology standards. Course activities include planning effective lessons, trying out new methods of teaching, inclusionary methods, reflective practice, and integrating instructional technologies into science learning. Evidence-based assessment types highlighted within instructional contexts.

**TLT 438 Mathematics in Middle Level and High School Education 3 Credits**

Standards-based and technology-intensive curricula, instructional activities, and manipulative aids for mathematics in middle level and high schools. This course models and explores an investigative and hands-on approach to secondary mathematics instruction. Particular attention given to learning theories, curriculum issues, and recommendations arising from state, national, and international assessments. Research-based practices and inclusionary approaches to teach mathematics to learners from a variety of backgrounds and across a range of abilities. Addresses standards-aligned instructional approaches and techniques, including co-teaching.

**TLT 440 Pre-professional Seminar 3 Credits**

Study, directed observation of, and initial practice in the various phases of teaching in secondary schools. Guided opportunities to try out strategies to facilitate the inclusion of special education students, differentiated instructional practices, and standards-aligned and evidence-based instructional approaches in actual school settings. Consent of program coordinator required.

**TLT 442 General Education and Special Education Student Teaching and Seminar 1-6 Credit**

Intensive practice in the application of principles of teaching for both general and special education settings in a supervised internship in the schools (for dual certification). Regular meetings among student teachers for critical analysis and discussion of classroom instructional practices, as illustrated by the student teachers' experiences in the schools. Practical mentoring on professionalism, applying differentiated instructional models in real-world setting, and aligning instruction with standards. Consent of program director required.

**TLT 444 General Education Student Teaching and Seminar 1-6 Credit**

Intensive practice in the application of principles of teaching for general education settings in a supervised internship in the schools. Regular meetings among student teachers for critical analysis and discussion of classroom instructional practices, as illustrated by the student teachers' experiences in the schools. Practical mentoring on professionalism, applying differentiated instructional models in real-world setting, and aligning instruction with standards. Consent of program director required.

**TLT 454 Applied Instructional and Interface Design Principles 3 Credits**

Exploration and application of design models for learning. Special emphasis on the application of perception theory, communication theory, and learning theory to the design of media for teaching and learning. Prerequisites as noted below or consent of instructor.

**Prerequisites:** TLT 403

**TLT 456 Instructional Design and Development Studio 3 Credits**

Studio-based, authentic and collaborative design experiences led by a faculty mentor. Students work in teams to complete substantial multimedia design and development projects. Prerequisites as noted below.

**Prerequisites:** TLT 454 and TLT 460

**TLT 458 Introduction to Multimedia Programming and Resource Development for Learning 3 Credits**

Introduction to programming and resource development tools used in the creation of interactive multimedia teaching and learning materials.

**Prerequisites:** TLT 406

**TLT 460 Advanced Multimedia Programming and Resource Development for Learning 3 Credits**

Advanced exploration of programming and resource development tools used in the creation of interactive teaching and learning materials.

Prerequisites as noted below or consent of instructor.

**Prerequisites:** TLT 458

**TLT 462 Special Topics in Development of Instructional Resources and Technologies for Learning 1-3 Credit**

Focus on using advanced Website and digital resource development-and-manipulation tools to create multimedia learning materials. Topics will vary (for example, Database-Driven Web Development; Assistive Devices for Special Populations; Programming Handheld Devices; Multimedia Resource Development; Media Production for Instructional Programming). May be repeated for credit under different subtitles. Prerequisites as noted below.

**Repeat Status:** Course may be repeated.

**Prerequisites:** TLT 460

**TLT 466 Field Experience: General Education Certification 1-3 Credit**

Intensive practice in the application of principles of teaching in general education in a supervised experience in the schools for students who already hold special education certification. Practical mentoring on professionalism, applying differentiated instructional models in real-world setting, and aligning instruction with standards. Pre-requisite: Consent of the program director.

**TLT 470 Technology for Teaching and Learning 3 Credits**

Analysis of available technologies (hardware, software, and Web resources), and identification of technologies matched to learner needs in traditional and/or non-traditional settings.

**TLT 474 Large-scale Planning and Implementation of Educational Technology 3 Credits**

Addresses topics such as planning, maintaining, funding, networking, staffing, staff development, and monitoring of educational technology implementations.

**TLT 476 Assessment of Instructional Technologies 3 Credits**

Techniques for evaluating technology implementations for teaching and learning. Focus on topics such as instrumentation, data collection and analysis, drawing conclusions from data sets, and preparing reports for stakeholders.

**TLT 480 Curriculum Theory and Design 3 Credits**

Curricular models and their features, with a focus on curriculum development and enactment. Special emphasis on design principles, curriculum's role in K-12 settings, and technology-enhanced curriculum.

**TLT 486 Doctoral Research Project 3 Credits**

This course provides students with the opportunity to design and conduct research studies under the supervision of specific faculty.

**TLT 492 Classroom Research Methods 3 Credits**

Introduces students to classroom research design paradigms and the assumptions behind them, use of the literature, developing research questions, qualitative and quantitative procedures, research design, sampling design, data collection, data analysis, and reporting research results using educational applications.

**TLT 494 Culminating Research Project 3 Credits**

Designing and conducting research projects in classroom settings.

**TLT 499 Dissertation 1-15 Credit**

**P.C. Rossin College of Engineering and Applied Science**

David Wu, dean

John P. Coulter, associate dean for graduate studies and research

Gregory L. Tonkay, associate dean for undergraduate studies

The P.C. Rossin College of Engineering and Applied Science offers the bachelor of science degree in 17 programs, combining a strong background in sciences and mathematics with requirements in humanities and social sciences. Students in college programs learn principles they can apply immediately in professional work; those who plan on further academic experience can design a curriculum centering on interests they will pursue in graduate school.

The mission of the college is to prepare undergraduate and graduate students to be critical thinkers, problem solvers, innovators, leaders and life-long learners in a global society and to create an environment where students pursue cutting-edge research in engineering and engineering science.

**Major Programs**

The P.C. Rossin College of Engineering and Applied Science includes seven departments and offers undergraduate and graduate degree programs at the bachelor, master, and doctor of philosophy levels.

The undergraduate degree programs leading to the bachelor of science degree are:

- Applied Science
- Bioengineering<sup>1</sup>
- Chemical Engineering<sup>1</sup>
- Chemistry
- Civil Engineering<sup>1</sup>
- Computer Engineering<sup>1</sup>
- Computer Science<sup>2</sup>
- Computer Science And Business<sup>3</sup>
- Electrical Engineering<sup>1</sup>
- Engineering Mechanics
- Engineering Physics
- Environmental Engineering<sup>1</sup>
- Industrial & Systems Engineering<sup>1</sup>
- Integrated Business And Engineering
- Integrated Degree In Engineering, Arts And Sciences
- Materials Science And Engineering<sup>1</sup>
- Mechanical Engineering<sup>1</sup>

<sup>1</sup> Accredited by the Engineering Accreditation Commission of ABET, <http://www.abet.org>

<sup>2</sup> Accredited by the Computing Accreditation Commission of ABET, <http://www.abet.org>

<sup>3</sup> Accredited by the Computing Accreditation Commission of ABET, <http://www.abet.org> and the American Assembly of Collegiate Schools of Business

*Programs in chemistry and physics have been approved by the faculty program review committee in these disciplines.*

**First Year Courses for Engineering Degrees**

**First Year**

<b>First Semester</b>	<b>CR Second Semester</b>	<b>CR</b>
ENGL 001	3 ENGL 002	3

MATH 021	4 MATH 022	4
ENGR 005	2 Select one of the following:	5-6
Select one of the following:	5-6 CHM 030 & ENGR 010	6
CHM 030 & ENGR 010	6 PHY 011 & PHY 012	5
PHY 011 & PHY 012	5 HSS Elective	3-4
<b>14-15</b>		<b>15-17</b>

Total Credits: 29-32

Bioengineering students take CHM 030 in the fall along with BIOE 001 instead of . In the spring they take and BIOS 041 (instead of HSS elective) along with PHY 011/PHY 012.

Students in Computer Science and Business, Integrated Business and Engineering, and Integrated Degree in Engineering, Arts and Sciences follow a different first year curriculum.

**Minimum Humanities/Social Sciences (HSS) Requirements for all Engineering Programs**

**Basic Requirement**

Economics and English. Three courses totaling a minimum of ten credit hours: Students must complete all three:

ECO 001	Principles of Economics	4
ENGL 001 or ENGL 003	Composition and Literature I for International Writers	3
ENGL 002 or ENGL 005	Composition and Literature II for International Writers	3
or ENGL 011	Literature Seminar for Freshmen	

Note: ENGL 011 is only for students with AP credit for ENGL 001

Total Credits 10

**Advanced Requirement**

A minimum of four multi-credit courses and a minimum of 13 credits in courses designated as HU (humanities) or SS (social science), with the following restrictions:

1. Depth: At least eight credits must be in a common discipline and from the same department or program. At least three of these credits must be at the 100-level or above, or at the intermediate level or above for a single modern foreign language.
2. Breadth: At least three credits in a discipline different from, and not cross-listed with, the discipline employed to satisfy the depth requirement.
3. At least three credits must be designated as HU.
4. None of the courses used for HSS can be taken Pass/Fail.
5. None of the course can be one-credit courses.

**Free Electives**

The college, through its advisers, is prepared to help students to use the credit hours of "free electives" that, along with other electives in the curriculum, may be used to develop a program of personal interest. Free electives may be satisfied by taking regular course offerings or up to six credit hours from each of the following from Mus 21-79, from Jour 1-8, or up to six credit hours of advanced ROTC courses.

**Interdisciplinary Degrees**

**Computer science & business**

The College of Business and Economics and the Computer Science and Engineering department in the P.C. Rossin College of Engineering and Applied Science jointly offer the Computer Science and Business (CSB) program. It is a four-year program that is fully accredited by AACSB International, the Association to Advance Collegiate Schools of Business, and by the Computing Accreditation Commission of ABET, <http://www.abet.org> .

### Integrated Business & Engineering Honors Program

The Integrated Business and Engineering Honors Program (IBE) is offered jointly by the P.C. Rossin College of Engineering and Applied Science and the College of Business and Economics. The program recognizes the need for today's leaders in business and industry to have a sound foundation in both commerce and technology.

After four years and a minimum of 137 credits, students will receive a single Bachelor of Science Degree in Integrated Business and Engineering. The program meets the accreditation standards of the American Assembly of Collegiate Schools of Business. Students are expected to maintain a minimum GPA of 3.25 in order to remain in the program.

A second option is the five-year dual degree program. This option allows students to obtain a second Bachelor of Science degree in engineering by completing course work in the engineering field chosen by the student as their IBE major. Students enrolled in the four year IBE Honors Program and in satisfactory standing are able to transfer to a dual-degree at any time, and stay within the honors program cohort. The additional time necessary to complete the second degree will depend on the curriculum selected, and the number of advanced placement credits. The number of additional credit hours will typically be in the range of 20 to 30.

Students in the IBE Honors Program can major in nearly any area of engineering or business that Lehigh offers. After their freshman year, each student will declare a major in either the P. C. Rossin College of Engineering and Applied Science or the College of Business and Economics.

Admission to the Integrated Business and Engineering Program is highly selective, with annual admission limited to approximately 50 students. The University's Office of Admissions can explain the procedure for applying to the program. It is possible that a small number of exceptional students may be admitted to the program following the completion of their freshman year. Admission at this point would be highly competitive and based upon freshman year GPA, faculty recommendations, and space availability.

The Co-Directors of the IBE Honors Program are Robert H. Storer, Professor of Industrial and Systems Engineering ([rhs2@lehigh.edu](mailto:rhs2@lehigh.edu)) and Stephen G. Buell, Professor of Finance ([sgb2@lehigh.edu](mailto:sgb2@lehigh.edu)). For additional information, see the IBE Honors Program or visit the IBE web site at [www.lehigh.edu/~inibep/inibep.html](http://www.lehigh.edu/~inibep/inibep.html).

### Integrated Degree Engineering, Arts and Sciences (IDEAS) Honors Program

The B.S. in Integrated Engineering, Arts and Sciences (IDEAS) provides students with a unique opportunity to combine the breadth and depth of two focus areas, one from engineering and one from arts and sciences in a four-year experience. More information is available in the IDEAS entry in this catalog, or online at [www.lehigh.edu/ideas](http://www.lehigh.edu/ideas).

Jointly administered by the College of Arts and Sciences and the P.C. Rossin College of Engineering and Applied Science, IDEAS is a four-year honors program that allows students to earn a bachelor's degree with concentrations in both colleges. In close collaboration with IDEAS advisors and faculty directors, students admitted to this highly selective honors program develop an individualized academic plan tailored to their interests.

IDEAS allows students to study diverse interests such as bioengineering and religion, computer science and graphic design, industrial engineering and international relations, bioengineering and molecular biology, and music and computer science. Key features of the program include:

- **Rigorous honors program:** Each year, IDEAS accepts 30-40 highly qualified first-year student candidates who have indicated an interest in the program. Students must maintain a 3.25 grade point average to continue.
- **Team-based and individual projects:** Each student builds toward a capstone research project and thesis in their senior year, developed through a combination of team-based and individualized instruction.

- **Communication as key to bridging disciplines:** IDEAS courses are writing-intensive and presentation-oriented. Participation in the program substitutes for some first-year courses in both colleges.

IDEAS graduates are awarded a Bachelor of Science degree, conferred by both colleges. Students interested in pursuing a professionally accredited degree in their selected engineering disciplines may choose to do so in an optional fifth year of study. Some programs of study in the College of Arts and Sciences, mainly in the sciences, may also require further study to complete certification.

### Other Options for Engineering Students

#### Cooperative Education (Co-Op)

Co-Op is available for undergraduates in the P.C. Rossin College of Engineering and Applied Science; the program provides eight months of paid, full-time work experience, bridging the gap between engineering theory and application and allowing students to graduate within a four year time-frame. Because of the rigorous academic schedule, the program is selective.

The Co-Op schedule provides for interviews and selection by the companies in the spring semester of the sophomore year. Those students selected attend Lehigh for a challenging summer schedule of junior-level coursework, then begin their first work rotation with the sponsoring company in mid-August. This rotation will last until mid-January when the student returns to Lehigh for the second semester coursework of the junior year. The Co-Op experience is completed with a second work rotation the following summer (mid-May through August). Students earn three, free elective credits per successful work assignment for a total of six free elective credits. These six credits are in ENGR 200 (p. 339) and are taken as P/F (Pass/Fail).

#### Technical minors (Available to all students but most require prerequisites from engineering curricula)

Technical Minor	Department
aerospace engineering	Mechanical Engineering
biotechnology	Chemical Engineering
chemical engineering	Chemical Engineering
computer science	Computer Science and Engineering
electrical engineering	Electrical Engineering
engineering leadership	Industrial and Systems Engineering
energy engineering	Mechanical Engineering
environmental engineering	Civil & Environmental Engineering
manufacturing systems	Industrial & Systems Engineering
materials science	Materials Science & Engineering
nanotechnology	Materials Science & Engineering
polymer science	Center for Polymer Science Engineering

#### Interdisciplinary Minors (For engineering students)

A minor in Engineering Leadership provides students with knowledge, experiences and interaction with successful business managers in order to become more effective leaders. For more information about this minor: <http://www.lehigh.edu/~inleader/curriculum.html>

The College of Business and Economics offers a minor in Business for students in the College of Arts and Sciences and P.C. Rossin College of Engineering and Applied Science to provide students with knowledge and skills to allow them to make informed business decisions. A sequential sequence of courses is designed to integrate such traditional topics as accounting, finance, marketing, and management. For more information about his minor: <http://www4.lehigh.edu/business/academics/undergraduate/businessminor.aspx>. There is also a minor in Real Estate: <http://www4.lehigh.edu/business/academics/undergraduate/realestateminor.aspx> and a minor in Entrepreneurship: <http://www4.lehigh.edu/business/academics/undergraduate/entrepreneurshipminor.aspx>. The courses in the latter treat subjects such as intellectual property, creativity and innovation, venture capital, positioning of products and services, and understanding the entrepreneurial mindset.

Students in engineering can also earn a minor in various humanities or social sciences by using their humanities and social science electives coupled with their free electives.

#### **Engineering Minor (for non-engineering students)**

The College of Engineering enables undergraduate students enrolled in the Colleges of Arts and Sciences and in the College of Business and Economics to earn a minor in engineering. This unique program provides students with insight into the world of engineers: who they are, what they do, and how they think. Students pursuing the Engineering Minor develop an understanding of the tools and techniques engineering use on a day-to-day basis.

The mission of the minor is to educate non-engineering students about engineering methodology, specifically how engineers solve problems; how they design, manufacture, and analyze problems; and how other factors such as economics, safety, ethics, and environmental issues affect the engineering design process. Fifteen credit hours of required and elective coursework are required to fulfill the engineering minor. For more information about this minor: <http://www.lehigh.edu/~inengmnr/index.html>

#### **Music Option**

Music and Engineering is not a major in itself. However, Lehigh attracts many engineering and science students who wish to continue their active involvement in music and the music department. For those students who are interested in pursuing this option, music can be taken as a second degree, minor or through free electives.

#### **Undergraduate research through Centers and Institutes**

Faculty and students in the college also have research and scholarship activities in a number of centers and institutes, where graduate and undergraduate students work closely with faculty members. These include: Center for Advanced Technology for Large Structural Systems, Biopharmaceutical Technology Institute, Chemical Process Modeling and Control Center, Emulsion Polymers Institute, Energy Research Center, Enterprise Systems Center, Fritz Laboratory, Sherman Fairchild Center for Solid-State Studies, Polymer Science and Engineering Center, Structural Stability Research Council, Council on Tall Buildings and Urban Habitat, Center for Manufacturing Systems Engineering, Ben Franklin Technology Partners, Manufacturers Resource Center, Center for Advanced Materials and Nanotechnology, and Center for Optical Technologies.

#### **Applied Science**

Director, Associate Dean of the P.C. Rossin College of Engineering and Applied Science

The Applied Science Program enables students to create interdisciplinary specialties that prepare them for careers in a world that increasingly bridges academic disciplines. Students pursue subject-area concentrations that represent academic interests they wish to integrate into a meaningful program. The core offers students the intellectual tools to identify connections between the concentrations and engage in interdisciplinary problem-solving and critical thinking.

The program leads to the Bachelor of Science in Applied Science. Each student's curriculum combines a general engineering education with a carefully customized concentration in engineering and/or science as well as another area of emphasis, which may include courses taken inside the P.C. Rossin College of Engineering & Applied Science and may also include courses taken in one or more of the other three Colleges within the University.

In order to ensure the success of this individualized approach to education, Applied Science places primary emphasis on advisement. Each student is teamed with an advisor who helps the student plan the course of study and who supervises independent study and internships. The advisor remains the student's advisor throughout his or her undergraduate career.

Unlike students in the traditional college programs, students in the Applied Science program of individualized study do not declare a major in a particular academic department. Instead, they develop a concentration that may combine study in several areas. Students are encouraged by their advisor to develop the concentration in such a

way that the student will be well prepared for further study in graduate school or for pursuing a particular career path. While the chosen concentration can be highly customized in consultation with the advisor, examples of concentrations include: Technical Communications, Digital Media, Entertainment Science, Technology/Science and Education, Technology/Science and Pre-law, Technology/Science and Pre-Medicine, Technology Management, Technology Marketing, and Engineering and Architecture. Many other combinations are possible.

**Professors.** Ivan Biaggio, PhD (ETH Zurich); Huai-Dong Cao, PhD (Princeton University); Donald M Davis, PhD (Stanford University); Gary G. DeLeo, PhD (University of Connecticut); Volkmar R. Dierolf, PhD (University of Utah); Bennett Eisenberg, MA (Massachusetts Institute of Technology); Gregory S Ferguson, PhD (Cornell University); Robert A. Flowers, II, PhD (Lehigh University); James D. Gunton, PhD (Stanford University); Ned D. Heindel, PhD (University of Delaware); Albert Peet Hickman, PhD (Rice University); Wei-Min Huang, PhD (University of Rochester); John P. Huennkens, PhD (University of Colorado Boulder); Garth Timothy Isaak, PhD (Rutgers University); David L. Johnson, PhD (Massachusetts Institute of Technology); Alvin S. Kanofsky, PhD (University of Pennsylvania); Yong W. Kim, PhD (University of Michigan Ann Arbor); Arnold H. Kritz, PhD (Yale University); George Eadon McCluskey, Jr., PhD (University of Pennsylvania); Terrence J. Napier, PhD (University of Chicago); H. Daniel Ou-Yang, PhD (University of California Los Angeles); Steven L. Regen, PhD (Massachusetts Institute of Technology); Eric P. Salathe, PhD (Brown University); Keith J. Schray, PhD (The Pennsylvania State University); Lee J. Stanley, PhD (University of California Berkeley); Michael J. Stavola, PhD (University of Rochester); Jean Toulouse, PhD (Columbia University); David A. Vicic, PhD (University of Rochester); Steven H. Weintraub, PhD (Princeton University); Joseph E. Yukich, PhD (Massachusetts Institute of Technology)

**Associate Professors.** Vladimir T. Dobric, PhD (University of Zagreb); Bruce A. Dodson, PhD (SUNY College Stony Brook); Kerney Jebrell Glover, PhD (University of California San Diego); Kai Manfred Martin Landskron, PhD (University of Munich); Jerome C. Licini, PhD (Massachusetts Institute of Technology); Mary Virginia McSwain, PhD (Georgia State University); James E. Roberts, PhD (Northwestern University); Vyacheslav Rotkin, PhD (Ioffe Institute); Mark Skandera, PhD (Massachusetts Institute of Technology); Xiaofeng Sun, PhD (Stanford University); Susan Szczepanski, PhD (Rutgers University New Brunswick); Dimitrios Vavylonis, PhD (Columbia University); Ramamirtham Venkataraman, PhD (Brown University); Dmitri V. Vezenov, PhD (Harvard University); Ping-Shi Wu, PhD (University of California Davis); Linghai Zhang, PhD (University of Minnesota Minneapolis)

**Assistant Professors.** Soutir Bandyopadhyay, PhD (Texas A&M University); Daniel Conus, PhD (Swiss Federal Institute of Technology); Heather Jaeger, PhD (University Georgia Athens); David T. Moore, PhD (University of North Carolina Chapel Hill); Robert W. Neel, PhD (Harvard University); Joshua A. Pepper, PhD (Ohio State University); Marcos Pires, PhD (Purdue University); Damien Thevenin, PhD (University of Delaware)

**Lecturer.** Vincent E Coll, PhD (University of Pennsylvania)

**Professors Of Practice.** Andy W. Ho, PhD (Harvard University); Rebecca S. Miller, PhD (Duke University); Raymond Sam Niedbala, PhD (Lehigh University)

**Emeriti.** Jack A. Alhadeff, PhD (Oregon Health Science University); Garold J Borse, PhD (University of Virginia); Robert T. Folk, PhD (Lehigh University); Natalie M Foster, PhD (Lehigh University); W. Beall Fowler, PhD (University of Rochester); Samir A. Khabbaz, PhD (University of Kansas); Jerry P. King, PhD (University of Kentucky Fort Knox); Kamil Klier, PhD (Acad Sciences Czech Republic); John W. Larsen, PhD (Purdue University Calumet); Joseph R. Merkel, PhD (University of Maryland College Park); Fortunato J. Micale, PhD (Lehigh University); Clifford S. Queen, PhD (Ohio State University); Shelden H. Radin, PhD (Yale University); Murray Schechter, PhD (New York University); Russell A. Shaffer, PhD (Johns Hopkins University); Gary W. Simmons, PhD (University of Virginia); Andrew K Snyder, PhD (Lehigh University); Robert S. Sprague, PhD (University of Illinois Urbana); James E. Sturm, PhD (University of Notre Dame); Albert Wilansky, PhD (Brown University); Daniel Zeroka, PhD (University of Pennsylvania)

The requirements for a BS in Applied Science program are a minimum of 129 credit hours including:

#### First Year Courses

ENGL 001	Composition and Literature	3
ENGL 002	Composition and Literature II	3
ENGR 005	Introduction to Engineering Practice	2
ENGR 010	Applied Engineering Computer Methods	2
CHM 030	Introduction to Chemical Principles	4
PHY 011 & PHY 012	Introductory Physics I and Introductory Physics Laboratory I	5
MATH 021	Calculus I	4
MATH 022	Calculus II	4

#### Other Natural Science

CHM 110 & CHM 111	Organic Chemistry I and Organic Chemistry Laboratory I	4
EES 021	Introduction to Planet Earth	3
EES 022	Exploring Earth	1
EES 031	Introduction to Environmental and Organismal Biology	3
PHY 021 & PHY 022	Introductory Physics II and Introductory Physics Laboratory II	5

#### Other Mathematics

MATH 021	Calculus I	4
MATH 022	Calculus II	4
MATH 023	Calculus III	4
MATH 205	Linear Methods	3
MATH 231	Probability and Statistics	3

#### Required HSS courses

ECO 001	Principles of Economics	4
PHIL 128	Philosophy Of Science	4
PSYC 001	Introduction to Psychology	4

#### Humanities & Social Science electives

Select 13 additional credits subject to college requirements. 13

#### Major electives

Select 24 credits 24

#### Approved electives

Select 18 credits 18

Total Credits 128

### Arts-Engineering

Program director. Bruce Thomas, Ph.D., (University of California, Berkley), associate professor of architecture, College of Arts and Sciences. The Arts-Engineering program provides the student with an opportunity to experience the breadth of an arts education and simultaneously follow the focused curriculum of an engineering major. This is a five-year, dual degree program administered by the College

of Arts and Sciences. An Arts-Engineering graduate is awarded two bachelors degrees, one from the College of Arts and Sciences and another from the College of Engineering and Applied Science, the latter a professional degree.

A typical freshman year class schedule for an Arts-Engineer is shown below. Note that an Arts-Bioengineering program has a different freshman year class schedule.

#### First Year

First Semester	CR Second Semester	CR
ENGL 001	3 ENGL 002	3
MATH 021	4 MATH 022	4
PHY 011 & PHY 012	5 ENGR 005	2
(Dept) 90 College Seminar or FYC	1-4 CHM 030	4
ENGR 010	2 Humanities /Social Science Elective	3-4
	<b>15-18</b>	<b>16-17</b>

Total Credits: 31-35

Selection of a major in the College of Engineering and Applied Science occurs prior to beginning the sophomore year. A major leading to a degree in the College of Arts and Sciences should be chosen prior to beginning the junior year.

Arts-Engineering candidates should recognize that pursuit of a bachelor of science degree (e.g., biology, chemistry, biochemistry, earth and environmental sciences, mathematics, and physics) or a bachelor of arts program with larger than average credit requirements (e.g., art, architecture, physical sciences, cognitive science, international careers, among others) will severely restrict choices of free electives.

Courses selected must fulfill major and distribution requirements of both the College of Arts and Sciences and the College of Engineering and Applied Science.

For all students, very careful planning of the academic program done in consultation with advisers in both colleges is necessary to guarantee completion of all major, distribution and total credit requirements for the two degrees in five years.

When selected properly, courses meet distribution requirements in the College of Arts and Sciences while also satisfying distribution requirements of the College of Engineering and Applied Science.

A course of study in Arts-Engineering may link any College of Engineering and Applied Science discipline degree program with any College of Arts and Sciences major. Please see individual departments for details concerning required courses and sequences for completing discipline – specific degrees and combinations of degree requirements for Arts Engineering. Below is a template listing all courses required for a civil engineering-architecture combination (the most common Arts-Engineering linkage). Please note that the large number of required credits for both degrees means that this combination results in a larger number of total credits than is required for some other combinations.

#### Civil Engineering - Architecture

A total of 170-175 credits is needed for the Bachelor of Science in Civil Engineering and the Bachelor of Art in Architecture degrees.

#### First Year

First Semester	CR Second Semester	CR
ENGL 001	3 ENGL 002	3
MATH 021	4 MATH 022	4
PHY 011	4 CHM 030	4
PHY 012	1 ENGR 010	2
(Dept) 90 College Seminar or FYC	1-4 Humanities /Social Science Elective	3-4
ENGR 005	2	
	<b>15-18</b>	<b>16-17</b>



**Second Year**

First Semester	CR Second Semester	CR
MATH 023	4 MATH 205	3
CEE 003	3 CEE 059	3
CEE 010	3 PHY 021 & PHY 022	5
DES 004	4 ARCH 002	4
ART 001 or ARCH 001	4 Art Studio Elective	4
	<b>18</b>	<b>19</b>

**Third Year**

First Semester	CR Second Semester	CR
CEE 123	3 CEE 117	2
CEE 011	1 CEE 222	3
CEE 012	2 ARCH 143	6
CEE 121	3 ECO 001	4
ARCH 043	4 Architectural History Elective <sup>1</sup>	4
Basic Science Elective <sup>4</sup>	3	
	<b>16</b>	<b>19</b>

**Fourth Year**

First Semester	CR Second Semester	CR
CEE 142	3 CEE 202	3
CEE 159	4 CEE 242	3
ARCH 243	6 CEE 262 or 264	3
ARCH 157	4 ARCH 343	6
	ARCH 210	4
	<b>17</b>	<b>19</b>

**Fifth Year**

First Semester	CR Second Semester	CR
CEE 203	2 CEE 170	4
Civil Engineering Approved electives <sup>2</sup>	8-9 CEE 290 <sup>3</sup>	3
Architectural History Elective <sup>1</sup>	4 Civil Engineering Approved elective <sup>2</sup>	6
	Art Studio Elective	4
	<b>14-15</b>	<b>17</b>

Total Credits: 170-175

- 1 One Architectural History elective should be filled by a course designated (SS) in order to fulfill the social science distribution requirement.
- 2 Of 17 CEE approved elective credits required for Civil Engineering three credits are satisfied by ARCH 343.
- 3 Multidisciplinary teaming versions of CEE 205 or CEE 381 can be substituted with departmental permission.
- 4 Basic Science Elective - List of approved courses is available from the CEE department.

Note: The College of Arts and Sciences requires a junior writing intensive course. This may be filled by an appropriate choice of elective.

**Bioengineering Program**

The mission of the Bioengineering Program is to prepare undergraduate students to be critical thinkers, problem solvers, innovators, leaders, and lifelong learners who can make a positive impact at the interfaces among the physical and life sciences, and engineering.

To achieve its educational mission, the Bioengineering Program has established the following set of Program Educational Objectives. Three to five years after graduation, we expect that

1. Graduates in professional practice function effectively as responsible and collaborative professionals in Bioengineering or in a related field.
2. Graduates pursue advanced degrees or engage in other forms of continuing education.

**Bioengineering Program Faculty**

**Professor Anand Jagota, Director**, Department of Chemical Engineering at 610-758-4396 or anj6@lehigh.edu

**Professor of Practice Lori Herz, Associate Director**, Department of Chemical Engineering at 610-758-6831 or loh208@lehigh.edu

**Core Program Faculty:** Yevgeny Berdichevsky, Ph.D. (UC San Diego) Electrical and Computer Engineering; Bryan Berger, Ph.D. (Delaware) Chemical Engineering; Xuanhong Cheng, Ph.D. (U. of Washington) Materials Science and Engineering; James T. Hsu, Ph.D. (Northwestern) Chemical Engineering; Anand Jagota, Ph.D. (Cornell) Chemical Engineering; Sabrina Jedlicka Ph.D. (Purdue) Materials Science and Engineering; Linda Lowe-Krentz, Ph.D. (Northwestern) Biological Sciences; Yaling Liu, Ph.D. (Northwestern) Mechanical Engineering and Mechanics; H. Daniel Ou-Yang, Ph.D. (UCLA) Physics; Svetlana Tatic-Lucic, Ph.D. (California Institute of Technology) Electrical and Computer Engineering; Arkady S. Voloshin, Ph.D. (Tel Aviv University, Israel), Mechanical Engineering and Mechanics; Xiaohui Zhang, Ph.D. (Miami) Mechanical Engineering and Mechanics; Chao Zhou, Ph.D. (Pennsylvania) Electrical and Computer Engineering.

**Associated Program Faculty:** Filbert Bartoli, Ph.D. (Catholic Univ.) Electrical and Computer Engineering; Angela Brown, Ph.D. (Drexel) Chemical Engineering; Derick Brown, Ph.D. (Princeton) Civil and Environmental Engineering; Brian Chen (Rice) Computer Science and Engineering; Matthias Falk, Ph.D. (Heidelberg) Biological Sciences; D. Gary Harlow, Ph.D. (Cornell) Mechanical Engineering and Mechanics; Xiaolei Huang, Ph.D. (Rutgers) Computer Science and Engineering; Himanshu Jain, Eng.Sc.D. (Columbia), Materials Science and Engineering; Shalinee Kishore, Ph.D. (Princeton) Electrical and Computer Engineering; Mayuresh Kothare, Ph.D. (Cal Tech) Chemical Engineering; Daniel Lopresti, Ph.D. (Princeton) Computer Science and Engineering; A.J. McHugh, Ph.D. (Delaware) Chemical Engineering; Wojciech Z. Misiolek, Ph.D. (University of Mining and Metallurgy, Krakow, Poland) Materials Science and Engineering; Jeetain Mittal, Ph.D. (Texas) Chemical Engineering; John Ochs, Ph.D. (Pennsylvania State) Mechanical Engineering and Mechanics; Eugene Peralov, Ph.D. (Texas) Industrial Systems Engineering; Kelly Schultz, Ph.D. (Delaware) Chemical Engineering; Neal G. Simon, Ph.D. (Rutgers) Biological Sciences; John Spletzer, Ph.D. (Pennsylvania) Computer Science and Engineering; Damien Thévinin (Delaware) Chemistry; Dimitrios Vavylonis, Ph.D. (Columbia) Physics; Dimitri Vezenov, Ph.D. (Harvard) Chemistry.

**Professor of Practice:** Lori E. Herz, Ph.D. (Rutgers) Chemical Engineering; R. Sam Niedbala, Ph.D. (Lehigh University) Chemistry; Susan F. Perry, Ph.D. (Pennsylvania State University) Chemical Engineering.

**Undergraduate Program**

The B.S. in Bioengineering degree provides a structured curriculum comprised of three tracks. Biopharmaceutical Engineering is for students whose interests lie in genomics, proteomics, bioinformatics, recombinant DNA, protein engineering, bioprocessing, drug synthesis and delivery. The Bioelectronics/photronics track covers education and research dealing with signal processing, biosensors, MEMS, biochips for DNA sequencing, laser and fiber based optical technology for biomedical applications. Cell and Tissue Engineering encompasses biomaterials and biomechanics, from cells and tissue to organs and systems.

The B.S. in Bioengineering will prepare students for careers in established and emerging fields that require combining engineering principles with the life sciences. Potential paths open to students include the health care, biomedical, pharmaceutical, biomaterials, and other biotechnology related industries through careers in medicine or graduate studies.

The program strongly encourages experiential learning, including two summers of internships, required participation in Lehigh's Integrated Product Development (IPD) program, and opportunities for undergraduate research for credit.

A total of 132 credit hours are required for graduation with a degree of bachelor of science in bioengineering.

**Bioengineering Core Requirements****General Requirements**

ENGL 001	Composition and Literature	3
ENGL 002	Composition and Literature II	3
PHIL 116	Bioethics	4
ECO 001	Principles of Economics	4
ENGR 010	Applied Engineering Computer Methods	2
Electives to satisfy HSS depth and breadth requirements		13
Free Electives	Number of general requirements and free elective credits are track-dependent.	3-5

**Mathematics**

MATH 021	Calculus I	4
MATH 022	Calculus II	4
MATH 023	Calculus III	4
MATH 205	Linear Methods <sup>1</sup>	3
MATH 231	Probability and Statistics <sup>1</sup>	3

**Chemistry**

CHM 030	Introduction to Chemical Principles	4
CHM 031	Chemical Equilibria in Aqueous Systems	4
CHM 110 & CHM 111	Organic Chemistry I and Organic Chemistry Laboratory I	4

**Physics**

PHY 011 & PHY 012	Introductory Physics I and Introductory Physics Laboratory I	5
PHY 021 & PHY 022	Introductory Physics II and Introductory Physics Laboratory II	5

**Biological Sciences**

BIOS 041 & BIOS 042	Biology Core I: Cellular and Molecular and Biology Core I: Cellular and Molecular Lab	4
BIOS 115 & BIOS 116	Biology Core II: Genetics and Biology Core II: Genetics Laboratory	4

**Integrated Bioengineering**

## Required by all Three Tracks

BIOE 001	Freshman Seminar 1, Introduction to Bioengineering 1: Philosophy to Practice (Pass/Fail)	1
BIOE 002	Freshman Seminar 2, Introduction to Bioengineering II: Current Topics (Pass/Fail)	1
BIOE 110	Elements of Bioengineering	4
BIOE 210	Introduction to Engineering Physiology	4
ENGR 211	Integrated Product Development (IPD) 1	3
ENGR 212	Integrated Product Development (IPD) II	2
BIOE 225	GMP Good manufacturing practice and regulatory affairs for bioengineers	1

**Engineering Requirement by Track**

Select one of the following tracks: 22-24

**Biopharmaceutical Engineering Track**

CHM 112	Organic Chemistry II	
BIOE 343	Integrated Biotechnology Laboratory	
MAT 033	Engineering Materials and Processes	
CHE 031	Material and Energy Balances of Chemical Processes	
CHE 210	Chemical Engineering Thermodynamics	
CHE 211	Chemical Reactor Design <sup>2</sup>	

BIOE 247 Biological Fluid Mechanics

**Bioelectronic/Biophotonics Track**

ECE 108	Signals and Systems	
BIOE 331	Integrated Bioelectronics/Biophotonics Laboratory	
ECE 081	Principles of Electrical Engineering	
ECE 121	Electronic Circuits Laboratory	
ECE 123	Electronic Circuits	
ECE 202	Introduction to Electromagnetics	
MECH 003	Fundamentals of Engineering Mechanics	
MAT 033	Engineering Materials and Processes	
<b>Cell and Tissue Engineering Track</b>		
BIOE 120 & BIOE 121	Biomechanics and Biomechanics Lab Co-op	
BIOE 357	Integrated Biostructural Mechanics Laboratory	
MECH 003	Fundamentals of Engineering Mechanics	
MECH 012	Strength of Materials	
MAT 033	Engineering Materials and Processes	
MAT 205	Thermodynamics of Macro/Nanoscale Materials	
ME 104	Thermodynamics I	
BIOE 247	Biological Fluid Mechanics	

**Bioengineering Electives**

Select one of the following:		3
BIOE/ME 315	Bioengineering Statistics	
BIOE 341	Biotechnology I <sup>3</sup>	
BIOE/PHY 321	Biomolecular & Cellular Mechanics	
BIOE 349	Metabolic Engineering	
ECE 337	Introduction to Micro- and Nanofabrication	
Technical Electives <sup>4</sup>		9
<b>Total Credits</b>		<b>130-134</b>

<sup>1</sup> Students must achieve a minimum of a C- in both MATH 205 and MATH 231 for the B.S. in Bioengineering.<sup>2</sup> Note: BIOE 349 (Metabolic Engineering) may be taken in lieu of CHE 211. If BIOE 349 is taken instead of CHE 211, it may not count as an elective.<sup>3</sup> Students in the Biopharmaceutical Engineering track are required to take BIOE 341, since it is a prerequisite for BIOE 343.<sup>4</sup> Students must take nine (9) credits of technical electives, which include undergraduate research, graphics for engineering design, engineering courses at the 200-level or higher, and BIOS/CHM/PHY/MATH courses at the 200-level or higher. (Several 200-level courses are excluded from this list; the complete list of approved courses is available from the Bioengineering Program or the Registrar.) At least three (3) of the nine (9) credits must be a BIOE class at the 300-level or higher. No more than six (6) credits can be from ME 010, BIOE 020, BIOE 132, BIOE 142, BIOE 242, and BIOE 290.**Typical four-year course schedule for BS in Bioengineering****Biopharmaceutical Engineering Track****First Year**

First Semester	CR Second Semester	CR
BIOE 001 (Pass/Fail)	1 BIOE 002 (Pass/Fail)	1
CHM 030	4 BIOS 041 & BIOS 042	4
MATH 021	4 MATH 022	4
ENGL 001	3 PHY 011 & PHY 012	5
ENGR 010	2 ENGL 002	3
	<b>14</b>	<b>17</b>

**Second Year**

First Semester	CR Second Semester	CR
BIOE 110	4 BIOE 210	4

MATH 023	4 BIOE 020	1
PHY 021 & PHY 022	5 CHM 031	4
CHE 031	3 MATH 205	3
	CHE 210	4
	<b>16</b>	<b>16</b>
<b>Third Year</b>		
<b>First Semester</b>	<b>CR Second Semester</b>	<b>CR</b>
CHM 110 & CHM 111	4 ENGR 211	3
BIOS 115 & BIOS 116	4 CHE 211	3
BIOE 341	3 BIOE 247	4
BIOE 225	1 CHM 112	3
MATH 231	3 ECO 001	4
Elective	3	
	<b>18</b>	<b>17</b>
<b>Fourth Year</b>		
<b>First Semester</b>	<b>CR Second Semester</b>	<b>CR</b>
ENGR 212	2 PHIL 116	4
BIOE 343	3 Electives	13
MAT 033	3	
Electives	9	
	<b>17</b>	<b>17</b>

Total Credits: 132

**Bioelectronics/Biophotonics Track**

<b>First Year</b>		
<b>First Semester</b>	<b>CR Second Semester</b>	<b>CR</b>
BIOE 001 (Pass/Fail)	1 BIOE 002 (Pass/Fail)	1
CHM 030	4 BIOS 041 & BIOS 042	4
MATH 021	4 MATH 022	4
ENGL 001	3 PHY 011 & PHY 012	5
ENGR 010	2 ENGL 002	3
	<b>14</b>	<b>17</b>
<b>Second Year</b>		
<b>First Semester</b>	<b>CR Second Semester</b>	<b>CR</b>
BIOE 110	4 BIOE 210	4
MATH 023	4 BIOE 020	1
ECE 081	4 MATH 205	3
PHY 021 & PHY 022	5 CHM 031	4
	ECE 123 & ECE 121	5
	<b>17</b>	<b>17</b>
<b>Third Year</b>		
<b>First Semester</b>	<b>CR Second Semester</b>	<b>CR</b>
BIOS 115 & BIOS 116	4 MATH 231	3
CHM 110 & CHM 111	4 ENGR 211	3
MAT 033	3 BIOE 331	2
ECE 108	4 MECH 003	3
BIOE 225	1 ECO 001	4
	Elective	3
	<b>16</b>	<b>18</b>
<b>Fourth Year</b>		
<b>First Semester</b>	<b>CR Second Semester</b>	<b>CR</b>
ENGR 212	2 PHIL 116	4
ECE 202 or PHY 212	3 Electives	13

Electives	12	
	<b>17</b>	<b>17</b>

Total Credits: 133

**Cell and Tissue Engineering Track**

<b>First Year</b>		
<b>First Semester</b>	<b>CR Second Semester</b>	<b>CR</b>
BIOE 001 (Pass/Fail)	1 BIOE 002 (Pass/Fail)	1
CHM 030	4 BIOS 041 & BIOS 042	4
MATH 021	4 MATH 022	4
ENGL 001	3 PHY 011 & PHY 012	5
ENGR 010	2 ENGL 002	3
	<b>14</b>	<b>17</b>
<b>Second Year</b>		
<b>First Semester</b>	<b>CR Second Semester</b>	<b>CR</b>
BIOE 110	4 BIOE 210	4
MECH 003	3 BIOE 020	1
MATH 023	4 MATH 205	3
PHY 021 & PHY 022	5 CHM 031	4
	MAT 033	3
	MAT 205	3
	<b>16</b>	<b>18</b>
<b>Third Year</b>		
<b>First Semester</b>	<b>CR Second Semester</b>	<b>CR</b>
BIOE 120 & BIOE 121	4 MATH 231	3
CHM 110 & CHM 111	4 ENGR 211	3
MECH 012	3 BIOE 357	2
BIOS 115 & BIOS 116	4 BIOE 247	4
BIOE 225	1 Electives	6
	<b>16</b>	<b>18</b>
<b>Fourth Year</b>		
<b>First Semester</b>	<b>CR Second Semester</b>	<b>CR</b>
ENGR 212	2 PHIL 116	4
ECO 001	4 Electives	13
Electives	12	
	<b>18</b>	<b>17</b>

Total Credits: 134

<b>Graduate Program</b>		
Bioengineering offers a graduate program leading to the doctor of philosophy degree. The graduate program will train students to solve problems that require the application of interdisciplinary knowledge, combining life sciences, physical sciences, and engineering. The program will emphasize cellular and biomolecular science and engineering, and aims to attract students with diverse academic backgrounds. Students who do not complete the doctor of philosophy have the option to earn a master of science.		
<b>Major Requirements</b>		
<b>Doctor of Philosophy Degree</b>		
Candidates for the doctor of philosophy degree are required to complete a minimum of 72 credits.		
ENGR 452	Mathematical Methods in Engineering	3
BIOS 411	Advanced Cell Biology	3
Two additional core courses from an approved list of courses		6
Twelve credits of adviser-approved technical electives at the 300-level or higher		12

Six credits of dissertation research	6
Additional 42 credits of electives and/or dissertation research	42
<b>Total Credits</b>	<b>72</b>

Students must pass a qualification exam, typically taken after three semesters of study, a final written dissertation as well as an oral defense of the dissertation.

#### Master of Science Degree

Two options for the master of science degree are available: a *thesis option* and a *non-thesis option*. Candidates for both the thesis and non-thesis master of science degree are required to complete a minimum of 30 credits. Per university policy, graduate students may count no more than 12 credits at the 300-level toward the M.S. degree.

#### Thesis Option

ENGR 452	Mathematical Methods in Engineering	3
BIOS 411	Advanced Cell Biology	3
Two additional core courses from an approved list of courses		6
Twelve credits of adviser-approved technical electives at the 300-level or higher.		12
Six credits of thesis research, culminating in a written thesis.		6
<b>Total Credits</b>		<b>30</b>

An oral defense of thesis research is dependent upon the requirements of the student's adviser.

#### Non-Thesis Option

ENGR 452	Mathematical Methods in Engineering	3
BIOS 411	Advanced Cell Biology	3
Two additional core courses from an approved list of courses		6
Eighteen credits of adviser-approved technical electives at the 300-level or higher. No thesis research or written thesis is required.		18
Six credits of thesis research, culminating in a written thesis. .		6
<b>Total Credits</b>		<b>36</b>

#### Courses

##### BIOE 001 Freshman Seminar 1, Introduction to Bioengineering 1: Philosophy to Practice 1 Credit

Overview of the bioengineering field, the advancements of related topics in sciences, technology, engineering and applications for health care and medicine. Humanity and ethical issues. Pass/Fail.

##### BIOE 002 Freshman Seminar 2, Introduction to Bioengineering II: Current Topics 1 Credit

Overview of a broad spectrum of current topical areas in biotechnology and bioengineering and their applications in health care and medicine. Pass/Fail.

##### BIOE 020 Bioengineering Sophomore Seminar II: Research Proposal 1 Credit

Prepare written research proposals for research projects. Define research topics, objectives of the research, specific goals, methodology, research plans and expected impact of the research.

##### BIOE 110 Elements of Bioengineering 4 Credits

An introduction to the fields of biotechnology and biomedical engineering. The areas include biomechanics, biomaterials, bioinstrumentation, medical imaging, rehabilitation engineering, biosensors, biotechnology and tissue engineering. Prerequisites as noted below.

**Prerequisites:** (BIOS 041 and BIOS 042)

##### BIOE 120 Biomechanics 3 Credits

Applications of mechanics to study behavior of anatomical structures and biological tissues of the musculoskeletal system. Specific topics include structure and function of biological tissues, mechanical properties of biological tissues, and analysis of specific tissues (i.e. bone, muscle, and soft connective tissues). Prerequisites as noted below.

**Prerequisites:** (MECH 003 or MECH 195 or MECH 002)

**Can be taken Concurrently:** MECH 003

##### BIOE 121 Biomechanics Lab Co-op 1 Credit

Applications of mechanics to study behavior of anatomical structures and biological tissues of the musculoskeletal system. Specific topics include structure and function of biological tissues, mechanical properties of biological tissues, and analysis of specific tissues (i.e. bone, muscle, and soft connective tissues). Prerequisites as noted below.

**Prerequisites:** (MECH 003 or MECH 002 or MECH 195)

**Can be taken Concurrently:** MECH 003

##### BIOE 132 Bioengineering Research 1 2 Credits

Research on a topic chosen by students, with the help of a faculty advisor from among the three bioengineering tracks (biopharmaceutical engineering, bioelectronic/biophotonics or cell and tissue engineering). Independent meetings with advising professor will track progress. Includes written report and oral presentation. Must have junior standing. Consent of instructor required.

##### BIOE 142 Bioengineering Research 2 2 Credits

Continuation of research initiated in BioE 132, Research 1. Topic chosen by student, with the help of a faculty advisor from among the three bioengineering tracks (biopharmaceutical engineering, bioelectronic/biophotonics or cell and tissue engineering). Independent meetings with advising professor will track progress. Includes written report and oral presentation. Prerequisites as noted below or consent of instructor.

**Prerequisites:** BIOE 132

##### BIOE 210 Introduction to Engineering Physiology 4 Credits

Mammalian physiology for bioengineering students, with an emphasis on control mechanisms and engineering principles. Basic cell function; biological control systems; muscle; neural; endocrine, circulatory, digestive, respiratory, renal, and reproductive systems; regulation of metabolism and defense mechanisms. Includes laboratory work. Prerequisites as noted below.

**Prerequisites:** (BIOS 041 and BIOS 042) and (BIOE 110)

##### BIOE 225 GMP Good manufacturing practice and regulatory affairs for bioengineers 1 Credit

Review of the principles of the Food and Drug Administration including its history, mission and applied regulations. Understanding of how the FDA works with industry and is integral to the development of new products and technologies. Review and critique of case studies in various parts of the biomedical industry to see how FDA regulations are applied. Validation and analysis of products using failure mode analysis.

**Prerequisites:** BIOE 110

##### BIOE 242 Bioengineering Research 3 1-4 Credit

Continuation of research initiated in BioE 132 and 142. Topic chosen by student, with a faculty advisor from among the three bioengineering tracks (biopharmaceutical engineering, bioelectronic/biophotonics or cell and tissue engineering). Written and oral reports approved by research advising professor will track progress. Prerequisites as noted below or consent of instructor.

**Prerequisites:** BIOE 142

##### BIOE 247 Biological Fluid Mechanics 4 Credits

Fluid and mass transport and their applications in biological systems. Mass conservation. Momentum and energy balances in fluid flow. Incompressible fluid flow with inviscid and viscous applications. Dimensional analysis. Fluid flow in pipes and porous media. Diffusion and convection. Prerequisites as noted below.

**Prerequisites:** MATH 205

##### BIOE 290 Bioengineering Thesis 1-3 Credit

Thesis, guided by a faculty advisor, based on work conducted in BioE 132, 142, 242, or in ENG 211, 212. Includes written report and oral presentation. Prerequisites as noted below or consent of instructor.

**Prerequisites:** BIOE 242 or ENGR 212

##### BIOE 300 Apprentice Teaching 1-4 Credit

**BIOE 308 Bioinformatics: Issues and Algorithms 3 Credits**

Computational problems and their associated algorithms arising from the creation, analysis, and management of bioinformatics data. Genetic sequence comparison and alignment, physical mapping, genome sequencing and assembly, clustering of DNA microarray results in gene expression studies, computation of genomic rearrangements and evolutionary trees. Credit will not be given for both BIOE 308 (CSE 308) and BIOE 408 (CSE 408). No prior background in biology is assumed. Prerequisites as noted below or consent of instructor.

**Prerequisites:** CSE 017 or CSE 018

**Attribute/Distribution:** ND

**BIOE 315 Bioengineering Statistics 3 Credits**

Advanced methods in probability and statistics applied to bioengineering problems focusing on modeling and data analysis. Topics include the following: types of data, types of distributions, parametric and nonparametric analyses, goodness-of-fit, regression, power analysis, and multivariate analysis, life models, simulation, cluster analysis, and Bayesian statistics. Special emphasis is placed on projects and case studies. Prerequisites as noted below.

**Prerequisites:** MATH 231

**BIOE 320 Biomedical Image Computing and Modeling 3 Credits**

Biomedical image modalities, image computing techniques, and imaging informatics systems. Understanding, using, and developing algorithms and software to analyze biomedical image data and extract useful quantitative information: Biomedical image modalities and formats; image processing and analysis; geometric and statistical modeling; image informatics systems in biomedicine. Credit will not be given for both BioE 320 and BioE 420. Prerequisites as noted below or consent of instructor.

**Prerequisites:** MATH 205 and CSE 109

**Attribute/Distribution:** ND

**BIOE 321 Biomolecular & Cellular Mechanics 3 Credits**

Mechanics and physics of the components of the cell, ranging in length scale from fundamental biomolecules to the entire cell. The course covers the mechanics of proteins and other biopolymers in 1D, 2D, and 3D structures, cell membrane structure and dynamics, and the mechanics of the whole cell. Prerequisites as noted below or consent of instructor.

**Prerequisites:** MATH 205 and MATH 231 and PHY 022 and (PHY 013 or PHY 021)

**Attribute/Distribution:** ND

**BIOE 324 Introduction to Organic Biomaterials 3 Credits**

Property, characterization, fabrication and modification of organic materials for biomedical and biological applications; host responses to biomaterials on the molecular, cellular and system level; general introduction to biosensors, drug delivery devices and tissue engineering. Prerequisites as noted below or consent of instructor.

**Prerequisites:** BIOE 110

**BIOE 325 Inorganic Biomaterials 3 Credits**

Fabrication methods for biomedical implants and devices. Selection of metals and ceramics with specific bulk and surface physical as well as chemical properties. The role of materials chemistry and microstructure. Biocompatibility. Case studies (dental and orthopedic implants, stents, nonporous ceramic filters for kidney dialysis). Prerequisites as noted below or consent of instructor.

**Prerequisites:** BIOE 110 or MAT 033

**BIOE 326 Biomimetic and Bio-enabled Materials 3 Credits**

The structure, function, properties and use of biopolymers, biocomposites, and biominerals. Biomimetic materials design, including colloids, interfaces, macromolecules, and applications of such materials. Environmental and ethical considerations, such as degradation products when using biomimetic materials. Closed to students who have taken BIOE 426 (MAT 426). Prerequisites as noted below.

**Prerequisites:** MAT 033 or BIOE 110

**Attribute/Distribution:** ND

**BIOE 331 Integrated Bioelectronics/Biophotonics Laboratory 2 Credits**

Experiments in design and analysis of bioelectronics circuits, micropatterning of biological cells, micromanipulation of biological cells using electric fields, analysis of pacemakers, instrumentation and computer interfaces, ultrasound, optic, laser tweezers and advanced imaging and optical microscopy techniques for biological applications. Prerequisites as noted below or consent of instructor.

**Prerequisites:** (ECE 081 or PHY 190) and (PHY 013 or PHY 021) and PHY 022

**Attribute/Distribution:** ND

**BIOE 335 BioFluid Mechanics of Physiological Systems 3 Credits**

Application of advanced fluid dynamic principles to physiological systems with emphasis on micron sized structures such as pulmonary airway/alveoli, small blood vessels and biological cells. Introduction to advanced topics relevant to the human body including a) oscillatory and transient flows in the cardiovascular and pulmonary systems b) non-Newtonian flows, c) surface tension driven flows, d) fluid-structure interactions, and e) cellular fluid mechanics.

**Prerequisites:** (MATH 205 and ME 231 and MATH 231)

**BIOE 339 Neuronal Modeling and Computation 3 Credits**

Neuroscience in a computational, mathematical, and engineering framework. Literature surveys and case studies with simulations. Computational aspects of information processing within the nervous system by focusing on single neuron modeling. Single neurons and how their biological properties relate to neuronal coding. Biophysics of single neurons, signal detection and signal reconstruction, information theory, population coding and temporal coding. Prerequisites as noted below.

**Prerequisites:** ENGR 001 and MATH 205

**BIOE 341 Biotechnology I 3 Credits**

Applications of material and energy balances; heat, mass, and momentum transfer; enzyme and microbial kinetics; and mathematical modeling to the engineering design and scale up of bioreactor systems. Closed to students who have taken BioE 441 (CHE 441). Prerequisites as noted below.

**Prerequisites:** (MATH 205 and CHE 031 and CHM 031)

**BIOE 342 Biotechnology II 3 Credits**

Engineering design and analysis of the unit operations used in the recovery and purification of products manufactured by the biotechnology industries. Requirements for product finishing and waste handling will be addressed. Consent of instructor required. Closed to students who have taken BIOE 442 (CHE 442). Prerequisites as noted below.

**Prerequisites:** CHE 031 and CHM 031

**BIOE 343 Integrated Biotechnology Laboratory 3 Credits**

Biosafety, sterilization, media formulation, biochemical and enzyme assays, recombinant DNA technique, protein and DNA isolation and purification, for microbial fermentation and animal cell culture. Integration of biotechnology techniques for biopharmaceutical production. Consent of instructor required. Prerequisites as noted below.

**Prerequisites:** BIOE 110 and (CHE 341 or BIOE 341)

**BIOE 344 Molecular Bioengineering 3 Credits**

Kinetics in small systems, stochastic simulation of biochemical processes, receptor-mediated adhesion, dynamics of ion-channels, ligand binding, biochemical transport, surface Plasmon resonance, DNA microarray design, and chemical approaches to systems biology. Prerequisites as noted below or senior standing in BIOE.

**Prerequisites:** (MATH 205 and MATH 231)

**BIOE 349 Metabolic Engineering 3 Credits**

Quantitative perspective of cellular metabolism and biochemical pathways. Methods for analyzing stoichiometric and kinetic models, mass balances, flux in reaction networks, and metabolic control. Solving problems using advanced mathematics and computer programming. Prerequisites as noted below.

**Prerequisites:** MATH 205 and MATH 231

**BIOE 350 Special Topics 1-4 Credit**

Special topics of study in bioengineering. Permission of Instructor.

**Repeat Status:** Course may be repeated.

**BIOE 357 Integrated Biostructural Mechanics Laboratory 2 Credits**  
Experimental manipulation and analysis of mammalian cells, with a focus on the biomechanical properties of cells, the interface of living and non-living materials, and on bioengineering applications. Experimental techniques include mammalian cell culture, advanced microscopy techniques, preparation of bioactive substrates, microfluidic device fabrication, micropatterning of cells and cell growth in 3D matrices. Consent of instructor required. Prerequisites as noted below.  
**Prerequisites:** BIOE 110

**BIOE 380 Biomolecular & Cellular Biophysics 3-4 Credits**  
Physical principles of biomolecular and cellular organization. Biomolecular interactions and recognition, molecular motors, physical organization and functioning of cellular membranes, electrical signaling in live cells. Modern techniques in biophysics, molecular spectroscopy, molecular modeling, fluorescence imaging, electrophysiology, electron microscopy.  
**Prerequisites:** (BIOS 115) and (PHY 013 or PHY 021)

**BIOE 408 Bioinformatics: Issues and Algorithms 3 Credits**  
Computational problems and their associated algorithms arising from the creation, analysis, and management of bioinformatics data. Genetic sequence comparison and alignment, physical mapping, genome sequencing and assembly, clustering of DNA microarray results in gene expression studies, computation of genomic rearrangements and evolutionary trees. This course, a version of 308 for graduate students requires advanced assignments. Credit will not be given for both BIOE 308 (CSE 308) and BIOE 408 (CSE 408). No prior background in biology is assumed. Prerequisites as noted below or consent of instructor.  
**Prerequisites:** CSE 017 or CSE 018  
**Attribute/Distribution:** ND

**BIOE 420 Biomedical Image Computing and Modeling 3 Credits**  
Biomedical image modalities, image computing techniques, and imaging informatics systems. Understanding, using, and developing algorithms and software to analyze biomedical image data and extract useful quantitative information: Biomedical image modalities and formats; image processing and analysis; geometric and statistical modeling; image informatics systems in biomedicine. This course, a graduate version of BioE 320, requires additional advanced assignments. Credit will not be given for both BioE 320 and BIOE 420. Prerequisites as noted below or consent of instructor.  
**Prerequisites:** MATH 205 and CSE 109  
**Attribute/Distribution:** ND

**BIOE 421 Biomolecular & Cellular Mechanics 3 Credits**  
Mechanics and physics of cell components, from fundamental biomolecules to the entire cell. The mechanics of proteins and other biopolymers in 1D, 2D, and 3D structures, cell membrane structure and dynamics, and the mechanics of the whole cell. This course is a graduate version of ChE 321 (BioE/Phy 321). The lecture content will be the same as in ChE 321 (BioE/Phy 321), but students enrolled in ChE 421 (BioE 421) will have more advanced assignments. Closed to students who have completed ChE 321 (BioE/Phy 321). Must have graduate standing or consent of instructor.

**BIOE 424 Introduction to Organic Biomaterials 3 Credits**  
Property, characterization, fabrication, and modification of organic materials for biomedical and biological applications; host responses to biomaterials on the molecular, cellular, and system level; general introduction to biosensors, drug delivery, and tissue engineering. Graduate version of BioE 324 requiring additional assignments. Credit is not given for both BioE 324 (MAT 324) and BioE 424 (MAT 424). Prerequisites as noted below or consent of instructor.  
**Prerequisites:** MAT 033

**BIOE 425 Inorganic Biomaterials 3 Credits**  
Fabrication methods for biomedical implants and devices. Selection of metals and ceramics with specific bulk and surface physical as well as chemical properties. Role of materials chemistry and microstructure. Biocompatibility. Case studies (dental and orthopedic implants, stents, nanoporous ceramic filters for kidney dialysis). Graduate version of BIOE 325 requiring additional assignments. Credit is not given for both BIOE 325 (MAT 325) and BIOE 425 (MAT 425). Prerequisites as noted below or consent of instructor.  
**Prerequisites:** MAT 033

**BIOE 426 Biomimetic and Bio-enabled Materials 3 Credits**  
This course is a graduate version of BIOE 326 (MAT 326). While the lecture content will be the same as the 300-level course, students enrolled in BIOE 426 (MAT 426) will have more advanced assignments. Closed to students who have taken BIOE 326 (MAT 326). Must have graduate standing in Bioengineering or Materials Science and Engineering, or consent of the instructor.  
**Attribute/Distribution:** ND

**BIOE 439 Neuronal Modeling and Computation 3 Credits**  
This course is a graduate version of BIOE 339 (CHE 339). While the lecture content will be the same as the 300-level course, students in the 400-level class will be expected to complete an independent term project. Closed to students who have completed BIOE 339 (CHE 339). Must have graduate standing in Bioengineering or Chemical Engineering, or consent of instructor.

**BIOE 441 Biotechnology I 3 Credits**  
See the course description listed for BioE 341. In order to receive 400-level credits, the student must do an additional, more advanced term project, as defined by the instructor at the beginning of the course. Closed to students who have taken BioE 341 (CHE 341).

**BIOE 442 Biotechnology II 3 Credits**  
See the course description listed for BIOE 342 (CHE 342). In order to receive 400-level credit, the student must do an additional, more advanced term project, as defined by the instructor at the beginning of the course. Closed to students who have taken BIOE 342 (CHE 342).

**BIOE 447 Molecular Bioengineering 3 Credits**  
This course is a graduate version of CHE 344 (BioE 344). While the lecture content will be the same as the 300-level course, students enrolled in CHE 447 will have more advanced assignments. Closed to students who have completed BioE 344 (CHE 344).

**BIOE 449 Metabolic Engineering 3 Credits**  
This course is a graduate version of BIOE 349. While the lecture content will be the same as the 300-level course, students enrolled in BIOE 449 (CHE 449) will have more advanced assignments. Closed to students who have completed BIOE 349. Must have graduate standing in Chemical Engineering or Bioengineering, or consent of instructor.

**BIOE 450 Special Topics 1-3 Credit**  
Special topics of study in bioengineering. Permission of instructor.

**BIOE 490 Thesis 1-6 Credit**  
**Repeat Status:** Course may be repeated.

**BIOE 499 Dissertation 1-12 Credit**

## Chemical Engineering

<http://www.che.lehigh.edu/blog/>

The mission of the undergraduate program is "to educate students in the scientific principles of chemical engineering and provide opportunities to explore their applications in the context of a humanistic education that prepares them to address technological and societal challenges."

Modern chemical engineering is built around the fundamentals enabling sciences of biology, chemistry, physics, and mathematics. Its curriculum encompasses three basic organizing principles: Molecular Transformations, Multi-scale Analysis, and System Approaches. Chemical engineers serve a wide variety of technical and managerial functions within the chemical processing industry. For a lifetime of effectiveness they need a sound background in the fundamental sciences of chemistry and physics; a working capability with mathematics, numerical methods, and application of computer solutions; and a broad education in humanities, social sciences,

and managerial techniques. These bases are applied in a sequence of chemical engineering courses in which logic and mathematical manipulation are applied to chemical processing problems. With the resulting habits of precise thought coupled to a broad base in scientific and general education, Lehigh graduates have been effective throughout industry and in advanced professional education. No effort is made toward any specific industry, but adaptation is rapid and the fundamental understanding forms the base for an expanding career.

The program is also designed to prepare a student for graduate study in chemical engineering. Further study at the graduate level leading to advanced degrees is highly desirable if an individual wishes to participate in the technical development of the field. The increasing complexity of modern manufacturing methods requires superior education for men and women working in research, development, and the design fields or for teaching.

To achieve its educational mission, the Department of Chemical Engineering has established the following set of Program Educational Objectives: Graduates of the Undergraduate Program in Chemical Engineering will:

1. Apply their broad education in chemical engineering to pursue careers in industry, government agencies, consulting firms, educational institutions, financial institutions, business, law, and medicine.
2. Pursue graduate studies, research, or continuing education.
3. Be sensitive to the social, ethical, and technical implications of their work as it affects the environment, safety, and health of citizens worldwide.

**Professors.** Hugo S. Caram, PhD (University of Minnesota Minneapolis); Mohamed S El-Aasser, MS (McGill University); Alice P. Gast, PhD (Princeton University); Tsai-An Hsu, PhD (Northwestern University); Anand Jagota, PhD (Cornell University); Andrew Klein, PhD (North Carolina State University); Mayuresh V. Kothare, PhD (California Institute of Technology); William L. Luyben, PhD (University of Delaware); Anthony J. McHugh, PhD (University of Delaware); Cesar A. Silebi, PhD (Lehigh University); Israel E. Wachs, PhD (Stanford University)

**Associate Professors.** Manoj K. Chaudhury, PhD (University at Buffalo, SUNY); James F. Gilchrist, PhD (Northwestern University); Steven McIntosh, PhD (University of Pennsylvania)

**Assistant Professors.** Bryan W. Berger, PhD (University of Delaware); Jeetain Mittal, PhD (University Texas Austin); Kelly Schultz, PhD (University of Delaware); Mark A Snyder, PhD (University of Delaware)

**Professors Of Practice.** Lori Herz, PhD (Rutgers University); Susan Fueshko Perry, BSBC (The Pennsylvania State University); Kemal Tuzla, PhD (Istanbul Technical University)

**Emeriti.** John C. Chen, PhD (University of Michigan Ann Arbor); Arthur E. Humphrey, MS (Massachusetts Institute of Technology); William E. Schiesser, PhD (Princeton University); Fred P. Stein, PhD (University Michigan Flint)

**Minor in Biotechnology**

The department of Chemical Engineering encourages engineering students to broaden their education by taking a minor. In this regard, a Biotechnology Minor is offered to students majoring in Engineering College. The Biotechnology minor requires 15 credit hours. A detailed listing of the required courses for the Biotechnology Minor can be obtained from the Chemical Engineering Department.

**Minor in Chemical Engineering**

Minor in Chemical Engineering provides students Chemical Engineering knowledge that they do not acquire in their major, such as knowledge of bio-chemical systems, transport phenomena, reaction engineering. This will widen their skills and help to increase the cooperation between the disciplines, which will lead to increased possibilities for employment.

**Physical Facilities**

The chemical engineering department is the only engineering department located on Lehigh's 780 acres Mountaintop Campus. Here the department occupies approximately one-third of Iacocca Hall, the

200,000-square-foot flagship building that contains offices, classrooms, and laboratories. Additional plant facilities, and the undergraduate chemical processing laboratory occupy approximately 10,000-square-feet in the nearby Imbt building.

These facilities provide excellent support for a wide range of general and special laboratory equipment for undergraduate and graduate studies of the behavior of typical chemical processing units; bioengineering research; nanotechnology; energy; biochemical engineering; polymers; digital computation for process dynamics study; and study of thermodynamics, kinetics, heat transfer, and mass transfer.

The chemical engineering department has established a senior design laboratory in Iacocca Hall featuring 25 PCs. In addition, a 10PC university maintained computing laboratory is available nearby.

**Career Opportunities**

Chemical engineers play important roles in all activities bearing on the chemical process industry. These include the functions of research, development, design, plant construction, plant operation and management, corporate planning, technical sales, and market analysis.

The industries that produce chemical and/or certain physical changes in fluids, including petroleum and petrochemicals, rubbers and polymers, pharmaceuticals, bioengineering, metals, industrial and fine chemicals, foods, and industrial gases, have found chemical engineers to be vital to their success. Chemical engineers are also important participants in pollution abatement, energy resources, national defense programs, and more recently in the manufacture of microelectronic devices and integrated circuits.

**Special Programs and Opportunities**

**Co-op Program**

The department, in conjunction with the College of Engineering and Applied Science, operates a cooperative program that is optional for specially selected students who are entering their junior year. This program affords early exposure to industry and an opportunity to integrate an academic background with significant periods of engineering practice. Our program is unique in offering two work experiences and still allowing the co-op students to graduate in four years with their class.

**OSI Program**

The Opportunities for Student Innovation (OSI) program seeks to develop students' propensities for critical assessment and innovative solution of meaningful problems. The OSI program affords selected seniors an opportunity to experience team research leading toward technological benefits. Some projects are hosted by industrial companies and carried out under the supervision of a Lehigh faculty members.

**Minors and Specializations**

Technical minors are available in biotechnology, energy engineering, computer science, environmental engineering, manufacturing systems, materials science and engineering, and polymer science and engineering. Minors are also available from the Business College and the College of Arts and Sciences.

**Overseas**

Study abroad is available in exchange programs that have been established by the department for the junior year at the University of Nottingham (United Kingdom) and for the summer following the junior year at the University of Dortmund (Germany). Please visit [http://www.che.lehigh.edu/blog/2007/01/undergraduate\\_program.html#more](http://www.che.lehigh.edu/blog/2007/01/undergraduate_program.html#more)

**Requirements of the Major**

131 credit hours are required for graduation with the degree of bachelor of science in chemical engineering.

**First Year**

First Semester	CR Second Semester	CR
ENGL 001	3 ENGL 002	3
MATH 021	4 MATH 022	4
ENGR 010	2 ENGR 010 or ECO 001	2-4
ENGR 005 or ECO 001	2-4 Select one of the following:	4-5
Select one of the following:	4-5 CHM 030 <sup>1</sup>	-

CHM 030 <sup>1</sup>	- PHY 011 & PHY 012 <sup>1</sup>	-
PHY 011 & PHY 012 <sup>1</sup>	-	-
	<b>15-18</b>	<b>13-16</b>
<b>Second Year</b>		
<b>First Semester</b>	<b>CR Second Semester</b>	<b>CR</b>
CHE 031	3 CHE 044	3
CHM 031	4 CHE 210	4
PHY 021 & PHY 022	5 CHE 179	1
MATH 023	4 MATH 205	3
	Electives	6
	<b>16</b>	<b>17</b>
<b>Third Year</b>		
<b>First Semester</b>	<b>CR Second Semester</b>	<b>CR</b>
CHE 151	3 CHE 244	3
CHE 201	4 CHE 211	3
CHM 110 & CHM 111	4 CHM 112	3
CHM 341	3 CHM 343	2
Electives	4 Electives	7
	<b>18</b>	<b>18</b>
<b>Fourth Year</b>		
<b>First Semester</b>	<b>CR Second Semester</b>	<b>CR</b>
CHE 202	3 CHE 203	2
CHE 233	3 ECE 083	3
CHE 242	3 CHE 234	3
Electives	6 Electives	7
	<b>15</b>	<b>15</b>

Total Credits: 127-133

1 Required natural science courses, one taken fall semester and the other taken in spring

There are six types of electives:

1. Humanities/Social Sciences: See the requirements (p. 293) set by the P.C. Rossin College of Engineering and Applied Science. Note that ECO 001 is required, as well as Freshman English.
2. Bio-Elective: Students must have AP BIOS credits or must pick one from BIOS 041, BIOE 349, CHE 341, or CHM 371.
3. Three credit hours from approved courses in other engineering departments (BioE, CEE, CSE, ECE, ISE, MEM, MSE).
4. Chemistry: 3 credit hours of CHM 300-level or higher, or CHE 380.
5. Chemical Engineering: 3 credit hours of CHE 300 level or higher.
6. Free electives: 6 credit hours in any subject area.

Electives in (2) to (5) above can be combined with any technical minor in RCEAS.

### Graduate Programs

The department of chemical engineering offers graduate programs leading to the master of science, master of engineering, and doctor of philosophy degrees in Chemical Engineering and master of engineering degree in Biological Chemical Engineering. The programs are all custom tailored for individual student needs and professional goals. These individual programs are made possible by a diversity of faculty interests that are broadened and reinforced by cooperation between the department and several research centers on the campus.

A free flow of personnel and ideas between the centers and academic departments ensures that the student will have the widest choice of research activities. The student is also exposed to a wide range of ideas and information through courses and seminars to which both faculty and center personnel contribute. In addition, strong relationships with industry are maintained by the department and the research centers, some of which operate industrially-sponsored liaison programs whereby

fundamental nonproprietary research is performed in areas of specific interest to participating sponsors.

While the department has interacted with most of the centers on campus, it has had unusually strong and continuing liaisons with Emulsion Polymers Institute, Process Modeling and Control Research Center, and Materials Research Center. The Department also has a strong relation with the Bioengineering Program.

In addition to interacting with the centers, the department originates and encourages programs that range from those that are classical chemical engineering to those that are distinctly interdisciplinary. The department offers active and growing programs in adhesion and tribology; emulsion polymerization and latex technology; bulk polymer systems; process control; process improvement studies; rheology; computer applications; environmental engineering; thermodynamics; kinetics and catalysis; enzyme technology; and biochemical engineering.

### Career Opportunities

Master of science, master of engineering, and doctor of philosophy graduates in the chemical engineering area are sought by industry for activities in the more technical aspects of their operations, especially design, process and product development, and research. Many of these graduates also find opportunities in research or project work in government agencies and in university teaching and research.

### Physical Facilities

The department is well equipped for research in bioengineering, nanotechnology, energy, colloids and surface science, adhesion and tribology, polymer science and engineering, catalysis and reaction kinetics, thermodynamic property studies, fluid dynamics, heat and mass transfer, process dynamics and control, and enzyme engineering and biochemical engineering.

The departmental and university computing facilities include PCs and workstations, connected by a university-wide high speed network, which in turn provides worldwide networking via the Internet.

All of these facilities can access a wide variety of general purpose, and scientific and engineering software via the university and local networks, including software specifically for the steady state and dynamic simulation of chemical engineering systems. The networks are extended as needed to ensure the chemical engineering department has access to the latest computing technology.

### Special Programs

Polymer Science and Engineering. The polymers activity includes work done in the Department of Chemical Engineering as well as the Departments of Chemistry, Materials Science, and Physics, the Materials Research Center, the Center for Polymer Science and Engineering, and the Emulsion Polymers Institute. More than 20 faculty members from these organizations or areas have major interests in polymers and cooperate on a wide range of research projects. For students with deep interest in the area, degree programs are available leading to the master of science, master of engineering, and doctor of philosophy degrees in polymer science and engineering.

There are three major polymer research thrusts in which chemical engineering students and faculty are involved. These are polymer colloids (latexes), polymer interfaces, and polymer materials. The Emulsion Polymers Institute, with strong industrial support, sponsors projects in the preparation of monosize polymer particles, in mechanisms and kinetics of emulsion, miniemulsion and dispersion polymerization, in latex particle morphology and film-formation, and in rheological properties of latexes and thickeners. The Engineering Polymers Laboratory investigates the behavior of bulk polymer materials, focusing on multicomponent polymers and composites.

### Distance Education

The Department offers some of its regular credit courses each semester via satellite and the World Wide Web for engineers in industry and government. These offerings, which are administered by the Distance Education Office, can lead to the Master of Engineering degree in Chemical Engineering or in Biological Chemical Engineering.



**Major Requirements**

Research Report or Thesis	6
CHE 400	3
CHE 410	3
CHE 415	4
CHE 452	3
<b>Total Credits</b>	<b>19</b>

Candidates for the Master of Engineering degree do not do research; all 30 credit hours are fulfilled by course work. Course selection is done individually for each student within the University requirements for a master's degree.

In addition to an approved course and thesis program, the Ph.D. student must pass a qualification examination given during the second year of residence.

**Courses****CHE 031 Material and Energy Balances of Chemical Processes 3 Credits**

Material and energy balances with and without chemical reaction. Introduction to phase equilibrium calculations. Applications in chemical process calculations and in design of staged separations: binary distillation, liquid-liquid extraction. Plant trips and special lectures introducing the profession. Prerequisites as noted below.

**Prerequisites:** (CHM 021 or CHM 095 or CHM 030 or CHM 040 or CHM 025) and (ENGR 001 or ENGR 097)

**Can be taken Concurrently:** ENGR 001, ENGR 097

**CHE 044 Fluid Mechanics 3 Credits**

Fluid mechanics and its applications to chemical processes. Momentum and energy balances in fluid flow. Dimensional analysis. Fluid flow in pipes, packed and fluidized beds. Mixing and agitation. Filtration and sedimentation.

**CHE 085 Undergraduate Research 1 Credit**

Independent study of a problem involving laboratory investigation, design, or theoretical studies under the guidance of a faculty. Consent of the department chair. The course may be repeated for up to 3 credits.

**CHE 151 Introduction to Heat Transfer 3 Credits**

Fundamental principles of heat transfer. Fourier's law. Conduction, convection and radiation. Analysis of steady and unsteady state heat transfer. Evaporation and condensation. Applications to the analysis and design of chemical processing units involving heat transfer. Prerequisites as noted below.

**Prerequisites:** CHE 044

**CHE 171 Fundamentals of Environmental Technology 4 Credits**

Introduction to water and air quality, water, air and soil pollution. Chemistry of common pollutants. Technologies for water purification, wastewater treatment, solid and hazardous waste management, environmental remediation, and air quality control. Global changes, energy and environment. Constraints of environmental protection on technology development and applications. Constraints of economic development on environmental quality. Environmental life cycle analysis and environmental policy. Not available to students in RCEAS.

**CHE 179 Professional Development 1 Credit**

Elements of professional growth, registration, ethics, and the responsibilities of engineers both as employees and as independent practitioners. Proprietary information and its handling. Patents and their importance. Discussions with the staff and with visiting Lecturers. A few plant trips.

**CHE 185 Undergraduate Research I 1-3 Credit**

Independent study of a problem involving laboratory investigation, design, or theoretical studies under the guidance of a faculty member. Can be repeated up to a total of three credits.

**CHE 186 Undergraduate Research II 1-3 Credit**

A continuation of the project begun under CHE 185. Can be repeated up to a total of three credits. Prerequisites as noted below or consent of department chair.

**Prerequisites:** (CHE 185)

**CHE 201 Methods of Analysis in Chemical Engineering 4 Credits**

Analytical and numerical methods of solution applied to dynamic, discrete and continuous chemical engineering processes. Laplace Transforms. MATLAB based computations. Methods of analysis applied to equilibrium, characteristic value and non-linear chemical engineering problems. Prerequisites as noted below.

**Prerequisites:** (CHE 044 and MATH 023)

**CHE 202 Chemical Engineering Lab I 3 Credits**

The laboratory study of chemical engineering unit operations and the reporting of technical results. One three-hour laboratory and one lecture period per week. Independent study and both group and individual reporting. Prerequisites as noted below.

**Prerequisites:** CHE 151

**CHE 203 Chemical Engineering Laboratory II 2 Credits**

Laboratory experience with more complex chemical processing situations including processes involving chemical reactions and those controlled automatically. Prerequisites as noted below.

**Prerequisites:** CHE 210 and CHE 244

**CHE 210 Chemical Engineering Thermodynamics 4 Credits**

Energy relations and their application to chemical engineering. Consideration of flow and nonflow processes. Evaluation of the effects of temperature and pressure on the thermodynamic properties of fluids. Heat effects accompanying phase changes and chemical reactions. Determination of chemical and physical equilibrium. Prerequisites as noted below.

**Prerequisites:** CHE 031

**CHE 211 Chemical Reactor Design 3 Credits**

The theory of chemical kinetics to the design and operation of chemical reactors. Plug flow and continuous stirred tank reactors. Homogeneous and heterogeneous reaction kinetics. Design of isothermal and adiabatic reactors. Prerequisites as noted below.

**Prerequisites:** CHE 210

**CHE 233 Process Design I 3 Credits**

Design of chemical plants incorporating traditional elements of engineering economics and synthesis of steady-state flowsheets with (1) both heuristic and rigorous optimization methods and (2) consideration of dynamic controllability of the process. Economic principles involved in the selection of process alternatives and determination of process capital, operating costs, and venture profitability. Energy conservation, pinch techniques, heat exchanger networks, and separation sequences. Considerations of market limitations, environmental and regulatory restrictions, and process safety. Use of modern computer aided software for steady-state and dynamic simulation and optimization. Group design projects. Prerequisites as noted below.

**Prerequisites:** (CHE 211 and CHE 242 and CHE 244)

**Can be taken Concurrently:** CHE 242

**CHE 234 Process Design II 3 Credits**

Continuation of CHE 233. Prerequisites as noted below.

**Prerequisites:** CHE 233

**Can be taken Concurrently:** CHE 233

**CHE 242 Introduction to Process Control and Simulation 3 Credits**

Dynamic simulation of chemical processes. Transfer functions and block diagrams. Introduction to process control equipment. Open-loop and closed-loop stability analysis using root locus and Nyquist techniques. Design of control systems. Prerequisites as noted below.

**Prerequisites:** (CHE 201 and CHE 151) and (ENGR 001 or ENGR 097)

**CHE 244 Mass Transfer and Separation Processes 3 Credits**

Diffusion, fluxes, and component conservation equations. Fick's law. Unsteady state diffusion. Convective mass transfer. Interphase mass transport coefficients. Design of multicomponent-distillation, absorption, extraction, and fixed-bed processes. Prerequisites as noted below.

**Prerequisites:** (CHE 031 and CHE 044)

**CHE 280 Unit Operations Survey 3 Credits**

The theory of heat, mass and momentum transport. Laminar and turbulent flow of real fluids. Heat transfer by conduction, convection and radiation. Application to a wide range of operations in the chemical and metallurgical process industries.

**CHE 281 Chemical Engineering Fundamentals I 4 Credits**

Fundamentals of material balances, fluid mechanics and heat transfer. Must have undergraduate degree in a scientific or engineering discipline or one semester undergraduate level general chemistry, one semester undergraduate level physics (statics and dynamics), and two semesters undergraduate calculus. Consent of department required.

**CHE 282 Chemical Engineering Fundamentals II 4 Credits**

Fundamentals of heat and mass transfer, process energy balances and unit operations. Consent of department required. Prerequisites as noted below.

**Prerequisites:** CHE 281

**CHE 283 Chemical Engineering Fundamentals III 4 Credits**

Fundamentals of thermodynamics, reaction kinetics and reactor analysis, and applied mathematics. Consent of department required. Prerequisites as noted below.

**Prerequisites:** CHE 282

**CHE 300 Apprentice Teaching 1-4 Credit**

**Repeat Status:** Course may be repeated.

**CHE 306 Introduction to Biomedical Engineering and Mathematical Biology 3 Credits**

Study of human physiology, including the cardiovascular, nervous and respiratory systems, and renal physiology. Mathematical analysis of physiological processes, including transport phenomena. Mathematical models of excitation and propagation in nerve. Biomechanics of the skeletal muscle system. Mathematical models in population dynamics and epidemiology. Independent study projects. Prerequisite as noted below.

**Prerequisites:** MATH 205

**CHE 321 Biomolecular & Cellular Mechanics 3 Credits**

Mechanics and physics of the components of the cell, ranging in length scale from fundamental biomolecules to the entire cell. The course covers the mechanics of proteins and other biopolymers in 1D, 2D, and 3D structures, cell membrane structure and dynamics, and the mechanics of the whole cell. Prerequisites as noted below or consent of instructor.

**Prerequisites:** MATH 205 and MATH 231 and PHY 022 and (PHY 013 or PHY 021)

**CHE 331 Separation Processes 3 Credits**

Industrial separation chemistry and processes. Computer solutions for simple and complex multicomponent distillation columns. Azeotropic and extractive distillation. Adsorption, ion exchange and chromatography in packed beds, moving beds and cyclic operation. Synthesis of polymer membrane and its applications to industrial separation processes.

**CHE 334 Electron Microscopy and Microanalysis 4 Credits**

Fundamentals and experimental methods in electron optical techniques including scanning electron microscopy (SEM) conventional transmission (TEM) and scanning transmission (STEM) electron microscopy. Specific topics covered will include electron optics, electron beam interactions with solids, electron diffraction and chemical microanalysis. Applications to the study of the structure of materials are given. Consent of department chair required.

**CHE 339 Neuronal Modeling and Computation 3 Credits**

Neuroscience in a computational, mathematical, and engineering framework. Literature surveys and case studies with simulations. Computational aspects of information processing within the nervous system by focusing on single neuron modeling. Single neurons and how their biological properties relate to neuronal coding. Biophysics of single neurons, signal detection and signal reconstruction, information theory, population coding and temporal coding. Prerequisites as noted below.

**Prerequisites:** ENGR 001 and MATH 205

**CHE 341 Biotechnology I 3 Credits**

Applications of material and energy balances; heat, mass, and momentum transfer; enzyme and microbial kinetics; and mathematical modeling to the engineering design and scale-up of bio-reactor systems. Consent of instructor required. Closed to students who have taken CHE 441 (BIOE 341 and 441). Prerequisites as noted below.

**Prerequisites:** (MATH 205 and CHE 031 and CHM 031)

**CHE 342 Biotechnology II 3 Credits**

Engineering design and analysis of the unit operations used in the recovery and purification of products manufactured by the biotechnology industries. Requirements for product finishing and waste handling will be addressed. Consent of instructor required. Closed to students who have taken CHE 442 (BIOE 342 and 442). Prerequisites as noted below.

**Prerequisites:** CHE 031 and CHM 031

**CHE 344 Molecular Bioengineering 3 Credits**

Kinetics in small systems, stochastic simulation of biochemical processes, receptor-mediated adhesion, dynamics of ion-channels, ligand binding, biochemical transport, surface Plasmon resonance, DNA microarray design, and chemical approaches to systems biology. Prerequisites as noted below or senior standing in ChE.

**Prerequisites:** MATH 205 and MATH 231

**CHE 346 Biochemical Engineering Laboratory 3 Credits**

Laboratory and pilot-scale experiments in fermentation and enzyme technology, tissue culture, and separations techniques. Consent of instructor required. Closed to students who have taken CHE 446. Prerequisites as noted below.

**Prerequisites:** CHE 341

**Can be taken Concurrently:** CHE 341

**CHE 350 Special Topics 1-3 Credit**

A study of areas in chemical engineering not covered in courses presently listed in the catalog. May be repeated for credit if different material is presented.

**Repeat Status:** Course may be repeated.

**CHE 373 Fundamentals of Air Pollution 3 Credits**

Introduction to the problems of air pollution including such topics as: sources and dispersion of pollutants; sampling and analysis; technology of economics and control processes; legislation and standards. Must have senior standing in the College of Engineering and Applied Science.

**CHE 374 Environmental Catalysis 3 Credits**

Pollution emissions in the USA (NO<sub>x</sub>, SO<sub>x</sub>, NH<sub>3</sub>, CO, VOCs, PM, heavy metals and persistent bioaccumulative chemicals) and their sources and fate. Fundamental concepts of catalysis (surface and their characterization, physical adsorption, surface reaction mechanisms and their kinetics). Application of catalysis to a wide range of environmental issues (catalytic combustion of VOCs, automotive catalytic converter, selective catalytic conversion of NO<sub>x</sub>, etc.) Must have senior standing. Consent of instructor required.

**CHE 375 Environmental Engineering Processes 3 Credits**

Processes applied in environmental engineering for air pollution control, treatment of drinking water, municipal wastewater, industrial wastes, hazardous/toxic wastes, and environmental remediation. Kinetics, reactor theory, mass balances, application of fundamental physical, chemical and biological principles to analysis and design. Prerequisites as noted below.

**Prerequisites:** CEE 170

**CHE 376 Energy: Issues & Technology 3 Credits**

Energy usage and supply, fossil fuel technologies, renewable energy alternatives and environmental impacts. The scope will be broad to give some perspective of the problems, but in-depth technical analysis of many aspects will also be developed. Must have college-level introductory courses in chemistry, physics and mathematics. Consent of instructor required.

**CHE 380 Senior Research Project (OSI) 1-6 Credit**

Independent study of a problem involving laboratory investigation, design, and theory, when possible involves one of the local communities or industries. Team work under the guidance of Faculty advisors. Experiential learning opportunity to bridge educational gap between conventional textbook learning and industrial approaches to real-world technical problem solving. Must have senior standing. Consent of department required. The course may be repeated for up to six credits.

**Repeat Status:** Course may be repeated.

**CHE 386 Process Control 3 Credits**

Open-loop and closed-loop stability analysis using root locus and Nyquist techniques, design of feedback controllers with time and frequency domain specifications. Experimental process identification. Control of multivariable processes. Introduction to sampled-data control theory. Prerequisites as noted below.

**Prerequisites:** CHE 242

**CHE 387 Digital Control 3 Credits**

Sampled-data systems; z-transforms; pulse transfer functions; stability in the z-plane; root locus and frequency response design methods; minimal prototype design; digital control hardware; discrete state variables; state transition matrix; Liapunov stability state feedback control (2 lectures and one laboratory per week). Prerequisites as noted below or consent of instructor.

**Prerequisites:** CHE 386 or ECE 212 or ME 343

**CHE 388 Polymer Synthesis and Characterization Laboratory 3 Credits**

Techniques include: free radical and condensation polymerization; molecular weight distribution by gel chromatography; crystallinity and order by differential scanning calorimetry; pyrolysis and gas chromatography; dynamic mechanical and dielectric behavior; morphology and microscopy; surface properties. Must have senior level standing in CHE, CHM or MAT, or consent of the instructor.

**Prerequisites:** (CHM 187 or CHM 189 or CHM 341 and CHM 051 or CHM 110)

**CHE 389 Control Systems Laboratory 2 Credits**

Experiments on a variety of mechanical, electrical and chemical dynamic control systems. Exposure to state-of-the-art control instrumentation: sensors, transmitters, control valves, analog and digital controllers. Emphasis on comparison of theoretical computer simulation predictions with actual experimental data. Lab teams will be interdisciplinary. Prerequisites as noted below.

**Prerequisites:** CHE 242 or ECE 212 or ME 343

**CHE 391 Colloid and Surface Chemistry 3 Credits**

Physical chemistry of everyday phenomena. Intermolecular forces and electrostatic phenomena at interfaces, boundary tensions and films at interfaces, mass and charge transport in colloidal suspensions, electrostatic and London forces in disperse systems, gas adsorption and heterogeneous catalysis. Consent of instructor required.

**CHE 392 Introduction to Polymer Science 3 Credits**

Introduction to concepts of polymer science. Kinetics and mechanism of polymerization, synthesis and processing of polymers, characterization. Relationship of molecular conformation, structure and morphology to physical and mechanical properties. Prerequisites as noted below.

**Prerequisites:** CHM 187

**CHE 393 Physical Polymer Science 3 Credits**

Structural and physical aspects of polymers (organic, inorganic, natural). Molecular and atomic basis for polymer properties and behavior. Characteristics of glassy, crystalline, and paracrystal-line states (including viscoelastic and relaxation behavior) for single- and multi-component systems. Thermodynamics and kinetics of transition phenomena. Structure, morphology, and behavior. Must have senior level standing in CHE, CHEM, or MAT, or consent of the instructor.

**CHE 394 Organic Polymer Science I 3 Credits**

Organic chemistry of synthetic high polymers. Polymer nomenclature, properties, and applications. Functionality and reactivity of monomers and polymers. Mechanism and kinetics of step-growth and chain-growth polymerization in homogenous and heterogenous media. Brief description of emulsion polymerization, ionic polymerization, and copolymerization. Must have completed one year of physical chemistry and one year of organic chemistry.

**CHE 400 Chemical Engineering Thermodynamics 3 Credits**

Applications of thermodynamics in chemical engineering. Topics include energy and entropy, heat effects accompanying solution, flow of compressible fluids, refrigeration including solution cycles, vaporization and condensation processes, and chemical equilibria. Must have completed an introductory course in thermodynamics.

**CHE 401 Chemical Engineering Thermodynamics II 3 Credits**

A detailed study of the uses of thermodynamics in predicting phase equilibria in solid, liquid, and gaseous systems. Fugacities of gas mixtures, liquid mixtures, and solids. Solution theories; uses of equations of state; high-pressure equilibria.

**CHE 410 Chemical Reaction Engineering 3 Credits**

The application of chemical kinetics to the engineering design and operation of reactors. Non-isothermal and adiabatic reactions. Homogeneous and heterogeneous catalysis. Residence time distribution in reactors.

**CHE 413 Heterogeneous Catalysis and Surface Characterization 3 Credits**

History and concepts of heterogeneous catalysis. Surface characterization techniques, and atomic structure of surfaces and adsorbed monolayers. Kinetics of elementary steps (adsorption, desorption, and surface reaction) and overall reactions. Catalysis by metals, metal oxides, and sulfides. Industrial applications of catalysis: selective oxidation, pollution control, ammonia synthesis, hydrogenation of carbon monoxide to synthetic fuels and chemicals, polymerization, hydrotreating, and cracking.

**CHE 415 Transport Processes 4 Credits**

A combined study of the fundamentals of momentum transport, energy transport and mass transport and the analogies between them. Evaluation of transport coefficients for single and multicomponent systems. Analysis of transport phenomena through the equations of continuity, motion, and energy. Prerequisites as noted below.

**Prerequisites:** CHE 461 or ENGR 452 or CHE 452

**CHE 419 Asymptotic Methods in the Engineering Sciences 3 Credits**

Introductory level course with emphasis on practical applications. Material covered includes: Asymptotic expansions. Regular and singular perturbations; algebraic problems. Asymptotic matching. Boundary value problems; distinguished limits. Multiple scale expansion. W.K.B. Theory. Non-linear wave equations.

**CHE 421 Biomolecular & Cellular Mechanics 3 Credits**

Mechanics and physics of cell components, from fundamental biomolecules to the entire cell. The mechanics of proteins and other biopolymers in 1D, 2D, and 3D structures, cell membrane structure and dynamics, and the mechanics of the whole cell. This course is a graduate version of ChE 321 (BioE/Phy 321). The lecture content will be the same as in ChE 321 (BioE/Phy 321), but students enrolled in ChE 421 (BioE 421) will have more advanced assignments. Closed to students who have completed ChE 321 (BioE/Phy 321). Must have graduate standing or consent of instructor.

**CHE 428 Rheology 3 Credits**

An intensive study of momentum transfer in elastic viscous liquids. Rheological behavior of solution and bulk phase polymers with emphasis on the effect of molecular weight, molecular weight distribution and branching. Derivation of constitutive equations based on both molecular theories and continuum mechanics principles. Application of the momentum equation and selected constitutive equations to geometries associated with viscometric flows. Consent of instructor required.

**Prerequisites:** CHE 461 or CHE 452

**CHE 430 Mass Transfer 3 Credits**

Theory and developments of the basic diffusion and mass transfer equations and transfer coefficients including simultaneous heat and mass transfer, chemical reaction and dispersion effects. Applications to various industrially important operations including continuous contact mass transfer, absorption, humidification, etc. Brief coverage of equilibrium stage operations as applied to absorption and to binary and multicomponent distillation.

**CHE 433 State Space Control 3 Credits**

State-space methods of feedback control system design and design optimization for invariant and time-varying deterministic, continuous systems; pole positioning, observability, controllability, modal control, observer design, the theory of optimal processes and Pontryagin's Maximum Principle, the linear quadratic optimal regulator problem, Lyapunov functions and stability theorems, linear optimal open-loop control; introduction to the calculus of variations; introduction to the control of distributed parameter systems. Intended for engineers with a variety of backgrounds. Examples will be drawn from mechanical, electrical and chemical engineering applications. Prerequisites as noted below or consent of instructor.

**Prerequisites:** CHE 386 or ME 343 or ECE 212

**CHE 434 Multivariable Process Control 3 Credits**

A state-of-the-art review of multivariable methods of interest to process control applications. Design techniques examined include loop interaction analysis, frequency domain methods (Inverse Nyquist Array, Characteristic Loci and Singular Value Decomposition) feed forward control, internal model control and dynamic matrix control. Special attention is placed on the interaction of process design and process control. Most of the above methods are used to compare the relative performance of intensive and extensive variable control structures. Prerequisites as noted below or consent of instructor.

**Prerequisites:** CHE 433 or ME 433 or ECE 433

**CHE 436 Systems Identification 3 Credits**

The determination of model parameters from time history and frequency response data by graphical, deterministic and stochastic methods. Examples and exercises taken from process industries, communications and aerospace testing. Regression, quasilinearization and invariant-embedding techniques for nonlinear system parameter identification included.

**CHE 437 Stochastic Control 3 Credits**

Linear and nonlinear models for stochastic systems. Controllability and observability. Minimum variance state estimation. Linear quadratic Gaussian control problem. Computational considerations. Nonlinear control problem in stochastic systems. Prerequisites as noted below or consent of instructor.

**Prerequisites:** CHE 433 or ME 433 or ECE 433

**CHE 438 Process Modeling and Control Seminar 1 Credit**

Presentations and discussions on current methods, approaches, and applications. Credit cannot be used for the M.S. degree.

**CHE 439 Neuronal Modeling and Computation 3 Credits**

This course is a graduate version of CHE 339 (BIOE 339). While the lecture content will be the same as the 300-level course, students in the 400-level class will be expected to complete an independent term project. Closed to students who have completed CHE 339 (BIOE 339). Must have graduate standing in Chemical Engineering or Bioengineering, or consent of instructor.

**CHE 440 Chemical Engineering in the Life Sciences 3 Credits**

Introduction of important topics in life sciences to chemical engineers. Topics include protein and biomolecule structures and characterization, recombinant DNA technology, immunoaffinity technology, combinatorial chemistry, metabolic engineering, bioinformatics. Must have Bachelor's degree in science or engineering.

**CHE 441 Biotechnology I 3 Credits**

See the course description listed for CHE 341 (BIOE 341). In order to receive 400-level credits, the student must do an additional, more advanced term project, as defined by the instructor at the beginning of the course. Closed to students who have taken CHE 341 (BIOE 341).

**CHE 442 Biotechnology II 3 Credits**

See the course description listed for CHE 342 (BIOE 342). In order to receive 400-level credits, the student must do an additional, more advanced term project, as defined by the instructor at the beginning of the course. Closed to students who have taken CHE 342 (BIOE 342).

**CHE 444 Bioseparations 3 Credits**

Separation techniques for biomolecule isolation and purification. Theory and problems of bioaffinity chromatography, electromigration processes, and aqueous two-phase polymer extraction systems. Engineering principles for scaling-up bioseparation processes. Consent of instructor required.

**CHE 446 Biochemical Engineering Laboratory 3 Credits**

Laboratory and pilot-scale experiments in fermentation and enzyme technology, tissue culture, and separations techniques. Closed to students who have taken CHE 346. Prerequisites as noted below.

**Prerequisites:** CHE 341 or CHE 444 or CHE 342

**Can be taken Concurrently:** CHE 342

**CHE 447 Molecular Bioengineering 3 Credits**

This course is a graduate version of CHE 344 (BIOE 344). While the lecture content will be the same as the 300-level course, students enrolled in CHE 444 will have more advanced assignments. Closed to students who have completed CHE 344 (BIOE 344).

**CHE 448 Topics in Biochemical Engineering 3 Credits**

Analysis, discussion, and review of current literature for a topical area of biotechnology. Course may be repeated for credit with the consent of the instructor. Consent of instructor required.

**CHE 449 Metabolic Engineering 3 Credits**

Quantitative perspective of cellular metabolism and biochemical pathways. Methods for analyzing stoichiometric and kinetic models, mass balances, flux in reaction networks, and metabolic control. Solving problems using advanced mathematics and computer programming. Closed to students who have completed BIOE 349. Must have graduate standing in Chemical Engineering or Bioengineering or consent of instructor.

**CHE 450 Special Topics 1-12 Credit**

An intensive study of some field of chemical engineering not covered in the more general courses. Credit above three hours is granted only when different material is covered.

**CHE 451 Problems In Research 1 Credit**

Study and discussion of optimal planning of experiments and analysis of experimental data. Discussion of more common and more difficult techniques in the execution of chemical engineering research.

**CHE 452 Mathematical Methods in Engineering 3 Credits**

Analytical techniques relevant to the engineering sciences are described. Vector spaces; eigenvalues; eigenvectors. Linear ordinary differential equations; diagonalizable and non-diagonalizable systems. Inhomogeneous linear systems; variation of parameters. Non-linear systems; stability; phase plane. Series solutions of linear ordinary differential equations; special functions. Laplace and Fourier transforms; application to partial differential equations and integral equations. Sturm-Liouville theory. Finite Fourier transforms; planar, cylindrical, and spherical geometries.

**CHE 453 Teaching Apprentice 1 Credit**

Students will work under the guidance of individual Faculty instructors to participate in some of the following teaching tasks: Development of the course syllabus, preparation and grading of homework and exams, holding a recitation and/or lecture section. Must have graduate standing in ChE department. Course may be repeated for up to three credits.

**CHE 454 Seminar 3 Credits**

sCritical discussion of recent advances in chemical engineering.

**CHE 455 Seminar 1-3 Credit**

Critical discussion of recent advances in chemical engineering. Credit above one hour is granted only when different material is covered.

**CHE 460 Chemical Engineering Project 1-6 Credit**

An intensive study of one or more areas of chemical engineering, with emphasis on engineering design and applications. A written report is required. May be repeated for credit.

**CHE 461 Mathematical Methods in Chemical Engineering 3 Credits**

Solution of chemical engineering problems with emphasis on chemical reactions and transport phenomena. Specific topics include Linear Vector Spaces; Eigenvalues, Eigenvectors and Eigenfunctions; Bessel and Legendre Functions; Green's Functions, Sturm-Louisville Problems, Qualitative and Quantitative Methods for Nonlinear Ordinary Differential Equations; Phase Plane; Separation of Variables; Fourier Transform Methods; Method of Characteristics. Example problems from the chemical engineering literature.

**CHE 464 Numerical Methods in Engineering 3 Credits**

See the course description listed for CHE 364. In order to receive 400-level credits the student must do an additional, more advanced term project, as defined by the instructor at the beginning of the course.

**CHE 473 Environmental Separation and Control 3 Credits**

Theory and application of adsorption, ion exchange, reverse osmosis, air stripping and chemical oxidation in water and wastewater treatment. Modeling engineered treatment processes. Prerequisites as noted below or consent of instructor.

**Prerequisites:** CEE 470

**CHE 480 Research 3 Credits**

Investigation of a problem in chemical engineering.

**CHE 481 Research 3 Credits**

Continuation of CHE 480.

**CHE 482 Mechanical Behaviors of Polymers 3 Credits**

Mechanical behavior of polymers. Characterization of viscoelastic response with the aid of mechanical model analogs. Time-temperature superposition, experimental characterization of large deformation, and fracture processes, polymer adhesion. Effects of fillers, plasticizers, moisture, and aging on mechanical behavior.

**CHE 483 Emulsion Polymers 3 Credits**

Examination of fundamental concepts important in the manufacture, characterization, and application of polymer latexes. Topics to be covered will include colloidal stability, polymerization mechanisms and kinetics, reactor design, characterization of particle surfaces, latex rheology, morphology considerations, polymerization with functional groups, film formation and various application problems.

**CHE 485 Polymer Blends and Composites 3 Credits**

Synthesis, morphology, and mechanical behavior of polymer blends and composites. Mechanical blends, block and graft copolymers, interpenetrating polymer networks, polymer impregnated concrete, and fiber and particulate reinforced polymers are emphasized. Must have completed any introductory course in polymers.

**CHE 486 Polymer Processing 3 Credits**

Application of fundamental principles of mechanics, fluid dynamics and heat transfer to the analysis of a wide variety of polymer flow processes. A brief survey of the rheological behavior of polymers is also included. Topics include pressurization, pumping, die forming, calendaring, coating, molding, fiber spinning and elastic phenomena.

**CHE 490 Thesis 1-6 Credit****CHE 492 Topics in Polymer Science 3 Credits**

Intensive study of topic selected from areas of current research interest such as morphology and mechanical behavior, thermodynamics and kinetics of crystallization, new analytical techniques, molecular weight distribution, non-Newtonian flow behavior, second order transition phenomena, novel polymer structures. Credit above three hours is granted only when different material is covered. Prerequisites as noted below.

**Prerequisites:** CHE 392 or CHE 392 or CHM 392 or CHM 392

**CHE 499 Dissertation 1-15 Credit**

**Repeat Status:** Course may be repeated.

**Civil and Environmental Engineering****Civil Engineering**

Civil engineering occupies a prominent position as one of the major fields in the engineering profession. Civil engineers are concerned with all aspects of the conception, planning, design, construction, operation, and maintenance of major physical works and facilities that are essential

to modern life. Civil engineering projects are typically characterized by extreme size, complexity, durability, and cost. Examples include bridges, buildings, transportation facilities, tunnels, coastal facilities, dams, foundations, and waterways.

The **Mission** of our Civil Engineering Bachelor of Science degree program is to educate students in the principles and methods essential to the practice and advancement of civil and environmental engineering. Our goal is to prepare students to apply and continually cultivate knowledge that will enable them to become successful practitioners, innovators and leaders in serving the needs of a complex society.

The **Program Educational Objectives** of our accredited Civil Engineering Bachelor of Science program are to prepare Civil Engineering Graduates to :

1. Develop careers in civil engineering and other professionally related fields.
2. Seek additional professional training and personal development.
3. Apply their skills to develop innovative solutions and technologies.
4. Pursue professional licensure and/or certification.
5. Advance to become members of professional societies and future leaders in their profession.

To achieve the program education objectives, the civil engineering program has adopted the following eleven ABET student outcomes:

- An ability to apply knowledge of mathematics, science, and engineering
- An ability to design and conduct experiments, as well as to analyze and interpret data
- An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
- An ability to function on multidisciplinary teams
- An ability to identify, formulate, and solve engineering problems
- An understanding of professional and ethical responsibility
- An ability to communicate effectively
- The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
- A recognition of the need for, and an ability to engage in life-long learning
- A knowledge of contemporary issues
- An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

**Environmental Engineering**

Environmental Engineering is an interdisciplinary branch of the engineering profession where science and engineering principles are combined to provide healthy soil, water and air; remediate contaminated sites; and to improve the overall quality of the environment through the development of sustainable processes. Example activities include design of water and wastewater treatment facilities, detecting and modeling fate and transport of contaminants in both natural and engineered environments; developing technology-based solutions for restoring environmental quality; and developing and/or modifying industrial processes for ecological preservation and enhanced sustainability.

The **Mission** of our Environmental Engineering Bachelor of Science degree program is to educate students in the principles and methods essential to the practice and advancement of the interdisciplinary field of environmental engineering. The program is proactive and continues to incorporate new and emerging paradigms in all aspects of teaching and education while maintaining rigorous standards in traditional approaches to engineered solutions of environmental problems. Graduates of the program possess technical expertise required to maintain a healthy balance between societal welfare, economic growth and the environment surrounding us.

The **Program Educational Objectives** of our accredited Environmental Engineering Bachelor of Science program are to prepare environmental engineering graduates to:

1. Develop careers in environmental engineering and other professionally related fields.
2. Seek additional professional training and personal development.
3. Apply their skills to develop innovative solutions and technologies.
4. Pursue professional licensure and/or certification.
5. Advance to become members of professional societies and future leaders in their profession.

To achieve the program education objectives, the environmental engineering program has adopted the following eleven ABET student outcomes:

- An ability to apply knowledge of mathematics, science, and engineering
- An ability to design and conduct experiments, as well as to analyze and interpret data
- An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
- An ability to function on multidisciplinary teams
- An ability to identify, formulate, and solve engineering problems
- An understanding of professional and ethical responsibility
- An ability to communicate effectively
- The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
- A recognition of the need for, and an ability to engage in life-long learning
- A knowledge of contemporary issues
- An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

#### Educational and Career Opportunities

In each curriculum, emphasis is placed on the development of a solid knowledge of civil or environmental engineering fundamentals. Both undergraduate programs include a strong base of mathematics, including calculus, probability and statistics, and the physical sciences, followed by a course in planning and engineering economics. A broad range of required and elective courses in engineering science, analysis and design in the areas listed above meet each set of program objectives. Elective courses in both programs extend across the areas of structural, geotechnical, hydraulic, environmental, construction, project management, and transportation engineering. Additional elective courses in the environmental program are available from chemical engineering, chemistry, biology, and earth and environmental science. Five-year programs are available for students interested in a second bachelor's degree in a major in the College of Arts and Sciences (see listings under Arts-Engineering (p. 296); Civil Engineering and Earth and Environmental Sciences (p. 318)).

The civil and environmental engineering programs prepare individuals for entry into the engineering profession or for entry into high-quality programs of graduate study. With proper selection of electives, students may also prepare for entrance into schools of law or medicine, or into master's-level programs in engineering management or business administration.

For additional useful information visit our departmental website [www.lehigh.edu/~incee/](http://www.lehigh.edu/~incee/).

**Professors.** Panayiotis Diplas, PhD (University of Minnesota Duluth); Dan M. Frangopol, PhD (Universite de Liege); Gerard P. Lennon, PhD (Cornell University); Sibel Pamukcu, PhD (Louisian State University); Stephen P. Pessiki, PhD (Cornell University); James M. Ricles, PhD (University Texas Austin); Richard Sause, Jr., PhD (University of California Berkeley); Arup K. Sengupta, PhD (University of Houston University Park); Richard N. Weisman, PhD (Cornell University); John L. Wilson, PhD (University of Pittsburgh)

**Associate Professors.** Derick G. Brown, PhD (Princeton University); Kristen Jellison, PhD (Massachusetts Institute of Technology); Peter Mueller, DSC (ETH Zurich); Clay Joshua Naito, PhD (University of California Berkeley)

**Assistant Professors.** Paolo Bocchini, PhD (University of Bologna); John Thomas Fox, PhD (The Pennsylvania State University); Shamim N. Pakzad, PhD (University of California Berkeley); Spencer E. Quiel, PhD (Princeton University); Muhannad T. Suleiman, PhD (Iowa State University); Tara Jeanne Troy, PhD (Princeton University)

**Professors Of Practice.** Jennifer H. Gross, MS (University Texas Austin); Mesut Pervizpour, PhD (Lehigh University)

**Emeriti.** John Hartley Daniels, PhD (Lehigh University); Hsai-Yang Fang, PhD (West Virginia Univ); John W. Fisher, PhD (Lehigh University); Ti Huang, PhD (University of Michigan Ann Arbor); Le-Wu Lu, PhD (Lehigh University); Alexis Ostapenko, SCD (Massachusetts Institute of Technology); Robert M. Sorensen, PhD (University of California Berkeley); David A. Van Horn, PhD (Iowa State University); Ben T. Yen, PhD (Lehigh University)

- Civil Engineering
- Environmental Engineering
- Technical Minor in Environmental Engineering

#### B.S. in Civil Engineering

##### Required Courses

A total of 130 credit hours are required for graduation with the degree of Bachelor of Science in Civil Engineering.

##### Recommended Sequence of Courses

The HSS Advanced Requirement of 13 credits is shown below as three 3-credit courses and one 4-credit course. Other options are possible.

#### First Year

First Semester	CR	Second Semester	CR
ENGL 001		3 ENGL 002	3
MATH 021		4 CHM 030	4
ENGR 005		2 MATH 022	4
PHY 011 & PHY 012		5 ENGR 010	2
		ECO 001	4
		<b>14</b>	<b>17</b>

#### Second Year

First Semester	CR	Second Semester	CR
MATH 023		4 MATH 205	3
CEE 003		3 CEE 059	3
CEE 010		3 PHY 021 & PHY 022	5
CEE 011		1 CEE 170	4
CEE 012		2 FE Free Elective	3
HSS Humanities/Social Sciences Elective		3	
		<b>16</b>	<b>18</b>

#### Third Year

First Semester	CR	Second Semester	CR
CEE 121		3 CEE 117	2
CEE 123		3 CEE 202	3
CEE 142		3 CEE 262 or 264	3
CEE 159		4 CEE 222	3
BSE Basic Science Elective <sup>1</sup>		3 CEE 242	3
		AE CEE Approved Elective <sup>2</sup>	3
		<b>16</b>	<b>17</b>

#### Fourth Year

First Semester	CR	Second Semester	CR
CEE 203		2 CEE 290 <sup>3</sup>	3

HSS Humanities/Social Sciences Elective	7 HSS Humanities/Social Science Elective	3
AE CEE Approved Electives <sup>2</sup>	8 AE CEE Approved Electives <sup>2</sup>	6
	FE Free Elective	3
	<b>17</b>	<b>15</b>

Total Credits: 130

- Basic Science Elective  
ASTR 007, ASTR 105, ASTR 301, ASTR 302, ASTR 332, ASTR 342, BIOS 010, BIOS 041, EES 011, EES 021, EES 024, EES 025, EES 026, EES 027, EES 028, EES 031, EES 032, EES 089
- Seventeen CEE elective credits approved by the CEE department; list available from department.
- Students must have completed successfully at least one CEE approved elective related to the design project topic area.

The selection of elective courses is to be in consultation with student's academic adviser in the Department of Civil and Environmental Engineering.

### B.S. in Environmental Engineering

#### Required Courses

A total of 130 credit hours are required for graduation with the degree Bachelor of Science in Environmental Engineering.

#### Recommended Sequence of Courses

The HSS Advanced Requirement of 13 credits is shown below as three 3-credit courses and one 4-credit course. Other options are possible.

#### First Year

First Semester	CR Second Semester	CR
ENGL 001	3 ENGL 002	3
MATH 021	4 MATH 022	4
CHM 030	4 PHY 011 & PHY 012	5
ENGR 005	2 ENGR 010	2
FE Free Elective	3	
	<b>16</b>	<b>14</b>

#### Second Year

First Semester	CR Second Semester	CR
MATH 023	4 MATH 205	3
CHM 110 & CHM 111	4 PHY 021 & PHY 022	5
CEE 012	2 CEE 170	4
ECO 001	4 CEE 272	2
Select one of the following:	HSS Humanities/Social Sciences Elective <sup>1</sup>	4

CEE 003, MECH 002, or MECH 003	3	
	<b>17</b>	<b>18</b>

#### Third Year

First Semester	CR Second Semester	CR
CEE 121	3 CEE 202	3
CEE 142	3 CEE 222	3
CEE 375	3 CEE 274	3
CHE 031	3 CHE 280	3
EES 022	1 CEE 275	2
ESR Earth Science Requirement <sup>3</sup>	3 EBR Environmental Biology Requirement <sup>4</sup>	3
	<b>16</b>	<b>17</b>

#### Fourth Year

First Semester	CR Second Semester	CR
CEE 203	2 CEE 377	3
CEE 378	3 HSS Humanities/Social Science Elective <sup>1</sup>	6
CEE 379	3 AE Approved Electives <sup>2</sup>	6

AE Approved Elective <sup>2</sup>	3	
HSS Humanities/Social Sciences Elective <sup>1</sup>	3	
FE Free Elective	3	
	<b>17</b>	<b>15</b>

Total Credits: 130

- HSS Advanced requirement is 13 credits, four credits of which must be an approved environmental studies course; list of approved courses are available from CEE department.
- Nine approved elective credits to satisfy proficiency in four focus areas of water supply and resources, environmental chemistry, waste management and biological processes; approved list available from CEE department.
- Earth Science Requirement, list of approved courses are available from CEE department.
- Environmental Biology Requirement, list of approved courses are available from CEE department.

The selection of elective courses is to be in consultation with student's academic adviser in the Department of Civil and Environmental Engineering.

### Technical Minor in Environmental Engineering

A technical minor in Environmental Engineering is available for students outside the department. At least two of the courses must be from the CEE department.

CHM 031	Chemical Equilibria in Aqueous Systems (Prerequisite)	4
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Select three of the following required courses: 9-10

CEE 170	Introduction to Environmental Engineering	
CEE 274	Environmental Water Chemistry	
CEE/CHE 373	Fundamentals of Air Pollution	
CEE/CHE 375	Environmental Engineering Processes	
Select one additional course from the required list or from the following:		3
CEE 222	Hydraulic Engineering	
CEE/EES 323	Environmental Groundwater Hydrology	
CEE/EES 327	Surface Water Quality Modeling	
CEE 345	Geo-Environmental Engineering	
CEE 370	Environmental Separation and Control	
CEE 371	Reaction Kinetics in Environmental Engineering	

Other courses may be selected with the minor adviser's approval.

### Graduate Programs

The Department of Civil and Environmental Engineering (CEE) has graduate degree programs leading to Master's and Ph.D. degrees in: Civil Engineering, Structural Engineering, and Environmental Engineering.

The department offers advanced work in the specialty areas of **structural engineering, geotechnical engineering, water resources engineering, and environmental engineering**. Degrees offered are:

M.Eng., M.S., Ph.D. in Structural Engineering

M.Eng., M.S., Ph.D. in Civil Engineering

M.Eng., M.S., Ph.D. in Environmental Engineering

The programs educate students through coursework and independent study and research. Our programs are designed to provide students with the knowledge and analytical problem-solving capabilities needed to lead and innovate within multi-disciplinary teams in technologically-complex environments.

Graduate studies in the department of civil and environmental engineering enable the student to build upon the broad background of undergraduate education in preparation for professional practice at an advanced level, for research and development, or for teaching.

A graduate program leading to the M.S. normally is concentrated in one, or possibly two, of the technical specialty areas, and consists of a number of courses designed to fulfill the individual student's program objectives. Each candidate for the M.S. is required to submit a thesis representing three to six credit hours (CEE 491), or alternatively, a report based on a research course of at least three credits (CEE 429, CEE 439, CEE 449, CEE 479 or CEE 481). The balance of the program will consist of courses in the specialty area(s).

A graduate program leading to the M.Eng. degree stresses engineering applications and design. The department offers two different M.Eng. degrees. The M.Eng. in Structural Engineering focuses specifically on structural engineering. Candidates for the M.Eng. in Structural Engineering degree complete a group design project and an individual project as part of a 3-course design project sequence (CEE 416, CEE 417, CEE 418). The M.Eng. degrees in Civil Engineering and Environmental Engineering allow students to select courses across the various specialty areas of civil and environmental engineering. Candidates for the M.Eng. degrees in Civil Engineering and Environmental Engineering have the option to complete an individual engineering project or a research report, representing 3 to 6 credits (CEE 480), or may take 30 course credits with no project or report.

The doctoral program, which leads to the Ph.D., normally includes courses in the major field, courses in minor fields, and a dissertation presenting results of original research. Holders of master's degrees planning to become candidates for the Ph.D. take a qualifying examination. After qualification, the candidate, the candidate's departmental Ph.D. committee, and the department chair formulate the program of work.

The departmental laboratories are located in the Fritz Engineering Laboratory and in the STEPS Building. The laboratories offer outstanding facilities for research and instruction in structural engineering, geotechnical engineering, water resources engineering, and environmental engineering. In particular, the structural testing equipment includes dynamic testing machines, a five-million-pound universal hydraulic testing machine, and other state-of-the-art facilities. Included in the latter are the facilities of the Center for Advanced Technology for Large Structural Systems (ATLSS center) located on the mountaintop campus. These include the largest 3-dimensional test bed in the U.S.A. and specialized earthquake testing facilities of the NSF George E. Brown, Jr. Network Earthquake Engineering Simulation (NEES). The water resources facilities include a wave tank, several flumes, a 10-cfs recirculating flow system, and two multipurpose tanks for model studies. The geotechnical facilities include state-of-the-art, fully automated triaxial compression and permeability machines for multiple simultaneous tests. The environmental facilities include state-of-the-art laboratories and analytical instrumentation for analysis of chemical, physical and microbiological systems.

In addition to departmental courses, a number of courses offered by the departments of mechanical engineering and mechanics, chemistry, chemical engineering, materials science and engineering, earth and environmental sciences, and biology may also be considered a part of the major field in civil and environmental engineering. A number of research and teaching assistantships are available to provide financial support to students of outstanding promise. The research or teaching activities required of holders of assistantships provides a valuable educational experience that supplements the formal course offerings. A very limited number of scholarships and fellowships are available to provide financial support for full-time study.

#### Courses

##### **CEE 003 Engineering Statics 3 Credits**

Force and moment vectors, resultants. Principles of statics and free-body diagrams. Applications to simple trusses, frames, and machines. Distributed loads. Internal forces in beams. Properties of areas, second moments. Laws of friction. Course is intended as a prerequisite for CEE 059. Prerequisites as noted below.

**Prerequisites:** PHY 011 and MATH 022

**Can be taken Concurrently:** MATH 022

##### **CEE 010 Engineering/Architectural Graphics and Design 3 Credits**

Graphical communication of civil engineering and architectural projects using manual techniques and commercial state-of-the-art computer software. Topics include visualization and sketching; orthographic, isometric and other drawings; points, lines and planes in descriptive geometry; site design; overview of geographical information systems and 3-D applications. Teamwork on design projects with oral and graphical presentations. Open to a limited number of architecture, design arts or other students with project roles consistent with students' background. Not available to students who have taken ME 010.

##### **CEE 011 Surveying 1 Credit**

Theory and practice of basic engineering surveying measurements and analysis. Topics to include field note taking, datums and measurement precision, equipment and techniques for measuring distance, elevation and angles, electronic distance measurement, topographic surveys, GPS and hydrographic surveys. Hands on experience with the use of survey levels, transits/theodolites and a total station will be provided.

##### **CEE 012 Civil Engineering Statistics 2 Credits**

Basic engineering statistics with a civil engineering orientation. Topics to include: random variables and histograms; central tendency, dispersion and skew; probability density functions and cumulative distribution functions, basic probability concepts and selected probability models, return period analysis, linear regression and least squares, correlation analysis, propagation of errors.

##### **CEE 059 Strength of Materials 3 Credits**

Principles stress and strain; Hooke's law, Mohr's circle for stress, transverse shear in beams, extension, torsion, and bending; beam deflections, column buckling, combined stresses, and plastic yield criteria. Prerequisites as noted below.

**Prerequisites:** (CEE 003 or MECH 003) and MATH 023

**Can be taken Concurrently:** MATH 023

##### **CEE 104 Readings in Civil Engineering 1-4 Credit**

Study of selected technical papers, with abstracts and reports.

##### **CEE 117 Numerical Methods in Civil Engineering 2 Credits**

Techniques for computer solution of linear and non-linear simultaneous equations; eigenvalue analysis; finite differences; numerical integration; numerical solutions to ordinary differential equations. Case studies in the various branches of civil engineering. Prerequisites as noted below.

**Prerequisites:** MATH 205

##### **CEE 121 Mechanics of Fluids 3 Credits**

Fluid properties and statics; concepts and basic equations for fluid dynamics. Forces caused by flowing fluids and energy required to transport fluids. Dynamics similitude and modeling of fluid flows. Includes laboratory experiments to demonstrate basic concepts. Prerequisites as noted below.

**Prerequisites:** MECH 002 or MECH 003 or CEE 003

##### **CEE 123 Civil Engineering Materials 3 Credits**

Properties of commonly used civil engineering materials including aggregate, Portland cement concrete, asphalt, concrete, wood, metals, and polymer based synthetics. Standard test methods. Includes laboratory work and reporting of results. Prerequisites as noted below.

**Prerequisites:** CEE 059 or MECH 012

##### **CEE 142 Soil Mechanics 3 Credits**

Physical properties of soils; mineralogy, composition and fabric. Phase and weight-volume relationships, consistency, gradation and classification of soils. Fluid flow through porous media. Stress-strain behavior; stresses within a soil mass, deformation behavior, measurement of stress-strain properties, shear strength of soil. Volume change in soils; compressibility, pore water pressure, consolidation and settlement. Laboratory experiments to measure physical and mechanical properties of soils. Prerequisites as noted below.

**Prerequisites:** MECH 002 or MECH 003 or CEE 003

##### **CEE 159 Structural Analysis I 4 Credits**

Elastic analysis of statically determinate beams, frames, and trusses; deflections by the methods of virtual work and moment area; influence lines for determinate structures; modeling for structural analysis; flexibility, stiffness, and approximate methods of analysis of indeterminate structures. Prerequisites as noted below.

**Prerequisites:** MECH 012 or CEE 059



**CEE 170 Introduction to Environmental Engineering 4 Credits**

Characterization and evaluation of natural water resources. Principles of basic water chemistry. Water and wastewater treatment processes. Sludge treatment, air pollution and multi-media transport. Pollutants mass balance and oxygen transfer. Field trips to water and wastewater process facilities. Laboratory experiments on water and wastewater characterization. Prerequisites as noted below.

**Prerequisites:** CHM 030

**CEE 171 Fundamentals of Environmental Technology 4 Credits**

Introduction to water and air quality, water, air and soil pollution. Chemistry of common pollutants. Technologies for water purification, wastewater treatment, solid hazardous waste management, environmental remediation, and air quality control. Global changes, energy and environment. Constraints of environmental protection on technology development and applications. Constraints of economic development on environmental quality. Environmental life cycle analysis and environmental policy. Not available to students in RCEAS.

**CEE 202 CEE Planning and Engineering Economics 3 Credits**

The planning and management of civil engineering projects. Modeling and optimization methods, project management techniques. Financial decision-making among alternatives. Present value and discounted cash flow analysis; incremental analysis and rate-of-return criteria.

**CEE 203 Professional Development 2 Credits**

Elements of professionalism; professional ethics; engineering registration; continuing education; responsibilities of an engineer in industry, government, private practice; role of professional and technical societies.

**CEE 205 Design Problems 1-6 Credit**

Supervised individual design problems, with report. Consent of the department chair required.

**Repeat Status:** Course may be repeated.

**CEE 207 Transportation Engineering 3 Credits**

Principles of the design of transportation facilities with emphasis on highways and airports in the areas of geometric, drainage, and pavement design. Design problems. Prerequisites as noted below.

**Prerequisites:** CEE 011

**CEE 211 Research Problems 1-6 Credit**

Supervised individual research problems, with report. Consent of the department chair required.

**Repeat Status:** Course may be repeated.

**CEE 222 Hydraulic Engineering 3 Credits**

Pipe and pump hydraulics, engineering hydrology, ground water hydraulics, and open channel hydraulics. Laboratory experiments in applied hydraulics. Prerequisites as noted below.

**Prerequisites:** CEE 121 or ME 231

**CEE 242 Geotechnical Engineering 3 Credits**

The principles related to analysis and evaluation of earthen infrastructure. Site characterization and in-situ testing of soils. Advanced stress-strain behavior, failure theories and stress path application. 2D fluid flow in porous media, flow nets, uplift forces, and liquefaction. Stability of earthen structures; slopes, dams and levees. Stability of retaining structures; lateral earth pressures. Introduction to shallow foundations; bearing capacity and settlement. Team project. Prerequisites as noted below.

**Prerequisites:** CEE 142

**CEE 244 Foundation Engineering 3 Credits**

Application of theories and principles of soil mechanics to geotechnical and structural foundation design. In-situ soil testing, subsurface exploration and soil sampling. Bearing capacity, settlement, lateral earth pressure principles. Design of shallow foundations: spread footings, beams on elastic foundations, mat foundations. Introduction to retaining walls: mechanically stabilized earth, concrete and sheet pile walls, walls for excavations. Design of deep foundations: single piles, pile foundations, drilled piers and caissons. Prerequisites as noted below.

**Prerequisites:** CEE 242

**CEE 258 Structural Laboratory 3 Credits**

Experimental study of behavior of members and structures. Planning, executing, and reporting experimental studies. Introduction to instrumentation and data acquisition. Nondestructive testing of civil engineering structures. Steel, rein-forced concrete, and other materials. Prerequisites as noted below.

**Prerequisites:** CEE 262 and CEE 264

**CEE 259 Structural Analysis II 3 Credits**

Analysis of statically indeterminate structures, methods of slope deflection and moment distribution; consideration of side-sway and nonprismatic members. Influence lines for determinate and indeterminate structures. Flexibility and stiffness matrix methods for computerized analysis. Use of computer library programs. Prerequisites as noted below.

**Prerequisites:** CEE 159

**CEE 262 Fundamentals of Structural Steel Design 3 Credits**

Introduction to steel structures. Behavior, strength and design of structural members, including members subjected to axial tension, axial compression, flexure and combined compression and flexure. Basic methods of joining members to form a structural system. Use of design specifications. Prerequisites as noted below.

**Prerequisites:** CEE 159

**CEE 264 Fundamentals of Structural Concrete Design 3 Credits**

Analysis, design, and detailing of reinforced concrete members and simple systems for strength and serviceability requirements, including beams, columns, and slabs. Introduction to prestressed concrete. Prerequisites as noted below.

**Prerequisites:** CEE 159

**CEE 266 Construction Management 3 Credits**

An overview of management and construction techniques used in engineering ventures and projects. Scheduling, estimation, construction methods, financial controls, contracts, labor relations and organizational forms. Case studies and lecturers from industry. Prerequisites as noted below or consent of instructor.

**Prerequisites:** CEE 202

**CEE 272 Environmental Risk Assessment 2 Credits**

Effects of chemical releases on human health; ecological risks. Application of risk assessment methodology, including hazard identification, exposure assessment, toxicity assessment, and risk characterization. Accounting for uncertainty in data during risk management, risk reduction and implementation of regulations and environmental policy.

**CEE 274 Environmental Water Chemistry 3 Credits**

Chemical principles and applications of those principles to the analysis and understanding of aqueous environmental chemistry in natural waters and wastewaters. The chemistry of ionic equilibria, redox reactions, precipitation/dissolution, acid-base concepts, buffer capacity, complexation, hydrolysis and biological reactions. Prerequisites as noted below.

**Prerequisites:** CHM 031 or CEE 170

**CEE 275 Environmental, Geotechnics and Hydraulics Laboratory 2 Credits**

Applying fundamentals of soil properties, hydraulics and environmental science through appropriate laboratory experiments for solution of environmental engineering problems. Experiments will include solute transport in surface and subsurface medium; characterization of soils, sludges and water; treatment of water and wastewater including biological processes. Illustration of techniques to generate design parameters for scale-up. Prerequisites as noted below.

**Prerequisites:** CEE 170

**CEE 279 Microbial Ecology 4 Credits**

The role of microorganisms in the environment. Topics include: Survey of microbial classification, structure, and metabolism; study of microbes at population, community, and ecosystem levels of organization; the role of microbes in biogeochemical cycles; application of microbes to bioremediation and resource recovery problems. Prerequisites as noted below or consent of instructor.

**Prerequisites:** EES 152

**CEE 281 Special Topics 1-6 Credit**

A study of selected topics in civil and environmental engineering not included in other formal courses. A design project or an interdisciplinary study of a problem related to civil or environmental engineering may be included. Civil and environmental engineering students working on design projects involving students from other departments or colleges working in cross-disciplinary teams may be included. A report is required. Consent of the department chair required.

**Repeat Status:** Course may be repeated.

**CEE 290 CEE Design Project 3 Credits**

Supervised design projects. Multidisciplinary teams applying the fundamentals of engineering science and the concepts of planning and systems analysis in the design of practical engineering works. The scope includes needs analysis, formulation of the design problem statement and evaluative criteria; analysis of alternative solutions and the generation of specifications. Includes most of the following considerations: economic, sustainability, manufacturability, ethical, social, environmental, aesthetic, political, health and safety. Practicing professional engineers are invited to serve as consultants. Written and oral reports are required. Must have senior standing in CEE department or consent of instructors.

**CEE 316 Hydrogeology 3,4 Credits**

Water plays a critical role in the physical, chemical, and biological processes that occur at the Earth's surface. This course is an introduction to surface and groundwater hydrology in natural systems, providing fundamental concepts and a process-level understanding using the hydrologic cycle as a framework. Geochemistry will be integrated to address natural variations and the human impact on the environment. Topics covered include: watershed hydrology, regional and local groundwater flow, water chemistry, and management of water resources. Lectures and recitation/laboratory. Prerequisites as noted below, or consent of instructor.

**Prerequisites:** EES 100 and (EES 105 or EES 115 or EES 131 or EES 152 or EES 172)

**Can be taken Concurrently:** EES 100, EES 105, EES 115, EES 131, EES 152, EES 172

**Attribute/Distribution:** NS

**CEE 320 Engineering Hydrology 3 Credits**

Rainfall-runoff analysis, overland flow, hydrograph theories, modeling. Frequency analysis of extreme events. Flood routing. Design storms. Floodplain hydraulics, floodplain delineation. Prerequisites as noted below.

**Prerequisites:** (CEE 222)

**Attribute/Distribution:** NS

**CEE 321 Open Channel Hydraulics 3 Credits**

Energy and momentum concepts, frictional resistance in open channels. Rapidly and gradually varied flow in open channels; unsteady flow in open channels; channel and culvert design. Prerequisites as noted below.

**Prerequisites:** CEE 222

**CEE 323 Environmental Groundwater Hydrology 3 Credits**

The study of subsurface water, its environment, distribution, and movement. Included are flow patterns, well hydraulics, and an introduction to the movement of contaminants. Design problems are included to simulate flow with analytical and numerical models, and contaminant migration using analytical models. Prerequisites as noted below or consent of instructor.

**Prerequisites:** CEE 121 or CEE 316 or EES 316 or ME 231 or CHE 044

**Attribute/Distribution:** NS

**CEE 327 Surface Water Quality Modeling 3 Credits**

Fundamentals of modeling water quality parameters in receiving water bodies, including rivers, lakes, and estuaries. Modeling of dissolved oxygen, nutrients, temperature, and toxic substances. Emphasis on water quality control decisions as well as mechanics and model building. Prerequisites as noted below or consent of instructor.

**Prerequisites:** (CEE 121 or ME 231 or CHE 044) and CEE 222

**CEE 335 Coastal Engineering 3 Credits**

Linear wave theory and wave characteristics; survey of nonlinear theories; tides, tsunamis, storm surge and basin resonance; wind-generated wave spectra, statistics and forecasting; wave-structure interaction; nearshore circulation and sediment transport; interaction of littoral processes with structures. Prerequisites as noted below.

**Prerequisites:** CEE 121 or ME 231 or CHE 044

**CEE 341 Ground Improvement and Site Development 3 Credits**

Soil stabilization; grouting and injection methods; preloading and dynamic consolidation; deep compaction; drainage and dewatering; application of geotextiles and geomembranes; soil nailing and reinforcement methods. Use of in-situ test for soil properties and site characterization; procedures and calibration methods for the basic in-situ tests - SPT, CPT, CPTU, DMT; theoretical, experimental and empirical interpretive methods for in-situ test results. Prerequisites as noted below.

**Prerequisites:** CEE 242

**CEE 342 Experimental Geotechnical Engineering 3 Credits**

Experimental studies dealing with the measurement of soil and other particulate materials properties, and behavior in the laboratory. Test procedures, calibration, data acquisition, interpretation of apparatus limitations and potential error sources, specimen preparation, data analysis and interpretation; designing experiments. Senior standing required. Prerequisites as noted below.

**Prerequisites:** CEE 242

**CEE 344 Behavior of Soils as Engineering Materials 3 Credits**

Soil mineralogy, bondage, crystal structure and surface characteristics; clay-water electrolyte system; soil fabric and its measurement; soil structure and physical property relationships; soil depositional and compositional characteristics; engineering properties of soils as they relate to soil mineralogy, fabric and composition: volume change behavior, intergranular stresses, shear strength and deformation behavior, conduction behavior, coupled and direct flow phenomena. Prerequisites as noted below.

**Prerequisites:** CEE 242

**CEE 345 Geo-Environmental Engineering 3 Credits**

Principles of interaction of soil and rock with various environmental cycles. Physical and chemical properties of soil. Soil fabric and its measurement, clay-water electrolyte system, electrical double layer and DLVO theory; contaminated site characterization, groundwater flow and contaminant transport; detection and quantification technologies; waste containment systems, landfills, liner systems, leachate collection; soil and groundwater cleanup technologies. Prerequisites as noted below or consent of instructor.

**Prerequisites:** CEE 242

**CEE 346 Fundamentals of Designing with Geosynthetics 3 Credits**

Fundamental and current theories of designing soil structures with geosynthetics. Roads and highway applications; reinforced embankments; slope stabilization; waste containment systems; erosion control; filtration and drainage. Prerequisites as noted below.

**Prerequisites:** CEE 242

**CEE 352 Structural Dynamics 3 Credits**

Analysis of linear structural systems to time-dependent loads. Free and forced vibration. Classical and numerical methods of solution. Lumped-mass techniques, energy methods, and introduction to matrix formulation of dynamic problems. Application to design. Prerequisites as noted below or graduate student status required.

**Prerequisites:** MATH 205 and CEE 159 and MECH 102

**CEE 354 Sensors, Signals, and Systems 3 Credits**

Characterization of sensing systems and analysis and processing of sensor data. Topics include formulation of signals in time and frequency domains: sampling, Nyquist theorem, interpolation, band-limited signals. Analysis of systems: LTI systems, convolution, Eigenfunctions, poles and zeros. Design and analysis of digital filters: ideal filters, FIR filters, filter behavior. Spectral analysis and system identification: stationary processes, power spectral density, frequency leakage. Fundamentals of sensing systems: piezoelectricity, actuation, measurement parameters.

**CEE 361 Bridge Systems Design 3 Credits**

Introduction to bridge structural systems in steel and concrete. Loads and specifications. Design and analysis of bridge structural components. Prerequisites as noted below.

**Prerequisites:** CEE 259 and CEE 262 and CEE 264

**CEE 363 Building Systems Design 3 Credits**

Building structural systems in steel, reinforced concrete and composite steel and concrete. Design loads (dead, live and environmental) and methodologies. Structural systems behavior and design. Design of floor systems, beam-columns, connections, walls, and overall frames. Final design. Prerequisites as noted below.

**Prerequisites:** CEE 259 and CEE 262 and CEE 264

**CEE 364 Advanced Project Management 3 Credits**

Interrelations of planning, design, construction, operation and maintenance, and decommissioning. Project life cycle cost analysis. Cost estimating and financial management principles. Economic feasibility studies. Advanced construction methods and construction contracting. Prerequisites as noted below or consent of instructor.

**Prerequisites:** (CEE 266)

**CEE 365 Prestressed Concrete 3 Credits**

Principles of prestressing. Analysis and design of basic flexural members. Instantaneous and time-dependent properties of materials. Prestress losses. Additional topics may include continuity, partial prestressing, compression members, circular prestressing, etc. Prerequisites as noted below or consent of department chair.

**Prerequisites:** CEE 264

**CEE 366 Finite Element Method in Structural Engineering 3 Credits**

The finite element method: fundamental concepts, theory, modeling, and computation for the analysis of structures. One, two, and three-dimensional finite elements. Isoparametric formulation and implementation for various kinds of elements. Applications to problems in the behavior of structural elements and systems including analysis of trusses, beams, plates, and frames and bridge systems. Extensions to nonlinear analysis and advanced topics. Use of contemporary commercial software. Prerequisites as noted below.

**Prerequisites:** CEE 259

**CEE 370 Environmental Separation and Control 3 Credits**

Theory and application of adsorption, ion exchange, reverse osmosis, air stripping and chemical oxidation in water and wastewater treatment. Modeling engineered treatment processes. Credit will not be given for both CEE 473 and CEE 370. Prerequisites as noted below or consent of instructor.

**Prerequisites:** CEE 371

**CEE 371 Reaction Kinetics in Environmental Engineering 3 Credits**

Theory of reaction kinetics and its application to the design and operation of chemical, physico-chemical and biological reactions in water, wastewater, and hazardous waste treatment. Basic design equations for various types of reactors and migration of pollutants in the environment. CEE 471 is a graduate version of this course. Prerequisites as noted below.

**Prerequisites:** CEE 375 or CHE 375

**CEE 373 Fundamentals of Air Pollution 3 Credits**

Introduction to the problems of air pollution including such topics as: sources and dispersion of pollutants, sampling and analysis; technology of economics and control processes; legislation and standards. Must have senior standing in the College of Engineering and Applied Science.

**CEE 375 Environmental Engineering Processes 3 Credits**

Processes applied in environmental engineering for air pollution control, treatment of drinking water, municipal wastewater, industrial wastes, hazardous/toxic wastes, and environmental remediation. Kinetics, reactor theory, mass balances, application of fundamental physical, chemical and biological principles to analysis and design. Prerequisites as noted below.

**Prerequisites:** CEE 170

**CEE 376 Environmental Biotechnology 3 Credits**

Fundamentals of microbiology and biochemistry applied to natural and engineered environmental systems. Systems ecology, energetics and kinetics of microbial growth, nutrition and toxicology, use of microorganisms for pollution monitoring and control. Pathogenicity and disease transmission, water quality using biological indices. Prerequisites as noted below or consent of instructor.

**Prerequisites:** CEE 375 or CHE 375

**CEE 377 Environmental Engineering Design 3 Credits**

Team-oriented course to develop design skills in the area of environmental engineering. Project components typically include: air pollution, drinking water, municipal wastewater, industrial wastes, hazardous/toxic wastes, and environmental remediation. Project work typically includes: a background report, a design report, and an oral presentation. Tools used in the design process may include simulation models. Must have senior standing in CEE department or consent of instructor. Prerequisites as noted below.

**Prerequisites:** CEE 375

**CEE 378 Hazardous Waste Treatment and Management 3 Credits**

Regulations for collection, transportation, disposal and storage of hazardous wastes. Containment systems, monitoring, new and available technologies to minimize, transform, destroy, detoxify and eliminate the hazardous components of the wastes. Environmentally benign processes and life cycle analysis. CEE 478 is a graduate version of this course. Prerequisites as noted below.

**Prerequisites:** CEE 375 or CHE 375

**CEE 379 Environmental Case Studies 3-4 Credits**

Case studies will be used to explore the impact of politics, economics, society, technology, and ethics on environmental projects and preferences. Environmental issues in both affluent and developing countries will be analyzed. Multidisciplinary student teams will investigate site characterization; environmental remediation design; environmental policy; and political, financial, social, and ethical implications of environmental projects. Prerequisites as noted below or consent of instructor.

**Prerequisites:** (EES 022 or CEE 375 or CHE 375)

**Attribute/Distribution:** NS

**CEE 381 Special Topics 1-3 Credit**

A study of selected topics in civil engineering, not included in other formal courses. A report is required. Consent of the department chair required.

**CEE 385 Research Procedures Seminar 1 Credit**

Planning and execution of research projects, survey of current research, elements of proposals and budgets. Literature search procedures. Presentation of data, and of written and oral reports. Guidelines for visual aids.

**CEE 404 Mechanics and Behavior of Structural Members 3 Credits**

Behavior of structural members, under a variety of loading conditions in the elastic and inelastic range. Introduction to the theory of elasticity and plasticity. Basics of linear elastic fracture mechanics and fatigue. Analysis of structural member behavior in axial, bending, shear, and torsion. Stability analysis of beam-columns. Beams on elastic foundations. Energy concepts and their use in structural analysis.

**CEE 405 Analytical and Numerical Methods I 3 Credits**

Analytical and numerical methods used in Civil Engineering, with emphasis on ordinary and partial differential equations. Analytical and numerical solutions of ordinary and partial differential equations. Initial and boundary value problems. Numerical integration, numerical error, and approximations of functions and data points. Finite differences, solution of systems of linear equations, eigenvalue problems, and solution of nonlinear equations. Prerequisites as noted below.

**Prerequisites:** MATH 205

**CEE 406 Structural Reliability of Components and Systems 3 Credits**

Probabilistic time-invariant failure analysis of structural components and systems. Statistics and probability; component time-invariant reliability analysis; system time-invariant reliability analysis; reliability-based structural design; and reliability of structural systems using Monte-Carlo simulation. Solutions suitable for practical computer implementation. Prerequisites as noted below.

**Prerequisites:** (MATH 021 and MATH 205 and CEE 259)

**CEE 409 Finite Element Method in Structural Mechanics 3 Credits**

Basic principles and equations governing the finite element method. Analysis of planar, axisymmetric, plate and articulated structures, with emphasis on analytical modeling. Accuracy and convergence studies, utilizing different discretizations and various types of elements. Case studies include application and extension to material nonlinearities, bridges, containment vessels, and soil-structure interaction. Prerequisites as noted below.

**Prerequisites:** CEE 405

**CEE 412 Methodologies of Structural Design 2 Credits**

Probabilistic analysis of uncertainties associated with structural design. Characterization of loads including dead and live loads, wind, earthquake, and vehicular loads. Variability of structural resistance based on strength limit states as well as serviceability. Assessment of safety and reliability. Deterministic and probabilistic methodologies of design.

**CEE 414 Analysis and Design of Steel and Composite Structural Members 3 Credits**

Fundamentals of limit state design. Ultimate strength analysis of steel and steel-and-concrete composite columns, beams, beam-columns, and members subjected to torsion and combined torsion and bending. Flexural and torsional instability. Background and requirements of current design codes.

**CEE 415 Analysis and Design of Ductile Steel Structural Systems 3 Credits**

Inelastic behavior of steel and steel structural members. Plastic limit strength analysis of continuous beams and frames. Effect of variable repeated loading. Methodology and code requirements for design based on plastic strength. Applications to seismic-resistant building structures. Current research. Prerequisites as noted below.

**Prerequisites:** CEE 262

**CEE 416 Design Project I 3 Credits**

Introduction to the overall M.Eng. design project for a civil infrastructure facility. Design decision making and communication processes. Roles of various players in the execution of the project (e.g. owner, architect, engineer, fabricator, construction manager, contractor), and the mechanisms of communication of information in the design process (e.g. design drawings, shop drawings, erection drawings, as-built drawings). Roles of codes and standards. Enrollment limited to students in M.Eng. program.

**CEE 417 Design Project II 3 Credits**

Task-specific teams will be organized to perform preliminary designs of different design options for the overall design project. Determination of project goals, performance requirements, and functional specifications. Winnowing and selection of alternatives for final design. Professor of practice and external specialists will guide examination and evaluation of design options based on cost and performance criteria. Prerequisites as noted below.

**Prerequisites:** (CEE 416)

**CEE 418 Design Project III 3 Credits**

Comprehensive, completed design of the civil infrastructure facility. Design project teams will address life cycle issues and integrated, multidisciplinary aspects of architecture, systems design, construction and management. Critical design reviews will be performed by teams of external specialists and members of the industrial advisory board. Prerequisites as noted below.

**Prerequisites:** (CEE 417)

**CEE 419 Structural Behavior Laboratory 3 Credits**

Experimental study of behavior of members, assemblages and structural systems. Introduction to methods and equipment used in laboratory simulations, numerical simulations, laboratory and in-situ measurements. Planning, executing and reporting experimental studies on performance of materials and large-scale structural systems. Non-destructive evaluation and damage assessment. Prerequisites as noted below or consent of instructor.

**Prerequisites:** (CEE 262 and CEE 264)

**CEE 420 Surface Wave Mechanics 3 Credits**

Elements of hydrodynamics and wave boundary conditions; linear wave theory and wave characteristics; nonlinear wave theories and application; wind wave generation, analysis and prediction; long waves; design wave determination; laboratory investigation of surface waves. Consent of instructor required.

**CEE 424 Surface Water Hydrology 3 Credits**

Advanced analysis and methods in surface water hydrology. Linear and non-linear hydrograph methods. Kinematic wave and other hydraulic routing techniques. Advanced techniques for evaporation, infiltration, and snow melt. Prerequisites as noted below.

**Prerequisites:** CEE 320 or EES 320

**CEE 425 Hydraulics of Sediment Transport 3 Credits**

Hydrodynamic forces on particles, settling velocity. Sediment transport in open channel: tractive force theory, bed load and suspension theory, total load and wash load. Bedform mechanics, cohesive channel hydraulics. Sediment transport in closed conduits. Shore processes and coastline hydraulics. Prerequisites as noted below.

**Prerequisites:** CEE 321

**CEE 427 Transport of Contaminants in Groundwater 3 Credits**

Theory of groundwater flow and transport of contaminants in the groundwater system. State-of-the-art groundwater flow and contaminant transport models used to solve governing equations of groundwater flow and transport of chemically reactive solutes. Selected case studies will be analyzed. Prerequisites as noted below or consent of instructor.

**Prerequisites:** CEE 323 or EES 323

**CEE 428 Advanced Topics in Hydraulics 1-3 Credit**

Recent developments in hydromechanics and hydraulics. Topics to be selected from: wave mechanics, theory of flow through porous media, dispersion, hydrodynamic forces on structures, potential flow, free streamline theory, open channel hydraulics, computer methods. May be repeated for credit. Consent of department required. Prerequisites as noted below.

**Repeat Status:** Course may be repeated.

**Prerequisites:** CEE 321

**CEE 429 Hydraulic Research 1-6 Credit**

Individual research problems with reports.

**Repeat Status:** Course may be repeated.

**CEE 431 Life-Cycle of Structural Systems 3 Credits**

Assessing the life-cycle performance of new and existing structural systems, designing structures for lifetime performance, and optimizing the remaining life of existing structures, considering uncertainties in structural performance, demands placed on structural systems, structural maintenance and monitoring, and costs. Prerequisites as noted below or consent of instructor.

**Prerequisites:** MATH 205 and CEE 259

**CEE 432 Structural Safety and Risk 3 Credits**

Assessing safety and risk of structural systems during their specified service life, designing structures for specified safety and risk criteria for a prescribed service life, introducing Markov, queueing and availability models, statistics of extremes, time-variant safety and structural health monitoring, and optimal decision making under uncertainty based on single objective or multiple objectives. Prerequisites as noted below or consent of instructor.

**Prerequisites:** MATH 205 and CEE 259

**CEE 433 Structural Optimization 3 Credits**

Problem formulation, relative merit of various numerical optimization techniques, possible difficulties in applications, and how alternative formulations and methods can be combined to solve different design problems. Numerical optimization techniques are in general terms and their application to structural design. Prerequisites as noted below or consent of instructor.

**Prerequisites:** (MATH 205 and CEE 259)

**CEE 436 Advanced Topics in Coastal Engineering 1-3 Credit**

Advanced study of selected topics in coastal engineering such as: non-linear wave theory, design of coastal structures, shore protection and stabilization, numerical solution of coastal hydrodynamics. Selection of topics will depend on particular qualifications of staff, as well as on the interests of the students.

**Repeat Status:** Course may be repeated.

**CEE 439 Coastal Engineering Research 1-6 Credit**

Individual research problems with reports.

**Repeat Status:** Course may be repeated.

**CEE 441 Dynamic Analysis in Geotechnical Engineering 3 Credits**

Vibration of elementary systems, 1D wave propagation, dynamic soil properties, analysis of response of shallow and deep foundations to dynamic loads, soil liquefaction and earthquake problems; laboratory tests, geophysical methods and non-destructive tests of foundation systems; dynamic analysis of pile driving. Prerequisites as noted below or consent of department chair.

**Prerequisites:** CEE 244

**CEE 443 Advanced Soil Mechanics 3 Credits**

Characterization of particulate media; particle-fluid interaction; load deformation, thermoelastic and viscoelastic behavior; elastic waves in particulate media; electromagnetic properties; empirical and analytical models. Must have completed a course in soil mechanics.

**CEE 445 Advanced Foundation Engineering 3 Credits**

Current theory and practice relating to the design of shallow and deep foundations for buildings and other structures. Analysis and limitation of settlements; bearing capacity; flexible and rigid retaining structure design; dynamic effects; anchor and other special foundations; site investigations; load-resistance-factor design (LRFD) criteria for foundations. Must have completed a course in soil mechanics.

**CEE 447 Advanced Topics in Geotechnical Engineering 1-3 Credit**

Advanced studies in selected subjects related to geotechnical engineering. The general areas may include: stress-strain-time relationships of soils, colloidal phenomena in soils, ground water flow and see page, soil dynamics, soil plasticity, numerical methods applied to soil mechanics, earth dam design, theories of layered systems and their application to pavement design, rock mechanics. The studies specifically undertaken in any particular semester depend on the availability of staff and the interest of students. Consent of department chair required.

**Repeat Status:** Course may be repeated.

**CEE 448 Constitutive Laws in Soil Mechanics 3 Credits**

Basic methods and constitutive laws used for the analysis of boundary value problems in soil mechanics. Linear elasticity, nonlinear elastic, linear elastic-perfectly plastic and non-linear elastoplastic models; critical state soil mechanics; application of select computational models. Consent of instructor required.

**CEE 449 Geotechnical Research 1-6 Credit**

Individual research problems relating to soil engineering, with report. Must have completed a course in soil mechanics.

**CEE 450 Advanced Structural Analysis I 3 Credits**

Theory and methods of linear and second order structural analysis. Linear theory and stiffness properties of structural members and linear transformations of structural analysis. Application of virtual work principles and development of displacement (stiffness) method of analysis in matrix form. Introduction to second order theory of structural members and second order equations of structural analysis. Prerequisites as noted below.

**Prerequisites:** CEE 259

**CEE 452 Fatigue and Fracture of Structures - An Interdisciplinary View 3 Credits**

This course examines the fatigue and fracture characteristics of steel structures from metallurgical, mechanical and structural engineering views. Both theory and experimental background are provided and applied to case studies and code development.

**CEE 453 Nonlinear Analysis of Structural Components and Systems 3 Credits**

Nonlinear analysis of structural components and systems, considering the effects of material and geometric nonlinearities. Solution strategies; material constitutive models; nonlinear member section analysis; computational plasticity; nonlinear beam-column element formulations; second order analysis; structural stability; and nonlinear time history analysis of structural dynamic systems. Prerequisites as noted below.

**Prerequisites:** CEE 352 and CEE 404 and CEE 450

**CEE 454 Sensors, Signals, and Systems 3 Credits**

Characterization of sensing systems and analysis and processing of sensor data. Topics include formulation of signals in time and frequency domains: sampling, Nyquist theorem, interpolation, band-limited signals. Analysis of systems: LTI systems, convolution, Eigenfunctions, poles and zeros. Design and analysis of digital filters: ideal filters, FIR filters, filter behavior. Spectral analysis and system identification: stationary processes, power spectral density, frequency leakage. Fundamentals of sensing systems: piezoelectricity, actuation, measurement parameters. This course, a version of CEE 354 for graduate students, requires advanced assignments. Credit will not be given for both CEE 354 and CEE 454.

**CEE 455 Advanced Structural Dynamics 3 Credits**

Analysis and design of structures to resist wind, earthquake, and blast loading. Matrix methods and computer applications. Non-linear and elasto-plastic response. Damping characteristics of structures and structural components, spectral analysis, dynamic instability. Characteristics of aerodynamic and seismic forces and explosions. Introduction to vibration of three-dimensional structural systems. Prerequisites as noted below.

**Prerequisites:** (CEE 352 or MECH 406) and CEE 405 and CEE 450

**CEE 456 Behavior and Design of Earthquake Resistant Structures 3 Credits**

Characteristics of earthquakes, effects of earthquakes on structures. Response of linear elastic structures to earthquakes. Response of inelastic structures to earthquakes. Behavior of structural components under cyclic loading. Principles of earthquake-resistant design. Seismic design procedures and their implementation in codes. Prerequisites as noted below.

**Prerequisites:** CEE 352

**CEE 457 Behavior and Design of Blast Resistant Structures 3 Credits**

Design and assessment of structures subject to blast demands generated from accidental or intentional detonation of high explosives. Topics include determination of blast demands, characterization of pressure distributions on structural systems and components, estimation of the response of systems to dynamic pressure demands, modeling techniques for structural components, dynamic time history analysis of systems, determination of allowable response limits and stand-off requirements for facilities, and design structures to resist the effects of close-in detonation of high explosives and the impact of ballistic fragments.

**CEE 459 Advanced Topics in Plastic Theory 3 Credits**

Fundamentals of the mathematical theory of plasticity; the general theorems of limit analysis and their applications to beams under combined loading, arches, space frames, plates and shells. Limit analysis of two- and three-dimensional problems in soil, concrete, rock, and metal. Current developments. Prerequisites as noted below.

**Prerequisites:** CEE 404

**CEE 461 Advanced Bridge Engineering 3 Credits**

Students in CEE 461 cover the same topics described under CEE 361, but in more depth. In addition each student conducts an intensive study of a bridge-related topic of his or her choice. A short written technical report on the findings of this study is required. Prerequisites as noted below.

**Prerequisites:** CEE 262 and CEE 264

**CEE 462 Stability of Structural Systems 3 Credits**

Stability analysis of structures systems, including moment-resisting and braced frames, trusses, and plate and box girders. Bracing requirements. Elastic and inelastic second-order analysis. Design considerations. Special topics. Prerequisites as noted below.

**Prerequisites:** CEE 404

**CEE 463 Advanced Mechanics of Reinforced Concrete 3 Credits**

Consistent mechanics for the design of reinforced concrete with or without prestress. Limit theorems of the theory of plasticity and their application to beams, slabs, and disturbed regions. Applications may include beams in flexure and combined flexure, axial load, and torsion; slabs (strip method, yield line analysis); corbels, deep beams, and other disturbed regions (truss models, strut-and-tie models, and associated failure mechanisms). Prerequisites as noted below.

**Prerequisites:** CEE 404

**CEE 467 Advanced Topics in Structural Engineering 1-3 Credit**

Advanced study of selected topics in structural mechanics and engineering, such as: finite element methods, suspension system; space frames; stability of nonlinear systems; coldformed and lightweight construction; optimization and reliability; second-order phenomena in structures; interaction of structures with the environment; structural use of plastics; composite construction, etc. Selection of topics will depend on particular qualifications of the staff, as well as on the interests of the students. Consent of department chair required.

**Repeat Status:** Course may be repeated.

**CEE 468 Stability of Elastic Structures 3 Credits**

Basic concepts of instability of a structure; bifurcation, energy increment, snap-through, dynamic instability. Analytical and numerical methods of finding buckling loads of columns. Postbuckling deformations of cantilever column. Dynamic buckling with nonconservative forces. Effects of initial imperfections. Inelastic buckling. Buckling by torsion and flexure. Variational methods. Buckling of frames. Instability problems of thin plates and shells. Prerequisites as noted below.

**Prerequisites:** MATH 205

**CEE 470 Reaction Kinetics in Environmental Engineering 3 Credits**

Theory of reaction kinetics and its application to the design and operation of chemical, physico-chemical and biological reactors in water and wastewater treatment. Basic design equations for various types of reactors and migration of pollutants in the environment.

**CEE 471 Environmental Risk Assessment 3 Credits**

Effects of chemical releases on human health; ecological risks. Application of risk assessment methodology, including hazard identification, exposure assessment, toxicity assessment, and risk characterization. Accounting for uncertainty in data during risk management, risk reduction and implementation of regulations and environmental policy. Term project.

**CEE 472 Water and Wastewater Treatment Facilities 3 Credits**

Theory and design of water and wastewater treatment facilities. Physical, chemical, and biological treatment processes for water and wastewater treatment. Prerequisites as noted below.

**Prerequisites:** CEE 375 or CHE 375

**CEE 473 Environmental Separation and Control 3 Credits**

Theory and application of adsorption, ion exchange, reverse osmosis, air stripping and chemical oxidation in water and wastewater treatment. Modeling engineered treatment processes. This course, a version of CEE 370 for graduate students, requires advanced assignments. Credit will not be given for both CEE 473 and CEE 370. Prerequisites as noted below or consent of instructor.

**Prerequisites:** CEE 470

**CEE 474 Aquatic Chemistry 3 Credits**

Applying basic principles of aqueous chemistry for quantifying complex, environmental systems. Specific examples of air-water-soil interactions and consequent effects. Heterogeneous equilibria with more than one solid phase. Kinetics and thermodynamics of some important ionic and biological reactions. Prerequisites as noted below.

**Prerequisites:** CEE 274

**CEE 475 Advanced Topics in Environmental Engineering 1-3 Credit**

Advanced concentrated study of a selected topic in environmental engineering such as non-point source pollution control, water reuse systems, new concepts in treatment technology, toxic substance control, etc. The instructor and student select topic. Courses may include specialized laboratory research, literature review, and specialty conference attendance. Consent of department chair required.

**Repeat Status:** Course may be repeated.

**CEE 476 Environmental Biotechnology 3 Credits**

Fundamentals of microbiology and biochemistry applied to natural and engineered environmental systems. Systems ecology, energetics and kinetics of microbial growth, nutrition and toxicology, use of microorganisms for pollution monitoring and control. Pathogenicity and disease transmission, water quality using biological indices. Prerequisites as noted below or consent of instructor.

**Prerequisites:** CEE 375 or CHE 375

**CEE 477 Environmental Engineering Processes 3 Credits**

Processed applied in environmental engineering for air pollution control, treatment of drinking water, municipal wastewater, industrial wastes and environmental remediation. Kinetics, reactor theory, mass balances, application of fundamental physical, chemical and biological principles to analysis and design. Prerequisites as noted below or consent of instructor.

**Prerequisites:** CEE 170

**CEE 478 Toxic and Hazardous Wastes 3 Credits**

Regulations for collection, transportation, disposal and storage of hazardous wastes. Containment systems, monitoring, types of liners, new and available technologies to eliminate or recover the hazardous components of the wastes. Prerequisites as noted below.

**Prerequisites:** (CEE 274 or CEE 375 or CHE 375)

**CEE 479 Environmental Engineering Research 1-6 Credit**

Individual research problems in environmental engineering with report.

**Repeat Status:** Course may be repeated.

**CEE 480 Civil Engineering Project 1-6 Credit**

An intensive study of one or more areas of civil engineering, with emphasis on engineering design and applications. A written report is required.

**Repeat Status:** Course may be repeated.

**CEE 481 Special Problems 1-6 Credit**

An intensive study, with report, of a special field of civil engineering, which is not covered in the other courses. A design project or an interdisciplinary study of a problem related to civil engineering may also be included.

**Repeat Status:** Course may be repeated.

**CEE 483 Graduate Seminar 1-3 Credit**

Study of current topics in civil engineering.

**CEE 491 Thesis 1-6 Credit****CEE 499 Dissertation 1-15 Credit****Civil and Environmental Engineering and Earth and Environmental Sciences**

This program is designed for students interested in combining programs in two departments: Civil & Environmental Engineering and Earth & Environmental Science, leading to two bachelor of science degrees, one in Civil Engineering or Environmental Engineering and the other in Earth and Environmental Sciences. Both degrees would be awarded at the end of the fifth year. This program is one of the dual degree programs mentioned in the Five-Year Programs section. The student will have a primary advisor in the P.C. Rossin College of Engineering and Applied Sciences and a secondary advisor in the Arts and Sciences College. The program provides alternatives for students who may decide not to

complete the dual-degree program. Students who make this decision prior to the beginning of the fourth year may qualify at the end of that year for the bachelor of science in civil or environmental engineering, as well as a minor in earth and environmental sciences. Also, if a student decides after two years to pursue only a bachelor of science degree in the EES department, it is possible to complete the requirements in four years. If the decision to work toward this degree is made during the fourth year, at least one additional semester is required to qualify for either B.S. degree. Interested students should consult with the respective departmental advisors to create a schedule of courses to resolve conflicts or if a specified course is not offered that semester. Required courses and major electives for the different EES B.S. degree programs are listed in the catalog entry for EES. Cross-listed EES/CEE courses used to satisfy Civil Engineering Approved Electives can reduce the individual semester and total program credits when chosen to satisfy EES program requirements. Additional useful information can be found on the web sites ([www.lehigh.edu/~incee/](http://www.lehigh.edu/~incee/) and [www.ees.lehigh.edu](http://www.ees.lehigh.edu)).

**Required courses for B.S. in Environmental Science and B.S. in Civil Engineering**

**Recommended Sequence of Courses**

The HSS Advanced Requirement of 13 credits is shown below as three 3-credit courses and one 4-credit course. Other options are possible.

A total of 173 credit hours are needed for both degrees depending on how many credits in the EES are satisfied by taking CEE Approved Electives that are cross-listed with EES courses<sup>3</sup>.

**First Year**

First Semester	CR	Second Semester	CR
ENGL 001	3	ENGL 002	3
MATH 021	4	MATH 022	4
CHM 030	4	ENGR 010	2
ENGR 005	2	PHY 011 & PHY 012	5
ECO 001	4	HSS Humanities/Social Science Elective	3
	<b>17</b>		<b>17</b>

**Second Year**

First Semester	CR	Second Semester	CR
MATH 023	4	PHY 021 & PHY 022	5
CEE 003	3	CEE 059	3
CEE 010	3	EES 100	4
CEE 011	1	MATH 205	3
CEE 012	2	CHM 031	4
EES Gateway Elective	3		
EES 022	1		
	<b>17</b>		<b>19</b>

**Third Year**

First Semester	CR	Second Semester	CR
CEE 121	3	CEE 242	3
CEE 123	3	CEE 222	3
CEE 142	3	CEE 170	4
EES 100-300 Level Elective <sup>5</sup>	4	EES 200	4
EES 100-300 Level Elective <sup>5</sup>	4	HSS Humanities/Social Science Elective	4
	<b>17</b>		<b>18</b>

**Fourth Year**

First Semester	CR	Second Semester	CR	Summer	CR
CEE 117	2	CEE 202	3	EES Field Experience <sup>6</sup>	

CEE 159	4	CEE 262 or 264	3		
EES 100-300 Level Elective <sup>5</sup>	4	AE CEE Civil Engineering Approved Elective <sup>3</sup>	3		
EES 100-300 Level Elective <sup>5</sup>	4	BSE Basic Science Elective <sup>2</sup>	3		
EES 100-300 Level Elective <sup>5</sup>	4	EES 100-300 Level Elective <sup>5</sup>	4		
	<b>18</b>		<b>16</b>		<b>0</b>
<b>Fifth Year</b>					
<b>First Semester</b>		<b>CR</b>	<b>Second Semester</b>	<b>CR</b>	
CEE 203		2	AE CEE Civil Engineering Approved Electives <sup>3</sup>	7	
AE CEE Civil Engineering Approved Elective <sup>3</sup>	3	3	CEE 290 <sup>4</sup>	3	
HSS Humanities/Social Sciences Elective	3	3	HSS Humanities/Social Sciences Electives	3	
EES 380	1	4	EES 100-300 Level Elective <sup>5</sup>	4	
EES 100-300 Level Elective <sup>5</sup>	4				
EES 100-300 Level Elective <sup>5</sup>	4				
	<b>17</b>			<b>17</b>	

Total Credits: 173

- BSE Basic Science Elective. List of courses is available from CEE Department.
- CHM 031 plus thirteen additional credits of CEE Approved Electives are required; list available from CEE department: that includes five CEE/EES cross-listed courses: CEE 279 (EES 358), CEE 316 (EES 316), CEE 320 (EES 320), CEE 323 (EES 323), CEE 327 (EES 327), and CEE 379 (EES 379).
- Usually CEE 290, but can be a multidisciplinary teaming version of CEE 205, CEE 377 or CEE 381; student must have completed successfully at least one CE approved elective related to the design project topic area.
- At least four of the EES electives must be at the 300 level. Up to 8 credits of EES internship (EES 093, EES 293) and EES research (EES 393) may be used as major electives (no more than 4 of which can be EES 093/EES 293).
- For more information on the EES field requirement see the EES catalog entry (p. 112).

**Required courses for B.S. in Environmental Science and B.S. in Environmental Engineering**

The HSS Advanced Requirement of 13 credits is shown below as three 3-credit courses and one 4-credit course. Other options are possible.

**Recommended Sequence of Courses**

A total of 173 credit hours are needed for both degrees. Some EES requirements are simultaneously satisfied by taking Environmental Engineering Technical Electives that are cross-listed with EES courses.

**First Year**

First Semester	CR	Second Semester	CR
ENGL 001	3	ENGL 002	3
MATH 021	4	MATH 022	4
CHM 030	4	PHY 011 & PHY 012	5
ENGR 005	2	ENGR 010	2
HSS Humanities/Social Science Elective	3	EES Gateway Elective	3
	<b>16</b>		<b>17</b>

**Second Year**

First Semester	CR	Second Semester	CR
MATH 023	4	MATH 205	3

CEE 003, MECH 002, or MECH 003	3 PHY 021 & PHY 022	5
CHM 110 & CHM 111	4 CEE 170	4
EES 022	1 EBR Environmental Biology Requirement <sup>4</sup>	3
ESR Earth Science Requirement <sup>3</sup>	3 EES 100	4
HSS Humanities/Social Sciences Elective	3	
	<b>18</b>	<b>19</b>

**Third Year**

First Semester	CR Second Semester	CR
CEE 012	2 CEE 274	3
CEE 375	3 CHE 280	3
EES 100-300 Level Elective <sup>5</sup>	4 EES 200	4
EES 100-300 Level Elective <sup>5</sup>	4 EES 100-300 Level Elective <sup>5</sup>	4
CHE 031	3 ECO 001	4
	<b>16</b>	<b>18</b>

**Fourth Year**

First Semester	CR Second Semester	CR Summer	CR
CEE 121	3 CEE 202	3 EES Field Requirement <sup>6</sup>	
CEE 142	3 CEE 222	3	
CEE 378	3 CEE 272	2	
EES 100-300 Level Elective <sup>5</sup>	4 CEE 275	2	
EES 100-300 Level Elective <sup>5</sup>	4 EES 100-300 Level Elective	4	
	EES 100-300 Level Elective	4	
	<b>17</b>	<b>18</b>	<b>0</b>

**Fifth Year**

First Semester	CR Second Semester	CR
CEE 203	2 CEE 377	3
CEE 379	4 HSS Humanities/Social Sciences Electives	3
EES 380	1 AE Approved electives <sup>2</sup>	6
EES 100-300 Level Elective <sup>5</sup>	4 EES 100-300 Level Elective <sup>5</sup>	4
AE Approved electives <sup>2</sup>	3	
HSS Humanities/Social Sciences Electives <sup>1</sup>	4	
	<b>18</b>	<b>16</b>

Total Credits: 173

- HSS advanced requirement is 13 credits, four credits of which must be CEE approved Environmental Studies (ES) course.
- 9 approved elective credits to satisfy proficiency in three focus areas of water supply and resources, environmental chemistry, and hazardous waste management; approved list available from CEE department.
- Earth Science Requirement, list of approved courses are available from CEE department.
- Environmental Biology Requirement, list of approved courses are available from CEE department.

- At least four of the EES electives must be at the 300 level. Up to 8 credits of EES internship (EES 093, EES 293) and EES research (EES 393) may be used as major electives (no more than 4 of which can be EES 093/EES 293).
- For more information on the EES field requirement see the EES catalog entry (p. 112).

**Computer Engineering**

Computer Engineering deals with the design and analysis of intelligent systems that have become indispensable in today's world. Because it requires expertise in both hardware and software areas, at Lehigh, the Computer Engineering program is offered jointly by the department of Computer Science and Engineering (CSE) and the department of Electrical and Computer Engineering (ECE).

**Undergraduate Programs****Mission Statement**

The mission of the computer engineering program is to prepare computer engineers to meet the challenges of the future; to promote a sense of scholarship, leadership and service among our graduates; to instill in the students the desire to create, develop, and disseminate new knowledge; and to provide international leadership to the computer engineering profession. The mission is attained through the following program educational objectives.

**Program Educational Objectives in Computer Engineering**

The objective of the Computer Engineering program is to produce students who within 5-10 years after graduation will:

- Meet expectations of the employers of computer engineers.
- Pursue diverse career paths if they so desire.
- Become leaders in their chosen careers.

**Bachelor of Science in Computer Engineering**

The required courses for this degree include the fundamentals of electronic circuits, signal theory, logic design, computer architecture, digital systems, structured programming, data structures, software engineering, operating systems and discrete mathematics. A strong foundation in the physical sciences and in mathematics is required. Approved technical electives, chosen with the advisor's consent, are selected in preparation for graduate study or entry into industry according to individual interests. The program totals 133 credit hours. The Computer Engineering program is accredited by the Engineering Commission of ABET, [www.ABET.org](http://www.ABET.org).

The recommended sequence of courses follows:

**First Year**

First Semester	CR Second Semester	CR
ENGL 001	3 ENGL 002	3
MATH 021	4 MATH 022	4
ENGR 005	2 Select one of the following:	4
Select one of the following	5-6 ECO 001	-
CHM 030 & ENGR 010 <sup>1</sup>	- HSS Elective <sup>3</sup>	-
PHY 011 & PHY 012 <sup>1</sup>	- Select one of the following	5-6
	CHM 030 & ENGR 010 <sup>1</sup>	-
	PHY 011 & PHY 012 <sup>1</sup>	-
	<b>14-15</b>	<b>16-17</b>

**Second Year**

First Semester	CR Second Semester	CR
ECE 081	4 CSE 002	2
MATH 023	4 ECE 123 & ECE 121	5
ECE 033	4 MATH 205	3



PHY 021 & PHY 022	5 HSS Elective <sup>3</sup>	4
	Select one of the following	3-4
	ECO 001	-
	HSS Elective <sup>3</sup>	-
	<b>17</b>	<b>17-18</b>
<b>Third Year</b>		
<b>First Semester</b>	<b>CR Second Semester</b>	<b>CR</b>
ECE 182	1 CSE 109	4
ECE 108	4 ECE 138	2
CSE 017	3 ECE 201	3
MATH 231 or 309	3 CSE 261	3
Approved technical elective <sup>2</sup>	3 free elective	3
Free elective	3 free elective	3
	<b>17</b>	<b>18</b>
<b>Fourth Year</b>		
<b>First Semester</b>	<b>CR Second Semester</b>	<b>CR</b>
CREG 257	3 CREG 258	2
ECE 319	3 Approved technical electives <sup>2</sup>	12
CSE 303	3 HSS elective <sup>3</sup>	4
CSE 216	3	
HSS elective <sup>3</sup>	3-4	
	<b>15-16</b>	<b>18</b>

Total Credits: 132-136

- 1 Required natural science courses, one taken fall semester and the other taken in spring
- 2 Approved technical electives (15 credits) are subjects in the area of science and technology. They are not restricted to offerings in the department of Electrical and Computer Engineering and the department of Computer Science and Engineering. One elective must be an engineering science elective from a department other than ECE and CSE. CSE 042, CSE 130, and CSE 252 are not approved technical electives.
- 3 Distribution of HSS courses must satisfy the college requirements.

### Graduate Programs

Graduate programs of study provide a balance between formal classroom instruction and research and are tailored to the individual student's professional goals. The programs appeal to individuals with backgrounds in computer or information science, in computer engineering, in electrical engineering, in mathematics, or in the physical science. Research is an essential part of the graduate program. The research topics are listed in the departmental descriptions for Computer Science and Engineering (CSE) and Electrical and Computer Engineering (ECE) which jointly administer the computer engineering program. Individual courses are listed in the catalog descriptions of the CSE and ECE departments.

The Master of Science degree requires the completion of 30 credit hours of work and may include a six credit hour thesis for Computer Engineering degree. A program of study must be submitted in compliance with the graduate school regulations. An oral presentation of the thesis is required.

The Master of Engineering degree requires the completion of 30 credit hours of work, which includes design-orientated courses and an engineering project. A program of study must be submitted in compliance with the college rules. An oral presentation of the project is required.

The Ph.D. degree in computer engineering requires the completion of 42 credit hours of work (including the dissertation) beyond the master's degree (48 hours if the master's degree is not from Lehigh), the passing of a departmental qualifying examination appropriate to each degree within one year after entrance into the degree program, the passing of a general examination in the candidate's area of specialization, the admission into candidacy, and the writing and defense of a dissertation. Competence in a foreign language is not required.

The program has a core curriculum requirement for graduate students. The purpose of this requirement is to guarantee that all students pursuing graduate studies in the department acquire an appropriate breadth of knowledge of their discipline. To satisfy the core curriculum requirements in Computer Engineering, students need to complete at least two courses in the computer hardware/architecture area, at least two courses in a second area, and at least one course in a third area. In each of the three areas at least one course must be at the 400 level. The areas are: computer software systems, signal processing and communications, computer software applications, and circuits and systems. See [www.compe.lehigh.edu](http://www.compe.lehigh.edu) for details about these areas.

Courses from other universities or undergraduate studies may be used to satisfy these requirements, by petition, at the discretion of the department faculty. Additional graduate program information may be obtained from the program's graduate coordinator.

Most courses in the Computer Engineering curriculum are listed in the Computer Science and Engineering (p. 321) (CSE) and Electrical and Computer Engineering (p. 330) (ECE) departments.

### Courses

#### CREG 257 Senior Lab Project I 3 Credits

With CREG 258, a complete design experience for Computer Engineers. Research, planning, and completion of the initial design for a capstone project that integrates the many facets of the undergraduate Computer Engineering program. The project, carried forward to completion in CREG 258, must involve the integration of hardware and software within a single system. Technical writing, product development, ethics and professional engineering, and presentation of design and research.

#### CREG 258 Senior Lab Project II 2 Credits

Continuation of CREG 257 Complete design, construction, and testing of projects selected and developed in CREG 257. Final design reviews and project presentations; final written report; development issues, including manufacturability, patents, and ethics. Pre-requisites as noted below or department approval.

**Prerequisites:** CREG 257

### Computer Science and Engineering

The department of computer science and engineering (CSE) offers undergraduate and graduate programs of study in computer science, computer science and business, and computer engineering, along with research opportunities in these fields. Computer science is the study of computer algorithms, software systems, and the effective use of computers to solve real-world problems and to develop new applications. Computer engineering is the study of how to develop new computer systems and how to integrate computers with electronic devices. Lehigh's majors prepare students for graduate school or for any of the different careers in computer science, computer engineering or computer systems analysis. Computer science and computer engineering and their related careers represent, in the US workplace, the largest field of engineering larger than all others, including electrical engineering, combined. More discussion on the career potential, as well as the most up to date course offerings can be found on our departmental web site, [www.cse.lehigh.edu](http://www.cse.lehigh.edu).

Lehigh University offers a bachelor of science degree in computer science from the P. C. Rossin College of Engineering and Applied Science; the bachelor of science degree in computer science, and the bachelor of arts degree with a major in computer science, from the College of Arts and Sciences; and a bachelor of science in Computer Science and Business, jointly supported by the P.C. Rossin College of Engineering and Applied Science and the College of Business and Economics. A minor in computer science is available except to students majoring in computer engineering or electrical engineering. Graduate study in the department leads to the degrees of master of science and doctor of philosophy (Ph.D.) in computer science. In conjunction with the department of Electrical and Computer Engineering (ECE), a bachelor of science degree in computer engineering and the master of science and Ph.D. degrees in computer engineering are also offered in the P.C. Rossin College of Engineering and Applied Science. In conjunction with the College of Business and Economics, the CSE department also takes part in the masters of business and engineering (MB&E) program

and in the integrated business and engineering major. Except for the Bachelor of Arts degree, each of the above programs is accredited by the Computer Accreditation Commission of ABET, Inc., [www.ABET.org](http://www.ABET.org).

The undergraduate programs emphasize the fundamental aspects of their respective areas, with extensive hands-on experiences for the students. Electives permit students to tailor their programs according to their interests and goals, whether they be in preparation for graduate study or entry into industry. The department highly recommends that students give focus to their electives by following one of the tracks listed in the department website at [www.cse.lehigh.edu/TRACKS](http://www.cse.lehigh.edu/TRACKS). Students have the opportunity to synthesize and apply their knowledge in a senior design project. Students are encouraged to become involved in the many research projects within the department, and may use independent study courses and their senior project as a way to participate while receiving course credit.

The graduate programs enable students to deepen their professional knowledge, understanding, and capability within their subspecialties. Each graduate student develops a program of study in consultation with his or her graduate advisor. Key thrust areas in the department include:

**Computer Systems Engineering:** computer architecture, sensor networks, robotics, mobile and wearable computing, and networking.

**Software Systems Engineering:** software architectures, parallel and distributed computing, object-oriented software, middleware, Web-based systems and networked software systems.

**Information Systems Engineering:** database, data mining, bioinformatics, computer graphics, optimization, multimedia systems, expert systems, artificial intelligence, and computer vision.

Both graduate and undergraduate research are encouraged. The department maintains a number of computer laboratories in support of computer science and computer engineering and the ECE department maintains additional laboratories supporting the hardware aspects of computer engineering. The department has research laboratories in robotics, networking, image processing, artificial intelligence, security, and web mining. These laboratories and their associated research activities are described more completely in the departmental web site ([www.cse.lehigh.edu](http://www.cse.lehigh.edu)). While these laboratories are research oriented, they are also used for undergraduate projects.

Computer laboratory usage is an essential part of the student's education. The primary department resources include a network of more than 60 workstations, file servers, and compute servers running the Unix operating system. These systems provide an array of software tools for our students and researchers including programming languages (C, C++, Java, Perl, Python, Ruby, Matlab, etc.), software development tools, software and hardware simulators, and computer-aided design packages. One of our teaching labs contains workstations specifically designed for flexibility in running different operating systems so that students can become system administrators, network defenders, or designers of high-performance code utilizing graphical processing units (GPUs) within a controlled environment.

The department's computers are connected via gigabit Ethernet to the university's backbone network. The university is connected through multiple high-capacity connections to the Internet as well as a connection to Internet2. Neither the department nor the university requires a student to own a personal computer. In addition to the departmental resources, the university provides campus-wide wireless network access, public sites containing hundreds of PCs and Macintoshes, multiple large-capacity compute servers, and most classrooms are equipped with a PC and a video projection system.

A detailed description of the curricular programs follows with a listing of the required courses and with a listing of the departmental course offerings. The departmental courses carry the prefixes CSE for computer science and engineering and ECE for electrical and computer engineering. Students should consult both listings for courses appropriate to their career goals.

**Professors.** Henry S. Baird, PhD (Princeton University); Henry F. Korth, PhD (Princeton University); Daniel P. Lopresti, PhD (Princeton University)

**Associate Professors.** Liang Cheng, PHDC (Rutgers University); Mooi Choo Chuah, PhD (University of California San Diego); Brian D. Davison, MS (Rutgers University); Jeffrey D. Heflin, PhD (University of Maryland University College); Xiaolei Huang, PhD (Rutgers University); Hector Munoz-Avila, PhD (Technische Universitat Kaiserslautern); John R. Spletzer, PhD (University of Pennsylvania)

**Assistant Professors.** Brian Y Chen, PhD (Rice University); Michael F. Spear, PhD (University of Rochester); Gang Tan, PhD (Princeton University)

**Professor Of Practice.** Sharon M. Kalafut, MS (The Pennsylvania State University)

**Emeriti.** Glenn D. Blank, PhD (University Wisconsin at Madison); Donald J. Hillman, PhD (University of Cambridge); Edwin J Kay, PhD (Lehigh University); Roger N. Nagel, PhD (University of Maryland)

## Undergraduate Programs

### Mission Statement for the Computer Science and Engineering Programs

The mission of the computer science and computer engineering programs is to prepare computer scientists and computer engineers to meet the challenges of the future; to promote a sense of scholarship, leadership and service among our graduates; to instill in the students the desire to create, develop, and disseminate new knowledge; and to provide international leadership to the computer science and engineering professions.

### Program Educational Objectives in Computer Science

Graduates of the Bachelor of Science in Computer Science Programs will:

- Apply their education in computer science to the analysis and solution of scientific, business, and industrial problems.
- Account for ethical and social issues when solving scientific, business, and industrial problems.
- Function effectively in a collaborative team and effectively communicate with members of the team.
- Engage in continued education in their field of expertise.
- Attain positions of leadership in their chosen field.

### Bachelor of Science in Computer Engineering

See catalog entry for Computer Engineering (p. 320).

### Bachelor of Science in Computer Science and Business

See catalog entry for Computer Science and Business (p. 369).

### Bachelor of Science in Computer Science

Bachelor of Science in Computer Science degree programs are available to students through either the College of Arts and Sciences or the P. C. Rossin College of Engineering and Applied Science. Both programs are accredited by the Computing Accreditation Commission of ABET, [www.ABET.org](http://www.ABET.org). The two programs are identical in the fundamental requirements in mathematics and computer science, and the programs are appropriate for entry into management or industrial positions. They are also appropriate for continued graduate study, though students considering graduate study are strongly encouraged to consider taking part in a research project during their junior year. The two BS programs differ in their non-computer science content in that the students must fulfill the distribution requirements of the respective college.

The required courses for the degrees contain the fundamentals of discrete mathematics, structured programming, algorithms, computer architecture, compiler design, operating systems, and programming languages. A strong foundation in mathematics is required. Because many courses are frequently offered, there are many sequences in which courses may be taken to satisfy the requirements. Below are the requirements for the B.S. degrees. See [www.cse.lehigh.edu/COURSES](http://www.cse.lehigh.edu/COURSES) for links to sample sequences and for a list of all CSE courses, their prerequisites, and when they are offered.

### P. C. Rossin College of Engineering and Applied Science Bachelor of Science in Computer Science

Total required credit hours: 128

**Required Computer Science courses**

CSE 002	Fundamentals of Programming	2
CSE 017	Programming and Data Structures	3
CSE 109	Systems Software	4
CSE 130	Technical Presentation	1
CSE 202	Computer Organization and Architecture	3
CSE 216	Software Engineering	3
CSE 261	Discrete Structures	3
CSE 262	Programming Languages	3
CSE 303	Operating System Design	3
CSE 318	Introduction to the Theory of Computation	3
CSE 340	Design and Analysis of Algorithms	3
CSE 379	Senior Project	3

**Required Math and Science courses**

CHM 030	Introduction to Chemical Principles	4
ENGR 010	Applied Engineering Computer Methods	2
ENGR 005	Introduction to Engineering Practice	2
MATH 021	Calculus I	4
MATH 022	Calculus II	4
MATH 023	Calculus III	4
MATH 205	Linear Methods	3
MATH 231	Probability and Statistics	3
PHY 011 & PHY 012	Introductory Physics I and Introductory Physics Laboratory I	5
PHY 021 & PHY 022	Introductory Physics II and Introductory Physics Laboratory II	5

**Required approved electives**<sup>1</sup>

CSE courses, not including CSE 042	12
Science and technology courses, chosen by the student with the approval of the student's advisor	6

**Humanities and Social Science (HSS) requirements**

ENGL 001	Composition and Literature	3
ENGL 002	Composition and Literature II	3
ECO 001	Principles of Economics	4
CSE 252	Computers, the Internet, and Society	3
HSS courses that satisfy the Engineering College "breadth and depth" requirements	17	

**Electives**

Free Electives	10
<b>Total Credits</b>	<b>128</b>

<sup>1</sup> The department highly recommends that students give focus to their approved electives by following one of the tracks listed in the department website at [www.cse.lehigh.edu/TRACKS](http://www.cse.lehigh.edu/TRACKS)

**College of Arts and Sciences****Bachelor of Science in Computer Science**

See the distribution requirements (p. 55) of the College of Arts and Sciences.

Total required credit hours: 127

**Required Computer Science courses**

CSE 001	Breadth of Computing	2
CSE 002	Fundamentals of Programming	2
CSE 017	Programming and Data Structures	3
CSE 109	Systems Software	4
CSE 130	Technical Presentation	1
CSE 202	Computer Organization and Architecture	3
CSE 216	Software Engineering	3

CSE 261	Discrete Structures	3
CSE 262	Programming Languages	3
CSE 303	Operating System Design	3
CSE 318	Introduction to the Theory of Computation	3
CSE 340	Design and Analysis of Algorithms	3
CSE 379	Senior Project	3

**Required Math and Science courses**

MATH 021	Calculus I	4
MATH 022	Calculus II	4
MATH 023	Calculus III	4
MATH 205	Linear Methods	3
MATH 231	Probability and Statistics	3
Natural science course <sup>1</sup>		12

**Required approved electives**<sup>2</sup>

CSE courses, not including CSE 042	12
Science and technology courses, chosen by the student with the approval of the student's advisor	6

**Humanities and Social Science (HSS) requirements**

ENGL 001	Composition and Literature	3
ENGL 002	Composition and Literature II	3
CSE 252	Computers, the Internet, and Society	3
HSS courses that satisfy the Arts and Sciences College distribution requirements	21	

**Electives**

Free Electives	12
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<sup>1</sup> Twelve credit hours of natural science, such that one course has an attached laboratory and such that two courses are in a laboratory science with the first course a prerequisite to the second course.

<sup>2</sup> The department highly recommends that students give focus to their approved electives by following one of the tracks listed in the department website at [www.cse.lehigh.edu/TRACKS](http://www.cse.lehigh.edu/TRACKS).

**College of Arts and Sciences****Bachelor of Arts in Computer Science**

This program of 120 credit hours is intended for students who desire a strong liberal arts program with a concentration in computer science. The program contains the fundamentals of computer science, including discrete mathematics, structured programming, data structures, programming languages, computer organization, compiler design, and operating systems.

See the distribution requirements (p. 55) of the College of Arts and Sciences. The requirements are listed below. For a suggested sequence of courses to satisfy this major and for a list of all CSE courses, their prerequisites, and when they are offered see [www.cse.lehigh.edu/COURSES](http://www.cse.lehigh.edu/COURSES)

Total required credit hours: 120

**Required Computer Science courses**

CSE 001	Breadth of Computing	2
CSE 002	Fundamentals of Programming	2
CSE 017	Programming and Data Structures	3
CSE 109	Systems Software	4
CSE 202	Computer Organization and Architecture	3
CSE 216	Software Engineering	3
CSE 261	Discrete Structures	3
CSE 262	Programming Languages	3
CSE 303	Operating System Design	3
CSE 318	Introduction to the Theory of Computation	3
CSE 340	Design and Analysis of Algorithms	3
Required CSE electives, any CSE course except CSE 042, CSE 130, or CSE 252		3

**Required Math and Science courses**

MATH 021	Calculus I	4
MATH 022	Calculus II	4
MATH 043	Survey of Linear Algebra	3
Total Credits		46

### Minor in Computer Science

The minor in computer science provides a basic familiarity with software development and programming, computer organization, and essential elements of computer science. This minor is not available to students majoring in Computer Engineering. The minor requires 17 credit hours, consisting of the following:

CSE 002	Fundamentals of Programming	2
CSE 017	Programming and Data Structures	3
CSE courses EXCEPT CSE 042, CSE 130, CSE 252		10
Total Credits		15

### P. C. Rossin College of Engineering and Applied Science

#### Graduate Programs

*Note: For information about graduate degrees in Computer Engineering, see the catalog entry for Computer Engineering (p. 320).*

Graduate programs of study provide a balance between formal classroom instruction and research and are tailored to the individual student's professional goals. The programs appeal to individuals with backgrounds in computer or information science, in computer engineering, in electrical engineering, in mathematics, or in the physical sciences. Research is an essential part of the graduate program. The research topics were listed earlier in the departmental description.

The Master of Science degree requires the completion of 30 credit hours of work and may include a three credit hour thesis. A program of study must be submitted in compliance with the graduate school regulations. An oral presentation of the thesis is required.

The Master of Engineering degree requires the completion of 30 credit hours of work, which includes design-oriented courses and an engineering project. A program of study must be submitted in compliance with the college rules. An oral presentation of the program is required.

The Ph.D. degree in computer science requires the completion of 42 credit hours of work (including the dissertation) beyond the master's degree (48 hours if the master's degree is not from Lehigh), the passing of departmental qualifying requirements appropriate to each degree within one year after entrance into the degree program, the admission into candidacy, the passing of a general examination in the candidate's area of specialization, and the writing and defense of a dissertation. Competence in a foreign language is not required.

The CSE department has a core curriculum requirement for graduate students in each of the degree programs. The purpose of this requirement is to guarantee that all students pursuing graduate studies in the department acquire an appropriate breadth of knowledge of their discipline.

Computer Science: PhD students in the CS program must satisfy a "Graduate Breadth" requirement which involves taking, in addition to the four mandated first-year courses, another four regular graduate-level courses in Computer Science and Engineering or a closely related subject. Courses appropriate to the student's educational objectives should be selected in consultation with the student's advisor. The plan must be approved by the advisor, the Director of Graduate Studies for CSE, and the Chair of the CSE Department. To satisfy the requirement, courses must be at the 400-level and may not be research, independent study, experimental, or special topics courses (for example, courses numbered CSE 450 or CSE 49X will not satisfy the requirement).

This new requirement applies to CS students entering the Ph.D. program in Fall 2010 or later (i.e., those who fall under the new rules regarding the first-year curriculum). For details on these requirements, see the department's web site [www.cse.lehigh.edu](http://www.cse.lehigh.edu).

Courses from other universities or undergraduate studies may be used to satisfy these requirements, by petition, at the discretion of the

department faculty. Additional graduate program information may be obtained from the department's graduate coordinator.

#### Courses

##### CSE 001 Breadth of Computing 2 Credits

Broad overview of computer science, computer systems, and computer applications. Interactive Web page development. Includes laboratory. Not available to students who have taken CSE 012 or ENGR 001.

##### CSE 002 Fundamentals of Programming 2 Credits

Problem-solving and object-oriented programming using Java. Includes laboratory. No prior programming experience needed.

##### CSE 012 Survey of Computer Science 3 Credits

Fundamental concepts of computing and "computational thinking": problem analysis, abstraction, algorithms, digital representation of information, and networks. Applications of computing and communication that have changed the world. Impact of computing on society. Concepts of software development using a scripting language such as Python, Perl, or Ruby. Not available to students who have taken CSE 015 or CSE 001.

##### CSE 017 Programming and Data Structures 3 Credits

Algorithmic design and implementation in a high level, object oriented language, such as Java. Classes, subclasses, recursion, searching, sorting, linked lists, trees, stacks, queues. Credit will not be given for both CSE 017 and CSE 018. Prerequisites as noted below.

**Prerequisites:** CSE 015 or CSE 002

**Attribute/Distribution:** MA

##### CSE 042 Game Design 3 Credits

Modern topics in game design: Finite State Machines, iterative design process, systems and interactivity, designing rules for digital games, emergence in games, games as Schemas of Uncertainty, games as Information Theory Schemas, games as Information Systems, games as Cybernetic Systems. The course does not count as a technical elective for majors in Computer Science, Computer Science and Business, or Computer Engineering.

##### CSE 109 Systems Software 4 Credits

Advanced programming and data structures, including dynamic structures, memory allocation, data organization, symbol tables, hash tables, B-trees, data files. Object-oriented design and implementation of simple assemblers, loaders, interpreters, compilers, and translators. Practical methods for implementing medium-scale programs. Prerequisites as noted below.

**Prerequisites:** CSE 017 or CSE 018

##### CSE 130 Technical Presentation 1 Credit

Oral and written communication of information in computer science. Technical writing; structure, style, and delivery of oral presentations; use of visual aids. Prerequisites as noted below.

**Prerequisites:** CSE 017 or CSE 018

**Can be taken Concurrently:** CSE 017, CSE 018

##### CSE 190 Special Topics 1-3 Credit

Supervised reading and research. Consent of department required.

##### CSE 202 Computer Organization and Architecture 3 Credits

Interaction between low-level computer architectural properties and high-level program behaviors: instruction set design; digital logic and assembly language; processor organization; the memory hierarchy; multicore and GPU architectures; and processor interrupt/exception models. Credit will not be given for both CSE 201 and CSE 202. Prerequisites as noted below.

**Prerequisites:** CSE 017 or CSE 018

##### CSE 216 Software Engineering 3 Credits

The software lifecycle; lifecycle models; software planning; testing; specification methods; maintenance. Emphasis on team work and large-scale software systems, including oral presentations and written reports. Prerequisites as noted below.

**Prerequisites:** CSE 109 or CSC 109

**CSE 241 Database Systems and Applications 3 Credits**

Design of large databases: Integration of databases and applications using SQL and JDBC; transaction processing; performance tuning; data mining and data warehouses. Not available to students who have credit for CSE 341 or IE 224. Prerequisites as noted below or consent of instructor.

**Prerequisites:** CSE 017 or CSE 018 or CSE 012 or CSC 017 or CSC 011 or CSE 015

**CSE 252 Computers, the Internet, and Society 3 Credits**

An interactive exploration of the current and future role of computers, the Internet, and related technologies in changing the standard of living, work environments, society and its ethical values. Privacy, security, depersonalization, responsibility, and professional ethics; the role of computer and Internet technologies in changing education, business modalities, collaboration mechanisms, and everyday life.

**Attribute/Distribution:** SS

**CSE 261 Discrete Structures 3 Credits**

Topics in discrete structures chosen for their applicability to computer science and engineering. Sets, propositions, induction, recursion; combinatorics; binary relations and functions; ordering, lattices and Boolean algebra; graphs and trees; groups and homomorphisms. Various applications. Prerequisites as noted below.

**Prerequisites:** (MATH 021 or MATH 031 or MATH 051 or MATH 076)

**Attribute/Distribution:** MA

**CSE 262 Programming Languages 3 Credits**

Use, structure and implementation of several programming languages. Prerequisites as noted below.

**Prerequisites:** CSE 017 or CSC 017 or CSE 018

**CSE 265 System and Network Administration 3 Credits**

Overview of systems and network administration in a networked UNIX-like environment. System installation, configuration, administration, and maintenance; security principles; ethics; network, host, and user management; standard services such as electronic mail, DNS, and WWW; file systems; backups and disaster recovery planning; troubleshooting and support services; automation, scripting; infrastructure planning. Prerequisites as noted below.

**Prerequisites:** CSE 017 or CSE 018

**CSE 271 Programming in C and the Unix Environment 3 Credits**

C language syntax and structure. C programming techniques. Emphasis on structured design for medium to large programs. Unix operating system fundamentals. Unix utilities for program development, text processing, and communications. Prerequisites as noted below.

**Prerequisites:** CSE 109

**CSE 300 Apprentice Teaching 1-4 Credit****CSE 302 Compiler Design 3 Credits**

Principles of artificial language description and design. Sentence parsing techniques, including operator precedence, bounded-context, and syntax-directed recognizer schemes. The semantic problem as it relates to interpreters and compilers. Dynamic storage allocation, table grammars, code optimization, compiler-writing languages. Prerequisites as noted below.

**Prerequisites:** (CSE 109)

**CSE 303 Operating System Design 3 Credits**

Process and thread programming models, management, and scheduling. Resource sharing and deadlocks. Memory management, including virtual memory and page replacement strategies. I/O issues in the operating system. File system implementation. Multiprocessing. Computer security as it impacts the operating system. Prerequisites as noted below.

**Prerequisites:** ECE 201 or (CSE 201 or CSE 202) and CSE 109

**CSE 307 Structural Bioinformatics 3 Credits**

Computational techniques and principles of structural biology used to examine molecular structure, function, and evolution. Topics include: protein structure alignment and prediction; molecular surface analysis; statistical modeling; QSAR; computational drug design; influences on binding specificity; protein-ligand, -protein, and -DNA interactions; molecular simulation, electrostatics. Tutorials on UNIX systems and research software support an interdisciplinary collaborative project in computational structural biology. Credit will not be given for both CSE 307 and 407. Must have junior standing or higher. Prerequisites as noted below or consent of instructor.

**Prerequisites:** BIOS 120 or CSE 109 or CHM 113 or MATH 231

**CSE 308 Bioinformatics: Issues and Algorithms 3 Credits**

Computational problems and their associated algorithms arising from the creation, analysis, and management of bioinformatics data. Genetic sequence comparison and alignment, physical mapping, genome sequencing and assembly, clustering of DNA microarray results in gene expression studies, computation of genomic rearrangements and evolutionary trees. Credit will not be given for both CSE 308 (BIOE 308) and CSE 408 (BIOE 408). No prior background in biology is assumed. Prerequisites as noted below or consent of instructor.

**Prerequisites:** CSE 017 or CSE 018

**CSE 313 Computer Graphics 3 Credits**

Computer graphics for animation, visualization, and production of special effects: displays, methods of interaction, images, image processing, color, transformations, modeling (primitives, hierarchies, polygon meshes, curves and surfaces, procedural), animation (keyframing, dynamic simulation), rendering and realism (shading, texturing, shadows, visibility, ray tracing), and programmable graphics hardware. Prerequisites as noted below or consent of instructor.

**Prerequisites:** CSE 109

**CSE 318 Introduction to the Theory of Computation 3 Credits**

Formal study of theoretical computational models: finite automata, pushdown automata, and Turing machines. Study of formal languages: regular, context-free, and decidable languages. Prerequisites as noted below.

**Prerequisites:** CSE 261 or MATH 261 or CSC 261

**CSE 319 Image Analysis and Graphics 3 Credits**

State-of-the-art techniques for fundamental image analysis tasks: feature extraction, segmentation, registration, tracking, recognition, search (indexing and retrieval). Related computer graphics techniques: modeling (geometry, physically-based, statistical), simulation (data-driven, interactive), animation, 3D image visualization, and rendering. Credit will not be given for both CSE 319 and CSE 419. Prerequisites as noted below or consent of instructor.

**Prerequisites:** CSE 313

**CSE 320 Biomedical Image Computing and Modeling 3 Credits**

Biomedical image modalities, image computing techniques, and imaging informatics systems. Understanding, using, and developing algorithms and software to analyze biomedical image data and extract useful quantitative information: Biomedical image modalities and formats; image processing and analysis; geometric and statistical modeling; image informatics systems in biomedicine. Credit will not be given for both CSE 320 and CSE 420. Prerequisites as noted below.

**Prerequisites:** (MATH 205 or MATH 043) and CSE 017

**Attribute/Distribution:** ND

**CSE 326 Pattern Recognition 3 Credits**

Bayesian decision theory and the design of parametric and nonparametric classifiers: linear (perceptrons), quadratic, nearest-neighbors, neural nets. Machine learning techniques: boosting, bagging. High-performance machine vision systems: segmentation, contextual analysis, adaptation. Students carry out projects, e.g. on digital libraries and vision-based Turing tests. Credit will not be given for both CSE 326 and CSE 426. Prerequisites as noted below or consent of instructor.

**Prerequisites:** CSE 109 and CSE 340 and MATH 205 and MATH 231

**CSE 327 Artificial Intelligence Theory and Practice 3 Credits**

Introduction to the field of artificial intelligence: Problem solving, knowledge representation, reasoning, planning and machine learning. Use of AI systems or languages. Advanced topics such as natural language processing, vision, robotics, and uncertainty. Prerequisites as noted below.

**Prerequisites:** CSE 015 or CSE 017 or CSE 018 or CSE 002

**CSE 331 User Interface Systems and Techniques 3 Credits**

Principles and practice of creating effective human-computer interfaces. Design and user evaluation of user interfaces; design and use of interface building tools. Programming projects using a variety of interface building tools to construct and evaluate interfaces. Prerequisites as noted below or consent of instructor.

**Prerequisites:** CSE 017

**CSE 332 Multimedia Design and Development 3 Credits**

Analysis, design and implementation of multimedia software, primarily for e-learning courses or training. Projects emphasize user interface design, content design with storyboards or scripts, creation of graphics, animation, audio and video materials, software development using high level authoring tools. Prerequisite: CSE 12 or CSE 15 or ENGR 1 or consent of instructor.

**Prerequisites:** CSE 012 or CSE 015 or ENGR 001

**CSE 334 Software System Security 3 Credits**

Survey of common software vulnerabilities: buffer overflows, format string attacks, cross-site scripting, and botnets. Discussion of common defense mechanisms: static code analysis, reference monitors, language-based security, secure information flow, and others. Credit will not be given for both CSE 334 and CSE 434. Prerequisites as noted below.

**Prerequisites:** CSE 109 and CSE 262

**CSE 335 Topics on Intelligent Decision Support Systems 3 Credits**

Intelligent decision support systems (IDSSs). AI techniques that are used to build IDSSs: case-based reasoning, decision trees and knowledge representation. Applications of these techniques: help-desk systems, e-commerce, and knowledge management. Credit will not be given for both CSE 335 and CSE 435. Prerequisites as noted below.

**Prerequisites:** CSE 327 or CSE 109

**CSE 336 Embedded Systems 3 Credits**

Use of small computers embedded as part of other machines. Limited-resource microcontrollers and state machines from high description language. Embedded hardware: RAM, ROM, flash, timers, UARTs, PWM, A/D, multiplexing, debouncing. Development and debugging tools running on host computers. Real-Time Operating System (RTOS) semaphores, mailboxes, queues. Task priorities and rate monotonic scheduling. Software architectures for embedded systems. Prerequisites as noted below.

**Prerequisites:** CSE 017 or CSE 018

**CSE 337 Reinforcement Learning 3 Credits**

Algorithms for automated learning from interactions with the environment to optimize long-term performance. Markov decision processes, dynamic programming, temporal-difference learning, Monte Carlo reinforcement learning methods. Credit will not be given for both CSE 337 and CSE 437. Prerequisites as noted below.

**Prerequisites:** MATH 231 and CSE 109

**CSE 340 Design and Analysis of Algorithms 3 Credits**

Algorithms for searching, sorting, manipulating graphs and trees, finding shortest paths and minimum spanning trees, scheduling tasks, etc.: proofs of their correctness and analysis of their asymptotic runtime and memory demands. Designing algorithms: recursion, divide-and-conquer, greediness, dynamic programming. Limits on algorithm efficiency using elementary NP-completeness theory. Credit will not be given for both CSE 340 (Math 340) and CSE 441 (Math 441). Prerequisites as noted below.

**Prerequisites:** (MATH 022 or MATH 032) and (CSE 261 or MATH 261 or CSC 261)

**CSE 341 Database Systems, Algorithms, and Applications 3 Credits**

Design of large databases; normalization; query languages (including SQL); Transaction-processing protocols; Query optimization; performance tuning; distributed systems. Not available to students who have credit for CSE 241 or IE 224. Prerequisites as noted below or consent of instructor.

**Prerequisites:** CSE 017 or CSE 018

**CSE 342 Fundamentals of Internetworking 4 Credits**

Architecture and protocols of computer networks. Protocol layers; network topology; data-communication principles, including circuit switching, packet switching and error control techniques; sliding window protocols, protocol analysis and verification; routing and flow control; local and wide area networks; network interconnection; client-server interaction; emerging networking trends and technologies; topics in security and privacy. Prerequisites as noted below.

**Prerequisites:** CSE 109

**CSE 343 Network Security 3 Credits**

Overview of network security threats and vulnerabilities. Techniques and tools for detecting, responding to and recovering from security incidents. Fundamentals of cryptography. Hands-on experience with programming techniques for security protocols. Credit will not be given for both CSE 343 and CSE 443. Prerequisites as noted below.

**Prerequisites:** CSE 265 or CSE 303 or CSE 342

**CSE 345 WWW Search Engines 3 Credits**

Study of algorithms, architectures, and implementations of WWW search engines; Information retrieval (IR) models; performance evaluation; properties of hypertext crawling, indexing, searching and ranking; link analysis; parallel and distributed IR; user interfaces. Credit will not be given for both 345 and 445. Prerequisites as noted below.

**Prerequisites:** CSE 109

**CSE 347 Data Mining 3 Credits**

Overview of modern data mining techniques: data cleaning; attribute and subset selection; model construction, evaluation and application. Fundamental mathematics and algorithms for decision trees, covering algorithms, association mining, statistical modeling, linear models, neural networks, instance-based learning and clustering covered. Practical design, implementation, application, and evaluation of data mining techniques in class projects. Credit will not be given for both CSE 347 and CSE 447.

**Prerequisites:** ((CSE 017 or CSE 018) and MATH 231) or (BIS 120 and ECO 045)

**Can be taken Concurrently:** ECO 045

**CSE 348 AI Game Programming 3 Credits**

Contemporary computer games: techniques for implementing the program controlling the computer component; using Artificial Intelligence in contemporary computer games to enhance the gaming experience: pathfinding and navigation systems; group movement and tactics; adaptive games, game genres, machine scripting language for game designers, and player modeling. Credit will not be given for both CSE 348 and CSE 448. Prerequisites as noted below.

**Prerequisites:** CSE 327 or CSE 109

**CSE 350 Special Topics 3 Credits**

Selected topics in the field of computer science not included in other courses. May be repeated for credit.

**Repeat Status:** Course may be repeated.

**Prerequisites:** MATH 205

**CSE 360 Introduction to Mobile Robotics 3 Credits**

Algorithms employed in mobile robotics for navigation, sensing, and estimation. Common sensor systems, motion planning, robust estimation, bayesian estimation techniques, Kalman and Particle filters, localization and mapping. Credit will not be given for both CSE 360 and CSE 460. Prerequisites as noted below.

**Prerequisites:** MATH 205 or MATH 023 or MATH 231

**CSE 363 Network Systems Design 3 Credits**

Design principles and issues of network systems. Traditional protocol processing systems and latest network processor/processing technologies. Packet processing, protocol processing, classification and forwarding, switching fabrics, network processors, and network systems design tradeoffs. Prerequisites as noted below or consent of instructor.

**Prerequisites:** CSE 342

**CSE 375 Principles of Practice of Parallel Computing 3 Credits**

Parallel computer architectures, parallel languages, parallelizing compilers and operating systems. Design, implementation, and analysis of parallel algorithms for scientific and data-intensive computing. Credit is not given for both CSE 375 and CSE 475.

**Prerequisites:** (ECE 201 or CSE 201) or CSE 303 or CSE 202

**Can be taken Concurrently:** ECE 201, CSE 201, CSE 303, CSE 202

**CSE 379 Senior Project 3 Credits**

Design, implementation, and evaluation of a computer science capstone project conducted by student teams working from problem definition to testing and implementation; written progress reports supplemented by oral presentations. Must have senior standing.

**CSE 389 Honors Project 1-8 Credit****CSE 392 Independent Study 1-3 Credit**

An intensive study, with report, of a topic in computer science which is not treated in other courses. May be repeated for credit. Consent of instructor required.

**Repeat Status:** Course may be repeated.

**CSE 401 Advanced Computer Architecture 3 Credits**

Design, analysis and performance of computer architectures; high-speed memory systems; cache design and analysis; modeling cache performance; principle of pipeline processing, performance of pipelined computers; scheduling and control of a pipeline; classification of parallel architectures; systolic and data flow architectures; multiprocessor performance; multiprocessor interconnections and cache coherence.

**CSE 403 Advanced Operating Systems 3 Credits**

Principles of operating systems with emphasis on hardware and software requirements and design methodologies for multi-programming systems. Global topics include the related areas of process management, resource management, and file systems. Prerequisites as noted below.

**Prerequisites:** CSE 303

**CSE 404 Computer Networks 3 Credits**

Study of architecture and protocols of computer networks. The ISO model; network topology; data-communication principles, including circuit switching, packet switching and error control techniques; sliding window protocols, protocol analysis and verification; routing and flow control; local area networks; network interconnection; topics in security and privacy.

**CSE 405 Advanced Programming Languages 3 Credits**

Basic ideas behind modern programming language design, with a focus on functional languages: type systems, modularity, operational semantics, and others. Students need to have some mathematical maturity, including familiarity with proof techniques such as induction.

**CSE 406 Research Methods 3 Credits**

Technical writing, reading the literature critically, analyzing and presenting data, conducting research, making effective presentations, and understanding social and ethical responsibilities. Topics drawn from probability and statistics, use of scripting languages, and conducting large-scale experiments. Must have first-year status in either the CS or CompE Ph. D. program.

**CSE 407 Structural Bioinformatics 3 Credits**

Computational techniques and principles of structural biology used to examine molecular structure, function, and evolution. Topics include: protein structure alignment and prediction; molecular surface analysis; statistical modeling; QSAR; computational drug design; influences on binding specificity; protein-ligand, -protein, and -DNA interactions; molecular simulation, electrostatics. This course, a version of 307 for graduate students, requires advanced assignments and a collaborative project. Credit will not be given for both CSE 307 and 407. Consent of instructor required.

**CSE 408 Bioinformatics: Issues and Algorithms 3 Credits**

Computational problems and their associated algorithms arising from the creation, analysis, and management of bioinformatics data. Genetic sequence comparison and alignment, physical mapping, genome sequencing and assembly, clustering of DNA microarray results in gene expression studies, computation of genomic rearrangements and evolutionary trees. This course, a version of 308 for graduate students requires advanced assignments. Credit will not be given for both BIOE 308 (CSE 308) and BIOE 408 (CSE 408). No prior background in biology is assumed. Prerequisites as noted below or consent of instructor.

**Prerequisites:** CSE 017 or CSE 018

**CSE 409 Theory of Computation 3 Credits**

Finite automata. Pushdown automata. Relationship to definition and parsing of formal grammars. Prerequisites as noted below.

**Prerequisites:** CSE 318 or CSC 318

**CSE 411 Advanced Programming Techniques 3 Credits**

Deeper study of programming techniques, data structures, backtracking, recursion. Applications of basic theoretical disciplines such as automata theory and formal language theory. Assignments using a contemporary programming language. Credit will not be given for both CSE 109 and CSE 411.

**CSE 419 Image Analysis and Graphics 3 Credits**

State-of-the-art techniques for fundamental image analysis tasks; feature extraction, segmentation, registration, tracking, recognition, search (indexing and retrieval). Related computer graphics techniques: modeling (geometry, physically-based, statistical), simulation (data-driven, interactive), animation, 3D image visualization, and rendering. This course, a graduate version of CSE 319, requires additional advanced assignments. Credit will not be given for both CSE 319 and CSE 419.

**CSE 420 Biomedical Image Computing and Modeling 3 Credits**

Biomedical image modalities, image computing techniques, and imaging informatics systems. Understanding, using, and developing algorithms and software to analyze biomedical image data and extract useful quantitative information: Biomedical image modalities and formats; image processing and analysis; geometric and statistical modeling; image informatics systems in biomedicine. This course, a graduate version of BIOE 320, requires additional advanced assignments. Credit will not be given for both BIOE 320 and BIOE 420. Prerequisites as noted below or consent of instructor.

**Prerequisites:** MATH 205 and CSE 109

**Attribute/Distribution:** ND

**CSE 424 Advanced Communication Networks 3 Credits**

Current and emerging research topics in communication networks: network protocols, network measurement, internet routing, network security, adhoc and sensor networks, disruption tolerant networks. Lecture, readings, and discussion, plus a project. Prerequisites as noted below or consent of instructor.

**Prerequisites:** (CSE 342 or CSE 404) and MATH 231

**CSE 426 Pattern Recognition 3 Credits**

Bayesian decision theory and the design of parametric and nonparametric classifiers: linear (perceptrons), quadratic, nearest-neighbors, neural nets. Machine learning techniques: boosting, bagging. High-performance machine vision systems: segmentation, contextual analysis, adaptation. Students carry out projects, e.g. on digital libraries and vision-based Turing tests. This course, a version of CSE 326 for graduate students requires advanced assignments. Credit will not be given for both CSE 326 and CSE 426.

**CSE 428 Semantic Web Topics 3 Credits**

Theory, architecture and applications of the Semantic Web. Issues in designing distributed knowledge representation languages, ontology development, knowledge acquisition, scalable reasoning, integrating heterogeneous data sources, and web-based agents.

**CSE 431 Intelligent Agents 3 Credits**

Principles of rational autonomous software systems. Agent theory; agent architectures, including logic-based, utility-based, practical reasoning, and reactive; multi-agent systems; communication languages; coordination methods including negotiation and distributed problem solving; applications.

**CSE 432 Object-Oriented Software Engineering 3 Credits**

Design and construction of modular, reusable, extensible and portable software using statically typed object-oriented programming languages (Eiffel, C++, Objective C). Abstract data types; genericity, multiple inheritance; use and design of software libraries; persistence, and object-oriented databases; impact of object-oriented programming on the software life cycle.

**CSE 434 Software System Security 3 Credits**

Survey of common software vulnerabilities: buffer overflows, format string attacks, cross-site scripting, and botnets. Discussion of common defense mechanisms: static code analysis, reference monitors, language-based security, secure information flow, and others. The graduate version differs from the undergraduate version by requiring advanced assignments and projects. Credit will not be given for both CSE 334 and CSE 434. Must have graduate standing in Computer Science or consent of instructor.

**CSE 435 Topics on Intelligent Decision Support Systems 3 Credits**

AI techniques used to build IDSSs: case-based reasoning, decision trees and knowledge representation. Applications: helpdesk systems, e-commerce, and knowledge management. This course, a version of 335 for graduate students, requires research projects and advanced assignments. Credit will not be given for both CSE 335 and CSE 435.

**CSE 437 Reinforcement Learning and Markov Decision Processes 3 Credits**

Formal model based on Markov decision processes for automated learning from interactions with stochastic, incompletely known environments. Markov decision processes, dynamic programming, temporal-difference learning, Monte Carlo reinforcement learning methods. Credit will not be given for both CSE 337 and CSE 437. Must have graduate standing in Computer Science or have consent of instructor.

**CSE 441 Advanced Algorithms 3 Credits**

This is a graduate-level version of CSE 340 (Math 340) Design and Analysis of Algorithms, covering that course's content plus matroid theory, linear programming, max-flow, computational geometry, matching patterns in strings, randomized algorithms, and approximation algorithms for NP-complete problems. Credit will not be given for both CSE 340 (Math 340) and CSE 441 (Math 441).

**CSE 443 Network Security 3 Credits**

Overview of network security threats and vulnerabilities. Techniques and tools for detecting, responding to and recovering from security incidents. Fundamentals of cryptography. Hands-on experience with programming techniques for security protocols. This course, a version of CSE 343 for graduate students, requires research projects and advanced assignments. Credit will not be given for both CSE 343 and CSE 443. Prerequisites as noted below.

**Prerequisites:** (CSE 404 or ECE 404) or CSE 265 or CSE 303 or CSE 342

**CSE 445 WWW Search Engines 3 Credits**

Study of algorithms, architectures, and implementations of WWW search engines. Information retrieval (IR) models; performance evaluation; properties of hypertext crawling, indexing, searching and ranking; link analysis; parallel and distributed IR; user interfaces. This course, a version of 345 for graduate students, requires research projects and advanced assignments. Credit will not be given for both CSE 345 and CSE 445.

**CSE 447 Data Mining 3 Credits**

Modern data mining techniques: data cleaning; attribute and subset selection; model construction, evaluation and application. Algorithms for decision trees, covering algorithms, association rule mining, statistical modeling, model and regression trees, neural networks, instance-based learning and clustering covered. This course, a version of CSE 347 for graduate students, requires research projects and advanced assignments. Credit will not be given for both CSE 347 and CSE 447.

**CSE 450 Special Topics 3 Credits**

Selected topics in computer science not included in other courses. May be repeated for credit.

**Repeat Status:** Course may be repeated.

**CSE 460 Mobile Robotics 3 Credits**

Algorithms employed in mobile robotics for navigation, sensing, and estimation. Common sensor systems, motion planning, robust estimation, Bayesian estimation techniques, Kalman and particle filters, localization and mapping. This course, a version of CSE 360 for graduate students will require an independent project to be presented in class. Credit will not be given for both CSE 360 and CSE 460.

**Prerequisites:** MATH 023 and MATH 205 and MATH 231

**Can be taken Concurrently:** MATH 231

**CSE 475 Principles and Practice of Parallel Computing 3 Credits**

Parallel computer architectures, parallel languages, parallelizing compilers and operating systems. Design, implementation, and analysis of parallel algorithms for scientific and data-intensive computing. This is a graduate version of CSE 375. As such, it will require additional assignments. Credit is not given for both CSE 375 and CSE 475.

**CSE 490 Thesis 1-6 Credit****CSE 491 Research Seminar 1-3 Credit**

Regular meetings focused on specific topics related to the research interests of department faculty. Current research will be discussed. Students may be required to present and review relevant publications. May be repeated for credit up to a maximum of three (3) credits. Consent of instructor required.

**Repeat Status:** Course may be repeated.

**CSE 492 Independent Study 1-3 Credit**

An intensive study, with report of a topic in computer science that is not treated in other courses. May be repeated for credit. Consent of instructor required.

**Repeat Status:** Course may be repeated.

**CSE 499 Dissertation 1-15 Credit****Cooperative Graduate Education**

The P.C. Rossin College of Engineering and Applied Science permits graduate students to spend part of their research experience in industry, business, or a government agency. In general, the external research experience should be complementary to their graduate studies at Lehigh University and can count towards their degree program through ENGR 400 Engineering Co-op for Graduate Students (see Graduate tab). Permission of the department chair is required in order to participate in this program.

Subject to university/federal regulations, when enrolled in courses at Lehigh University, a student can work for a maximum of 20 hours at the company/laboratory (co-op partner). If not enrolled in courses other than ENGR 400, a student will be permitted to work full time at the co-op partner. Full time employment over the summer will also be permitted. Maintenance of full-time status, however, requires that during the semester students must be registered for the minimum number of credit hours as listed in R&P or meet the qualifications to be certified as a full-time student.

**MS/MEng Co-op programs**

- ENGR 400 can be taken for a maximum of 6 credits, with at most 3 credits in any registration period.
- Minimum of 18 course credit hours, excluding ENGR 400 and Thesis (ENGR 490) must be obtained through Lehigh University



**Ph.D. program**

• 9 credits of ENGR 400 can be taken throughout a student's entire graduate study at Lehigh, with at most 3 credits in any registration period.

**Courses**

**ENGR 400 Engineering Co-op for Graduate Students 1-3 Credit**

Supervised cooperative work assignment to obtain practical experience in field of study. Requires consent of department chairperson. When on a cooperative assignment, the student must register for this course to maintain continuous student status. Limit to at most three credits per registration period. No more than six credits may be applied towards a master's program and no more than nine credits may be used throughout a student's entire graduate study at Lehigh.

**Repeat Status:** Course may be repeated.

**ENGR 401 Teaching/Presentation Skills 1 Credit**

Development of teaching and presentation skills for scientific professionals. Presentation effectiveness, teaching/presentation methodologies, classroom management, course development/content preparation, lecture/presentation development and lecture/presentation delivery. Individualized undergraduate course specific modules selected by student. Enrollment limited to Rossin Doctoral Fellows.

**ENGR 402 Preparing for the Professoriate 1 Credit**

Overview of the job search, research program development and service skills for graduate students entering academic careers. Transition from graduate student to faculty responsibilities, the post-doctoral experience, time management, CV/resume preparation, faculty search process, tenure and promotion, research leadership and program development, research proposal preparation and research sponsorship. Enrollment limited to Rossin Doctoral Fellows.

**ENGR 452 Mathematical Methods in Engineering 3 Credits**

Analytical techniques are developed for the solution of engineering problems described by algebraic systems, and by ordinary and partial differential equations. Topics covered include: linear vector spaces; eigenvalues, eigen-vectors, and eigenfunctions. First and higher-order linear differential equations with initial and boundary conditions; Sturm-Louville problems; Green's functions. Special functions; Bessel, etc. Qualitative and quantitative methods for nonlinear ordinary differential equations; phase plane. Solutions of classical partial differential equations from the physical sciences; transform techniques; method of characteristics.

**ENGR 490 Thesis (Moc) 1 Credit**

**ENGR 499 Dissertation (Moc) 1 Credit**

**Electrical Engineering and Engineering Physics**

This dual-degree curriculum is particularly well suited for students seeking thorough preparation in the field of electronic device physics. It is a combination of the basic electrical engineering and engineering physics curricula and requires 162 credit hours, distributed over five years. The student will earn two degrees: B.S. in electrical engineering and B.S. in engineering physics.

Two alternative course sequences are listed below. Students who follow the EE-EP (EE first) course sequence will complete 132-134 credit hours, including all of the required electrical engineering courses, by the end of the fourth year and the rest of the 163 credit hours at the end of the fifth year. Since the electrical engineering degree requires 134 credit hours, students normally will complete the requirements for that degree by the end of the eighth or ninth semester.

In the alternative EP-EE (EP first) course sequence, the student completes 131-133 credit hours by the end of the fourth year, including all the required physics courses, and the rest of the 163 credits at the end of the fifth year. Since 131 credit hours are required for the engineering physics degree, the student will complete the requirements for that degree at the end of the fourth year, and the requirements for the electrical engineering degree at the end of the fifth year.

Students interested in a dual-degree program combining physics (rather than engineering physics) and electrical engineering should consult the Physics section of this catalog. That program allows the student to earn the B.S. in physics and the B.S. in electrical engineering.

Students interested in either dual-degree program should contact Prof. Gary G. DeLeo, Department of Physics.

**The recommended sequences of courses for the two different EEEP sequences**

**EE-EP**

**First Year**

First Semester	CR	Second Semester	CR
ENGL 001	3	ENGL 002	3
MATH 021	4	MATH 022	4
ENGR 005	2	ENGR 005	2
Select one of the following: <sup>1</sup>		5-6 Select one of the following: <sup>1</sup>	
PHY 011 & PHY 012	5	CHM 030 & ENGR 010	6
CHM 030 & ENGR 010	6	PHY 011 & PHY 012	5

**14-15**

**14-15**

**Second Year**

First Semester	CR	Second Semester	CR
PHY 021 & PHY 022	5	PHY 031	3
ECE 033	4	ECE 121	2
ECE 081	4	ECE 123	3
MATH 023	4	ECE 182	1
		MATH 205	3
		MATH 208	3
		HSS	3
	<b>17</b>		<b>18</b>

**Third Year**

First Semester	CR	Second Semester	CR
PHY 212	3	PHY 213	3
ECE 108	4	PHY 215	4
MATH 231	3	ECE 125	3
MATH 322	3	ECE 126	3
ECO 001	4	ECE 138	2
		HSS	3
	<b>17</b>		<b>18</b>

**Fourth Year**

First Semester	CR	Second Semester	CR
PHY 362	3	ECE 136	3
PHY 363	3	ECE - Ap. Elec.	9
ECE 257	3	Elective	4
ECE - Ap. Elec.	3		
HSS	6		
	<b>18</b>		<b>16</b>

**Fifth Year**

First Semester	CR	Second Semester	CR
PHY 340 or ME 104	3	PHY 262	2
EP - Ap. Elec.	6	EP - Ap.Elec.	6
Electives	6	Electives	7
	<b>15</b>		<b>15</b>

Total Credits: 162-164

<sup>1</sup> Required natural science courses, one taken fall semester and the other taken in spring.

Total Credits [163]

Credits in 4 yrs [132-134]

The EP-approved electives must include at least three courses from the following:

PHY 363	Physics of Solids	3
PHY 369	Quantum Mechanics I	3
PHY 352	Modern Optics	3
or PHY 355	Nonlinear Optics	
PHY 348	Plasma Physics	3
or PHY 365	Physics Of Fluids	
PHY 380	Introduction to Computational Physics	3

The ECE-approved electives must be approved by the student's advisor.

#### EP-EE

##### First Year

First Semester	CR	Second Semester	CR
ENGL 001	3	ENGL 002	3
MATH 021	4	MATH 022	4
ENGR 005	2	ENGR 005	2
Select one of the following: <sup>1</sup>	5-6	Select one of the following: <sup>1</sup>	5-6
PHY 011 & PHY 012	5	CHM 030 & ENGR 010	6
CHM 030 & ENGR 010	6	PHY 011 & PHY 012	5
	<b>14-15</b>		<b>14-15</b>

##### Second Year

First Semester	CR	Second Semester	CR
PHY 021 & PHY 022	5	PHY 031	3
ECE 033	4	ECE 123 & ECE 121	5
ECE 081	4	ECE 182	1
MATH 023	4	MATH 205	3
		MATH 208	3
		HSS	3
	<b>17</b>		<b>18</b>

##### Third Year

First Semester	CR	Second Semester	CR
PHY 212	3	PHY 213	3
ECE 108	4	PHY 215	4
MATH 322	3	PHY 262	2
ECO 001	4	ECE 125	3
EP - Ap. Elec.	3	ECE 126	3
		HSS	3
	<b>17</b>		<b>18</b>

##### Fourth Year

First Semester	CR	Second Semester	CR
PHY 340 or ME 104	3	ECE 138	2
PHY 362	3	EP - Ap. Elec.	5
PHY 363	3	HSS	3
EP - Ap. Elec.	3	Electives	8
HSS	3		
	<b>15</b>		<b>18</b>

##### Fifth Year

First Semester	CR	Second Semester	CR
MATH 231	3	ECE 136	3
ECE 257	3	ECE - Ap. Elec.	9
ECE - Ap. Elec.	3	Elective	4
Electives	6		
	<b>15</b>		<b>16</b>

Total Credits: 162-164

<sup>1</sup> Required natural science courses, one taken fall semester and the other taken in spring.

Total Credits [163]

Credits in 4 yrs [131-133]

The EP-approved electives must include at least three courses from the following:

PHY 363	Physics of Solids	3
PHY 369	Quantum Mechanics I	3
PHY 352	Modern Optics	3
or PHY 355	Nonlinear Optics	
PHY 348	Plasma Physics	3
or PHY 365	Physics Of Fluids	
PHY 380	Introduction to Computational Physics	3

The ECE-approved electives must be approved by the student's advisor.

#### Electrical and Computer Engineering

The department of electrical and computer engineering (ECE) offers undergraduate and graduate programs of study along with supporting research for students interested in the field of electrical engineering. It also jointly supports undergraduate and graduate programs in computer engineering, and computer science with the computer science and engineering (CSE) department. Graduate study leads to the degrees master of science, master of engineering, and doctor of philosophy in electrical engineering, and the master of science and doctor of philosophy in computer engineering.

The undergraduate programs emphasize the fundamental aspects of their respective areas. Engineering design concepts are introduced early in the curriculum, and required instructional laboratories introduce design as a hands-on activity. Electives permit students to tailor their programs according to their interests and goals, whether they be in preparation for graduate study or entry into industry. Students are free to select courses offered by other departments and are encouraged to do so when appropriate. In this way they can prepare themselves for activities which straddle departmental boundaries or for entry into professional schools such as medicine or management. Students have the opportunity to synthesize and apply their knowledge in a senior design project. Students may use the senior design project as a way to participate in the various research projects in the department.

The department maintains a number of laboratories in support of its curricular programs. These laboratories include the sophomore and junior lab electronic circuits and systems laboratory, microcomputer laboratory, electromechanics laboratory, digital signal processing laboratory, digital systems laboratory and senior projects laboratories.

The department has research laboratories in computer architectures, wireless communications, optoelectronics, compound semiconductors, electron device physics, microelectronics fabrication, signal processing, and communications. These laboratories, among others, are available for undergraduate projects.

The graduate programs allow students to deepen their professional knowledge, understanding, and capability within their subspecialties. Each graduate student develops a program of study in consultation with his or her graduate advisor. Key research thrust areas in the department include:

1. Microelectronics and Nanotechnology.
2. Wireless Communications and Networking.
3. Optoelectronics.
4. Bio-Engineering.

Graduate research is encouraged in these and other areas.

Computers and computer usage are an essential part of the student's environment. The university provides a distributed network of about 75 high-performance workstations and over 300 PC-compatible microcomputers in public sites throughout the campus. The ECE department, in conjunction with the CSE department, has state-of-the-art systems to augment and extend the generally available university systems. A primary resource is a network of more than 60 Sun workstations, file servers, and compute servers, running the Unix operating system. In addition, the ECE department has a 16 node cluster that is used for high performance computing. Additional resources to facilitate learning are the approximately 90 workstations

running the Microsoft and Linux platforms, that are located in the various ECE teaching labs. These systems provide an array of software tools for students and researchers, such as Cadence, Freescale, Agilent Data Systems software, Silvaco, VPI, Matlab, and Labview. The workstations are connected via multiple high-speed ethernet, fiber optic, and ATM networks, which are in turn connected to the university's backbone network, and to the external world through Internet 2. Students are not required by the department, nor the university, to own a personal computer, but many find such a tool a valuable asset.

A detailed description of the curricular programs follows with a listing of the required courses and with a listing of the departmental course offerings. The departmental courses carry the prefix ECE for electrical and computer engineering. Courses given by the Computer Science and Engineering department have the prefix CSE. Students are urged to search both listings for courses appropriate to their career goals.

**Professors.** Filbert J. Bartoli, PhD (Catholic University of America); Ricky S. Blum, PhD (University of Pennsylvania); David Richard Decker, PhD (Lehigh University); Yujie Ding, PhD (Johns Hopkins University); Douglas R. Frey, PhD (Lehigh University); Miltiadis K. Hatalis, PhD (Carnegie Mellon University); James C. Hwang, PhD (Cornell University); Alan J. Snyder, PhD (The Pennsylvania State University)

**Associate Professors.** Shalinee Kishore, MENG (Princeton University); Jing Li, PhD (Texas A&M University); Karl H. Norian, PhD (University of London); Nelson Tansu, PhD (University Wisconsin at Madison); Svetlana Tatic-Lucic, PhD (California Institute of Technology); Meghanad D. Wagh, PhD (Indian Institute of Technology Bombay); Zhiyuan Yan, PhD (University of Illinois Urbana)

**Assistant Professors.** Yevgeny Berdichevsky, PhD (University of California San Diego); Sushil Kumar, PhD (Massachusetts Institute of Technology); Parvathinathan Venkatasubramanian, PhD (Cornell University); Chao Zhou, PhD (University of Pennsylvania)

**Professors Of Practice.** William Andrew Best, MS (Virginia Tech); Martha Dodge, MA (Lehigh University); William R. Haller, MS (Lehigh University)

**Emeriti.** Bruce D. Fritchman, PhD (Lehigh University); Frank H. Hielscher, PhD (University of Illinois Urbana); Carl S. Holzinger, PhD (Lehigh University); Alastair D. McAulay, PhD (Carnegie Mellon University); Donald L. Talhelm, MS (Lehigh University); Eric D. Thompson, PhD (Massachusetts Institute of Technology); Kenneth Kai-Ming Tzeng, PhD (University of Illinois Urbana); George D. Watkins, PhD (Harvard University); Marvin H. White, PhD (Ohio State University)

**Undergraduate Programs**

**Mission Statement for the Electrical Engineering and Computer Engineering Programs**

The mission of the electrical engineering and computer engineering programs is to prepare engineers to meet the challenges of the future, to promote a sense of scholarship, leadership, and service among our graduates, to instill in the students the desire to create, develop, and disseminate new knowledge, and to provide international leadership to the electrical engineering and computer engineering professions.

**Program Educational Objectives in Electrical Engineering and Computer Engineering**

The graduates of the electrical engineering program will:

1. Solve technologically challenging problems in electrical engineering using their fundamental knowledge of math, science and engineering.
2. Attain positions of responsibility in their chosen careers, including industry, government, medicine, business, law and academia by applying their electrical engineering skills, professional attitudes and ethics.
3. Engage in lifelong learning through graduate studies, research, and continuing education.

4. Apply their knowledge of global, societal and environmental issues in solving engineering problems.
5. Function on multidisciplinary teams using their technical knowledge and effective communication skills.

**Bachelor of Science in Electrical Engineering**

The required courses for this degree contain the fundamentals of linear circuits, systems and control theory, electronic circuits, signal theory, physical electronics, electromagnetic theory, energy conversion, digital systems, and computing techniques. A strong foundation in the physical sciences and in mathematics is required. Approved electives, chosen with the advisor's consent, are selected in preparation for graduate study or entry into industry according to individual interests. The program totals 134 credit hours. The recommended sequence of courses follows:

<b>First Year</b>			
<b>First Semester</b>	<b>CR</b>	<b>Second Semester</b>	<b>CR</b>
ENGL 001	3	ENGL 002	3
MATH 021	4	MATH 022	4
Select one of the following: ENGR 010 or 005	4-5	Select one of the following: 2 CHM 030 <sup>1</sup>	4-5
CHM 030 <sup>1</sup>	4	ENGR 010 or 005	2
PHY 011 & PHY 012 <sup>1</sup>	5	PHY 011 & PHY 012 <sup>1</sup>	5
<b>22-23</b>		<b>22-23</b>	
<b>Second Year</b>			
<b>First Semester</b>	<b>CR</b>	<b>Second Semester</b>	<b>CR</b>
ECE 033	4	ECE 121	2
ECE 081	4	ECE 123	3
PHY 021 & PHY 022	5	ECE 126	3
MATH 023	4	MATH 205	3
		ECO 001	4
		HSS elective	3
<b>17</b>		<b>18</b>	
<b>Third Year</b>			
<b>First Semester</b>	<b>CR</b>	<b>Second Semester</b>	<b>CR</b>
ECE 108	4	ECE 125	3
ECE 182	1	ECE 138	2
ECE 202	3	ECE 203	3
MATH 208	3	MATH 231	3
HSS elective	3-4	approved technical elective <sup>1</sup>	3
free elective	3	free elective	3
<b>17-18</b>		<b>17</b>	
<b>Fourth Year</b>			
<b>First Semester</b>	<b>CR</b>	<b>Second Semester</b>	<b>CR</b>
ECE 136	3	ECE 258	2
ECE 257	3	approved technical electives <sup>1</sup>	9
HSS elective	3-4	HSS elective	3-4
approved technical electives <sup>1</sup>	6	free elective	3
free elective	3		
<b>18-19</b>		<b>17-18</b>	

Total Credits: 148-153

1 Required natural science courses, one taken fall semester and the other taken in spring  
 2 Approved technical electives are subjects in the area of science and technology. Students must select a minimum of four courses from the ECE or CSE course listings, with a minimum of two courses in one of the technical areas described in the following list. Students must also choose at least one engineering elective in either materials, mechanics, thermodynamics, fluid mechanics or physical chemistry, and at least one science elective in physics, chemistry or biology. For students interested in solid-state electronics, quantum mechanics is recommended for the science elective.

**Approved Technical Electives for Electrical Engineering****Breadth Requirement**

Minimum of 4 ECE or CSE elective courses.

**Depth Requirement**

Minimum of 2 courses in one of the technical areas described below.

**Solid-State Circuits**

ECE 308	Physics and Models of Electronic Devices	3
ECE 332	Design of Linear Electronic Circuits	3
ECE 333	Medical Electronics	3
ECE 337	Introduction to Micro- and Nanofabrication	3
ECE 351	Microelectronics Technology	3
ECE 355	Applied Integrated Circuits	3
ECE 361	Introduction to VLSI Circuits	3
ECE 362	Introduction to VLSI System Design	3

**Signal Processing and Communications**

ECE 337	Introduction to Micro- and Nanofabrication	3
ECE 212	Control Theory	3
ECE 339	Graphical Signal Processing	3
ECE 341	Fundamentals of Wireless Communications	3
ECE 342	Communication Theory	3
ECE 343	Digital Signal Processing	3
ECE 344	Statistical Signal Processing	3
ECE 364	Introduction to Cryptography and Network Security	3
ECE 387	Digital Control	3
ECE 389	Control Systems Laboratory	2
ECE 342	Communication Theory	3

**Microwaves and Lightwaves**

ECE 310	Wireless Circuits	3
ECE 325	Semiconductor Lasers I	3
ECE 326	Semiconductor Lasers II	3
ECE 338	Quantum Electronics	3
ECE 347	Introduction to Integrated Optics	3
ECE 348	Lightwave Technology	3
ECE 371	Optical Information Processing	3
ECE 372	Optical Networks	3

**Computers**

Any CSE course except CSE 012, CSE 015, or CSE 252

ECE 201	Computer Architecture	3
ECE 316	Microcomputer System Design	3
ECE 319	Digital System Design	3
ECE 320	Logic Design	3
ECE 324	Microprocessors	3
ECE/CSE 336	Embedded Systems	3

Note: Special Topics (3) (The area of each course must be evaluated individually)

**Minor in Electrical Engineering**

Minor Program Director: William R. Haller

The purpose of the Electrical Engineering minor is to enable students to supplement their major with knowledge and skills that increase their ability to realize their multi-disciplinary goals and/or make them more marketable upon graduation.

**Required Courses**

ECE 081	Principles of Electrical Engineering <sup>1</sup>	4
or ECE 083 & ECE 162	Introduction to Electrical Engineering and Electrical Laboratory	

ECE 108	Signals and Systems <sup>2</sup>	4
ECE 123	Electronic Circuits	3
Select one of the following Electrical and Computer Engineering Courses or Other Approved Elective:		3-4
ECE 033	Introduction to Computer Engineering	
ECE 125	Circuits and Systems	
ECE 126	Fundamentals of Semiconductor Devices	
ECE 136	Electromechanics	
ECE 339	Graphical Signal Processing	
ECE 341	Fundamentals of Wireless Communications	
ECE 343	Digital Signal Processing	
ECE 371	Optical Information Processing	
ECE 372	Optical Networks	

Total Credits 14-15

<sup>1</sup> ECE 083 and ECE 162 plus departmental approval.

<sup>2</sup> Mechanical Engineering substitute ME 245 Engineering Vibrations for ECE 108, by petition, but must select an additional ECE elective. Because of similar course requirements between electrical and computer engineering majors, computer engineering students wishing to minor in electrical engineering can use one required course in their major and must choose four electives, excluding required courses, from the above list to satisfy the requirements of the electrical engineering minor. Computer engineering technical electives (chosen from the above list) can be used to satisfy the requirements of the minor.

Technical minors must be declared by the end of pre-registration of the student's sixth semester. If course requirements change or a student wishes to vary the list of courses above, a revised minor declaration form must be submitted.

**Bachelor of Science in Computer Engineering**

See catalog entry for Computer Engineering.

**Graduate Programs**

Graduate programs of study provide a balance between formal classroom instruction and research and are tailored to the individual student's professional goals. The programs appeal to individuals with backgrounds in electrical or computer engineering, mathematics, or the physical sciences. Research is an essential part of the graduate program. Major research areas include:

**Wireless Communications and Networking**

Signal design (CDMA, OFDM, etc), near-far communication strategies, space-time diversity coding, channel and interference modeling, digital audio and video compression, digital signal processing, novel devices, communication networks, image processing, data fusion, and compound semiconductor devices.

**Microelectronics Devices, Integrated Circuits, VLSI Design**

Mixed Signal design, Silicon integrated circuit technology, processing, fabrication and testing. Semiconductor device physics, nano scale devices, CMOS VLSI logic design and verification, computer-aided design (CAD), VLSI chip architectures, computer architecture including embedded systems and systems-on-a-chip. New sensors, actuators and novel microsystems, ranging from micro-electromechanical-systems (MEMS) to chemical microreactors and Biochips.

**Optoelectronics and Photonics**

Fiber optic communications and networks, applications of nonlinear optics, optical switching, novel devices, and optical computing. Freespace optical communication systems. Terahertz generation, amplification, detection, and applications, nanostructures and nanodevices. Biophotonics.

The Master of Science degree requires the completion of 30 credit hours of work that may include a six credit hours thesis for the EE and CompE degrees. A program of study must be submitted in compliance with the graduate school regulations. An oral presentation of the thesis is required.

The Master of Engineering degree requires the completion of 30 credit hours of work, which includes design-oriented courses and

an engineering project. A program of study must be submitted in compliance with the college rules. An oral presentation of the project is required.

The Ph.D. degree in electrical engineering requires the completion of 42 credit hours of work (including the dissertation) beyond the master's degree (48 hours if the master's degree is non-Lehigh), the passing of a departmental qualifying examination appropriate to each degree within one year after entrance into the degree program, the passing of a general examination in the candidate's area of specialization, the admission into candidacy, and the writing and defense of a dissertation. Competence in a foreign language is not required.

The ECE Department has a core curriculum requirement for graduate students in each of the degree programs. The purpose of this requirement is to guarantee that all students pursuing graduate studies in the department acquire an appropriate breadth of knowledge of their discipline.

### Electrical Engineering

To satisfy the core curriculum requirements in Electrical Engineering:

Select three courses from the following five different areas: 9

ECE 401	Advanced Computer Architecture	9
ECE 402	Advanced Electromagnetics	
ECE 441	Fundamentals of Wireless Communications	
ECE 420	Advanced Circuits and Systems	
ECE 451	Physics of Semiconductor Devices	

Total Credits 9

### Computer Engineering

See catalog entry for Computer Engineering.

### M.S. in Photonics

The Masters of Science degree in Photonics is an interdisciplinary degree that is designed to provide students with a broad training experience in the various aspects of photonics, including topics in Physics, Electrical Engineering and Materials Science and Engineering. It covers both theoretical and practical topics in areas such as fiber optics, integrated optics, lasers, nonlinear optics and optical materials to prepare the students to work in industry directly after graduation. The program is also designed so as to make it possible for students who wish to continue on for a Ph.D. to still satisfy the requirements of their individual departments for the more advanced degree. For details on this program, see the separate catalog section under Interdisciplinary Graduate Study and Research.

### M. S. in Wireless Communications and Network Engineering

The Master of Science degree in Wireless Communications and Network Engineering at Lehigh University is designed to prepare the next generation of engineers for the communications and networking industries. The curriculum aims to produce graduates that can contribute to the design and analysis of communication systems in the broadest context. To accommodate the student's study of various aspects of wireless communications and networking, we have limited the number of required core courses to allow maximum flexibility in pursuing specific interests.

### Required Core Courses

ECE 342	Communication Theory <sup>1</sup>	3
ECE 441	Fundamentals of Wireless Communications	3
ECE 404	Computer Networks	3

### Advanced Courses <sup>2</sup>

<sup>1</sup> ECE 342 must be the first course taken and the core courses should precede advanced courses.

<sup>2</sup> In addition to the core courses, the students will take advanced courses that are aimed to furnish the student with a deeper knowledge of more specific types and aspects of information networks.

### Departmental Courses

Courses are listed under the prefixes ECE and CSE. Generally, electrical engineering courses carry the ECE prefix and appear in the following listing. Computer science courses carry the CSE prefix. Computer engineering courses are found under either prefix. The CSE courses are listed in the Computer Science and Engineering department section in this catalog. The reader should consult both listings.

### Courses

#### ECE 033 Introduction to Computer Engineering 4 Credits

Analysis, design and implementation of small digital circuits. Boolean algebra. Minimization techniques, synchronous sequential circuit design, number systems and arithmetic. Microcomputer architecture and assembly level programming. Prerequisites as noted below.

**Prerequisites:** CSE 017 or ENGR 001 or ENGR 010

#### ECE 081 Principles of Electrical Engineering 4 Credits

Circuit elements and laws. Behavior of simple linear networks, include equivalent circuits and solution techniques. Solution of DC circuits and AC circuits using phasor techniques. Introduction to operational amplifiers. Steady state and transient response of simple circuits. Includes a weekly session for review and discussion. May not be taken with ECE 083 for credit. Prerequisites as noted below.

**Prerequisites:** (MATH 022 and PHY 021)

**Can be taken Concurrently:** PHY 021

#### ECE 082 Sophomore Lab 1 Credit

An introduction to the fundamental laboratory instrumentation and measurement techniques of electrical and computer engineering. Five or six experiments based on the fundamental concepts discussed in the prerequisite courses. Introduction to PSPICE and application of various computer aids to design and documentation. Discussions of electrical components and laboratory safety. Use of an engineering notebook and report writing. One three-hour laboratory per week. Prerequisites: ECE 33 and ECE 81, previously.

**Prerequisites:** (ECE 033 and ECE 081)

#### ECE 083 Introduction to Electrical Engineering 3 Credits

Circuit elements and laws. Behavior of simple linear networks. Characteristics of electronic circuits and modeling. Introduction to functional circuits, such as operational amplifiers, instrumentation amplifiers, and power systems. Introduction to basic filters and data converters. May not be taken with ECE 081 for credit. Prerequisites as noted below.

**Prerequisites:** MATH 022 and PHY 021

**Can be taken Concurrently:** PHY 021

#### ECE 108 Signals and Systems 4 Credits

Continuous and discrete signal and system descriptions using signal space and transform representations. Includes Fourier series, continuous and discrete Fourier transforms, Laplace transforms, and z-transforms. Introduction to sampling. Prerequisites as noted below.

**Prerequisites:** ECE 081

#### ECE 121 Electronic Circuits Laboratory 2 Credits

One lecture and one laboratory per week. Experiments illustrating the principles of operation of electronic devices and their circuit applications. Basic electronic instrumentation and measurement techniques. Prerequisites as noted below.

**Prerequisites:** ECE 081

#### ECE 123 Electronic Circuits 3 Credits

Methods for analyzing and designing circuits containing electronic devices. Topics include device models, basic amplifier configurations, operating point stabilization, frequency response analysis, and computer-aided analysis of active circuits. Prerequisites as noted below.

**Prerequisites:** ECE 081

#### ECE 125 Circuits and Systems 3 Credits

Formulation of linear circuit equations in the time and frequency domain. Complete solutions of difference and differential equations. Network theorems. Basic stability and feedback concepts. Modulation theory, sampling theory and basic digital signal processing ideas. Prerequisites as noted below.

**Prerequisites:** ECE 108

**ECE 126 Fundamentals of Semiconductor Devices 3 Credits**

Introduction to the physics of semiconductors in terms of atomic bonding and electron energy bands in solids. Charge carriers in semiconductors and carrier concentration at thermal equilibrium. Principles of electron and hole transport, drift and diffusion currents, generation and recombination processes, continuity. Treatment of semiconductor devices including p-n junctions, bipolar junction transistors and field effect transistors. Prerequisites as noted below.

**Prerequisites:** ECE 081

**ECE 136 Electromechanics 3 Credits**

Two lectures and one laboratory per week. An experimental introduction to electromechanical energy conversion. Basic concepts of magnetic fields and forces and their application to electrical apparatus including electromechanical transducers, transformers, AC and DC machines. Prerequisites as noted below.

**Prerequisites:** ECE 081

**ECE 138 Digital Systems Laboratory 2 Credits**

Implementation issues and techniques for digital logic design. Combinational and sequential logic design using standard integrated circuits. I/O and interrupt processing. Design and implementation of real-time complex digital logic using microprocessor systems. Prerequisites as noted below.

**Prerequisites:** ECE 033

**ECE 162 Electrical Laboratory 1 Credit**

Experiments on circuits, machines, and electronic devices. Elementary network theory. Survey laboratory for students not majoring in electrical or computer engineering. Prerequisites as noted below.

**Prerequisites:** (ECE 081 or ECE 083)

**ECE 182 Junior Lab 1 Credit**

An introduction to the fundamental laboratory instrumentation and measurement techniques of electrical and computer engineering. Five or six experiments based on the fundamental concepts discussed in the prerequisite courses. Introduction to PSpice and application of various computer aids to design and documentation. Discussions of electrical components and laboratory safety. Use of an engineering notebook and report writing. One three hour laboratory per week. Prerequisites as noted below.

**Prerequisites:** (ECE 033 or CSE 033) and ECE 081

**ECE 201 Computer Architecture 3 Credits**

Structure and function of digital computers. Computer components and their operations. Computer interconnection structures. Memory system and cache memory. Interrupt driven input/output and direct memory access. Instruction sets and addressing modes. Instruction pipelining. Floating-point representation and arithmetic. Alternative architectures: RISC vs. CISC and introduction to parallel architectures. Prerequisites as noted below.

**Prerequisites:** ECE 033

**ECE 202 Introduction to Electromagnetics 3 Credits**

Elements of vector analysis, Coulomb's law, Biot-Savart's and Ampere's laws, Lorentz Forces, Laplace's, and Maxwell's equations, boundary conditions, methods of solution in static electric and magnetic fields, including finite element numerical approach. Quasistationary fields, inductance. Prerequisites as noted below.

**Prerequisites:** MATH 205 and PHY 021

**ECE 203 Introduction to Electromagnetic Waves 3 Credits**

Uniform plane waves in free space and in materials, skin effect. Waves in transmission lines and waveguides, including optical fibers. Energy and power flow, Poynting's theorem. Reflection and refraction. Resonators. Radiation and diffraction. Prerequisites as noted below.

**Prerequisites:** ECE 202

**ECE 212 Control Theory 3 Credits**

Introduction to feedback control. Dynamic analysis of linear feedback systems in the time and frequency domain, with emphasis on stability and steady-state accuracy. Major analytical tools: signal-flow graphs, root-locus methods. Nyquist plot, Bode analysis. Cascade compensation techniques. Prerequisites as noted below.

**Prerequisites:** ECE 125

**ECE 256 Honors Project 1 Credit**

Open by invitation only to students who have completed ECE 257, Senior Project. Selection is based upon the quality of the senior project with regard to ingenuity, design approach and completeness. The objective of this course is to carry the successful senior projects forward to completion of a technical paper suitable for publication or submission to a technical conference. A written paper and oral presentation are required by mid-semester. Oral presentations will be made before an appropriate public forum. Enrollment limited.

**ECE 257 Senior Lab I 3 Credits**

With ECE 258, provides a complete design experience for Electrical and Computer Engineers. Research, planning, and completion of the initial design for a project involving hardware and/or software, integrating the many facets of their undergraduate program. Instruction in technical writing, product development, ethics and professional engineering, and presentation of design and research. Two three hour sessions and one additional two hour lecture per week. Must have senior status or consent of department.

**ECE 258 Senior Lab II 2 Credits**

Continuation of ECE 257. Complete design, construction, and testing of projects selected and developed in ECE 257. Present final design reviews and project presentations. Submit a final written report. Discuss development issues, including manufacturability, patents, and ethics. Two three-hour sessions per week. Prerequisites as noted below or consent of department.

**Prerequisites:** ECE 257

**ECE 300 Apprentice Teaching 1-4 Credit****ECE 308 Physics and Models of Electronic Devices 3 Credits**

Physics of metal-semiconductor junction, p-n junctions, and MOS capacitors. Models of Schottky barrier and p-n junction diodes, JFET, MOSFET, and bipolar transistors. Prerequisites as noted below.

**Prerequisites:** ECE 126

**ECE 310 Wireless Circuits 3 Credits**

Theory and design of high-frequency circuits for wireless communications. Transmission lines and microwave networks. Types of circuits explored include filters, amplifiers, mixers, voltage controlled oscillators (VCOs), phase locked loops (PLLs), synthesizers, modulators and demodulators, and antennae. Design using scattering parameters, Smith chart and RF/microwave CAD programs for simulation. System performance analysis based on noise figure, antenna gain and the Friis equation will be developed. Modulation techniques of AM, FM, PM, and QPSK systems will be compared based on bit error rates (BER) calculated from system parameters. Prerequisites as noted below.

**Prerequisites:** ECE 203

**ECE 316 Microcomputer System Design 3 Credits**

Content is primarily hardware oriented, but software issues are covered where required. Includes performance characteristics or the more popular devices on the market today. Specific topics include: basic microcomputer structure, bus interconnections, memory systems, serial and parallel interfacing, CRT controllers, interrupt structures, DMA.

**Prerequisites:** ECE 033

**ECE 319 Digital System Design 3 Credits**

Design techniques at the register transfer level. Control strategies for hardware architectures. Implementation of microprogramming, intersystem communication and peripheral interfacing. Hardware design languages and their use in design specification, verification and simulation. Prerequisites as noted below.

**Prerequisites:** ECE 138

**ECE 320 Logic Design 3 Credits**

Review of basic switching theory, vector boolean algebra, canonical implementations of medium size circuits, threshold logic, fault detection in combinational and sequential logic, Multivalued and Fuzzy logic, regular expressions, nondeterministic sequential machines.

Prerequisites as noted below.

**Prerequisites:** ECE 033

**ECE 324 Microprocessors 3 Credits**

Microprocessor architectures with focus on Motorola 8, 16, and 32-bit microprocessors (68HC11, 9S12DP256 and Coldfire MCF5XXX series). Chip features, programming model, instruction set, use of programming tools, flash memory programming, interrupt programming and interfacing to external devices and memory. Programming primarily in C-language with some assembly. (two lectures and one laboratory per week) Prerequisites as noted below.

**Prerequisites:** ECE 033

**ECE 325 Semiconductor Lasers I 3 Credits**

Review of elementary solid-state physics. Relationships between Fermi energy and carrier density and leakage. Introduction to optical waveguiding in simple double-heterostructures. Density of optical modes, Blackbody radiation and the spontaneous emission factor. Modal gain, modal loss, and confinement factors. Einstein's approach to gain and spontaneous emission. Periodic structures and the transmission matrix. Ingredients. A phenomenological approach to diode lasers. Mirrors and resonators for diode lasers. Gain and current relations. Credit will not be given for both ECE 325 and ECE 425. Prerequisites as noted below.

**Prerequisites:** ECE 203

**ECE 326 Semiconductor Lasers II 3 Credits**

Continuation of Semiconductor Lasers I. Topics covered include: Gain and current relations; dynamic effects; perturbation and coupled-mode theory; dielectric waveguides; and photonic integrated circuits. Credit will not be given for both ECE 326 and ECE 426. Prerequisites as noted below.

**Prerequisites:** ECE 325

**ECE 332 Design of Linear Electronic Circuits 3 Credits**

Introduction to a variety of linear design concepts and topologies, with contemporary audio networks providing many of the concrete examples. Topics include low- and high-level preamps; equalizers and filters; mixers; voltage-controlled amplifiers; input and output stage modifications; power amplifiers; analog switching and digital interface circuitry. Prerequisites as noted below.

**Prerequisites:** (ECE 123 and ECE 125)

**ECE 333 Medical Electronics 3 Credits**

Bioelectric events and electrical methods used to study and influence them in medicine, electrically excitable membranes, action potentials, electrical activity of muscle, the heart and brain, bioamplifiers, pulse circuits and their applications. Prerequisites as noted below.

**Prerequisites:** ECE 123

**ECE 336 Embedded Systems 3 Credits**

Use of small computers embedded as part of other machines. Limited-resource microcontrollers and state machines from high level description language. Embedded hardware: RAM, ROM, flash, timers, UARTs, PWM, A/D, multiplexing, debouncing. Development and debugging tools running on host computers. Real-Time Operating System (RTOS) semaphores, mailboxes, queues. Task priorities and rate monotonic scheduling. Software architectures for embedded systems. Prerequisites as noted below.

**Prerequisites:** CSE 017

**ECE 337 Introduction to Micro- and Nanofabrication 3 Credits**

Survey of the standard IC fabrication processes, such as photolithography, dry and wet etching, oxidation, thin-film deposition and chemical mechanical polishing. In-depth analysis of MEMS-specific processes such as wafer bonding, wet anisotropic etching, photolithography using thick photoresist, and deep reactive ion etching of silicon. The basics of nanofabrication techniques. The fundamentals of MEMS design will be outlined. A wide variety of MEMS and NEMS devices will be discussed. Prerequisites as noted below or consent of instructor.

**Prerequisites:** (MAT 033 and MATH 231) or ECE 351

**ECE 338 Quantum Electronics 3 Credits**

Electromagnetic fields and their quantization. propagation of optical beams in homogeneous and lens-like media. Modulation of optical radiation. Coherent interactions of radiation fields and atomic systems. Introduction to nonlinear optics-second-harmonic generation. Parametric amplification, oscillation, and fluorescence. Third-order optical nonlinearities. Credit will not be given for both ECE 338 and ECE 438.

Prerequisites as noted below.

**Prerequisites:** ECE 203

**ECE 339 Graphical Signal Processing 3 Credits**

Application of graphical programming to mathematical principles in data analysis and signal processing. Review of digital signal processing, use of structures, arrays, charts, building virtual instruments, graphical programming for linear algebra, curve fitting, solving differential and difference equations, signal generation, DFT and FFT analysis, windowing and filtering. Prerequisites as noted below.

**Prerequisites:** ECE 108

**ECE 341 Fundamentals of Wireless Communications 3 Credits**

Overview of wireless communication systems basics. Cellular concept and other wireless systems. System design fundamentals. Mobile Radio Propagation Modeling: Flat, Frequency Selective, Fast, Slow fading channels, Path Loss Models. Multiple access. Modulation Techniques for wireless. Introduction to wireless networking. Wireless systems and standards. Future wireless systems. Prerequisites as noted below or consent of instructor.

**Prerequisites:** ECE 108

**ECE 342 Communication Theory 3 Credits**

Theory and application of analog and digital modulation. Sampling theory with application to analog-to-digital and digital-to-analog conversion techniques. Time and frequency division multiplexing. Introduction to random processes including filtering and noise problems. Introduction to statistical communication theory with primary emphasis on optimum receiver principles. Prerequisites as noted below.

**Prerequisites:** ECE 125 and (MATH 309 or MATH 231)

**ECE 343 Digital Signal Processing 3 Credits**

Study of orthogonal signal expansions and their discrete representations, including the Discrete Fourier Transform and Walsh-Hadamard Transform. Development of fast algorithms to compute these, with applications to speech processing and communication. Introduction to the z-transform representation of numerical sequences with applications to input/output analysis of discrete systems and the design of digital filters. Analysis of the internal behavior of discrete systems using state variables for the study of stability, observability and controllability. Prerequisites as noted below.

**Prerequisites:** ECE 108

**ECE 344 Statistical Signal Processing 3 Credits**

Introduction to random processes, covariance and spectral density, time average, stationarity, and ergodicity. Response of systems to random inputs. Sampling and quantization of random signals. Optimum filtering, estimation, and hypothesis testing. Prerequisites as noted below.

**Prerequisites:** (ECE 108) and (MATH 231 or MATH 309)

**ECE 347 Introduction to Integrated Optics 3 Credits**

Theory of dielectric waveguides (ray and wave approach). Modes in planar slab optical guides and in waveguides with graded index profiles. Coupled-mode formalism and periodic structures. Coupling of optical beams to planar structures. Switching and modulation of light in dielectric guides: phase, frequency and polarization modulators; electro-optic, acousto-optic and magneto-optic modulators. Semiconductor lasers. Fabrication of semiconductor components. Recent advances. Prerequisites as noted below.

**Prerequisites:** (ECE 202 and ECE 203)

**ECE 348 Lightwave Technology 3 Credits**

Overview of optical fiber communications. Optical fibers, structures and waveguiding fundamentals. Signal degradation in fibers arising from attenuation, intramodal and intermodal dispersion. Optical sources, semiconductor lasers and LEDs. Rate equations and frequency characteristics of a semiconductor laser. Coupling efficiency of laser diodes and LEDs to single-mode and multimode fibers. PIN and avalanche photodetectors. Optical receiver design. Transmission link analysis. Prerequisites as noted below.

**Prerequisites:** ECE 203

**ECE 350 Special Topics 3 Credits**

Selected topics in the field of electrical and computer engineering not included in other courses. May be repeated for credit.

**Repeat Status:** Course may be repeated.

**ECE 351 Microelectronics Technology 3 Credits**

Technology of semiconductor devices and of integrated circuits, including crystal growth and doping, phase diagrams, diffusion, epitaxy, thermal oxidation and oxide masking, lithography. The major emphasis will be on silicon technology, with additional lectures on GaAs technology. Prerequisites as noted below.

**Prerequisites:** ECE 126

**ECE 355 Applied Integrated Circuits 3 Credits**

Emphasis on understanding of terminal characteristics of integrated circuits with excursion into internal structure only as necessary to assure proper utilization in system design. Classes of devices studied include operational amplifiers, digital-to-analog and analog-to-digital converters, linear multipliers, modulators, and phase-locked loops. Prerequisites as noted below.

**Prerequisites:** (ECE 108 and ECE 123)

**ECE 361 Introduction to VLSI Circuits 3 Credits**

The design of Very Large Scale Integrated (VLSI) Circuits, with emphasis on CMOS Standard Cell design. Topics include MOS transistor physics, device behavior and device modeling, MOS technology and physical layout, design of combinational and sequential circuits, static and dynamic memories, and VLSI chip organization. The course includes a design project using CAE tools for layout, design rule checking, parameter extraction, and SPICE simulations for performance prediction. Two one-hour lectures and three hours of laboratory per week. Prerequisites as noted below.

**Prerequisites:** ECE 123

**ECE 362 Introduction to VLSI System Design 3 Credits**

Structured hierarchical approach to the design of digital VLSI circuits and systems. Use of CAE tools for design and verification. Topics include: systems aspects of VLSI design, design methodologies, schematic capture, functional verification, timing simulation, use of a CMOS standard cell library and of a silicon compiler. The course includes a semester-long design project, with the design to be fabricated by a foundry. Two one-hour lectures and three hours of design laboratory per week. Prerequisites as noted below.

**Prerequisites:** ECE 138

**ECE 364 Introduction to Cryptography and Network Security 3 Credits**

Introduction to cryptography, classical cipher systems, cryptanalysis, perfect secrecy and the one time pad, DES and AES, public key cryptography covering systems based on discrete logarithms, the RSA and the knapsack systems, and various applications of cryptography. May not be taken with ECE 464 for credit. Must have junior or senior standing.

**ECE 371 Optical Information Processing 3 Credits**

Introduction to optical information processing and applications. Interference and diffraction of optical waves. 2D optical matched filters that use lenses for Fourier transforms. Methods and devices for modulating light beams for information processing, communications, and optical computing. Construction and application of holograms for optical memory and interconnections. Prerequisites as noted below.

**Prerequisites:** (ECE 108 and ECE 202)

**ECE 372 Optical Networks 3 Credits**

Study the design of optical fiber local, metropolitan, and wide area networks. Topics include: passive and active photonic components for optical switching, tuning, modulation and amplification; optical interconnection switches and buffering; hardware and software architectures for packet switching and wavelength division multiaccess systems. The class is supported with a laboratory. Prerequisites as noted below.

**Prerequisites:** (ECE 081 and ECE 202)

**ECE 387 Digital Control 3 Credits**

Sampled-data systems; z-transforms; pulse transfer functions; stability in the z-plane; root locus and frequency response design methods; minimal prototype design; digital control hardware; discrete state variables; state transition matrix; Liapunov stability; state feedback control. Prerequisites as noted below or consent of instructor.

**Prerequisites:** CHE 386 or ECE 212 or ME 343

**ECE 389 Control Systems Laboratory 2 Credits**

Experiments on a variety of mechanical, electrical and chemical dynamic control systems. Exposure to state of the art control instrumentation: sensors, transmitters, control valves, analog and digital controllers. Emphasis on comparison of theoretical computer simulation predictions with actual experimental data. Lab teams will be interdisciplinary. Prerequisites as noted below.

**Prerequisites:** CHE 386 or ECE 212 or ME 343

**ECE 392 Independent Study 1-3 Credit**

An intensive study, with report of a topic in electrical and computer engineering which is not treated in other courses. May be repeated for credit. Consent of instructor required.

**Repeat Status:** Course may be repeated.

**ECE 401 Advanced Computer Architecture 3 Credits**

Design, analysis and performance of computer architectures; high-speed memory systems; cache design and analysis; modeling cache performance; principle of pipeline processing, performance of pipelined computers; scheduling and control of a pipeline; classification of parallel architectures; systolic and data flow architectures; multiprocessor performance; multiprocessor interconnections and cache coherence. Prerequisites as noted below.

**Prerequisites:** (ECE 201)

**ECE 402 Advanced Electromagnetics 3 Credits**

Maxwell's equations for various media and boundary geometries. Electromagnetic wave propagation through anisotropic and nonlinear media. Guided waves, layered media and resonators. Radiation, antennas, strong and weak scattering. Scalar and vector diffraction, and periodic structures. Numerical solutions for boundary value problems. Prerequisites as noted below.

**Prerequisites:** (ECE 202 and ECE 203)

**ECE 404 Computer Networks 3 Credits**

Study of architecture and protocols of computer networks. The ISO model; network topology; data-communication principles, including circuit switching, packet switching and error control techniques; sliding window protocols, protocol analysis and verification; routing and flow control; local area networks; network interconnection; topics in security and privacy.

**ECE 407 Linear and Nonlinear Optics 3 Credits**

Diffraction theory, Gaussian beams. Optical resonators and waveguides. Crystal optics, second harmonic generation, parametric amplification. Third order nonlinearities and associated phenomena such as phase conjugation, optical bistability, self-focusing, optical switching, solutions, etc. Photorefractive effect. Brillouin and Raman scattering.

**ECE 410 Digital Communication Systems 3 Credits**

Unified description of digital communication systems based on signal space concepts. Analysis of system performance in the presence of channel noise and bandwidth limitations. Comparison of many different types of digital-modulation techniques, combined with error correction, against theoretical limits. Both bandpass and baseband systems are considered. Optimum methods of detection are considered for all systems. Suboptimum techniques such as adaptive equalization are considered for baseband systems. Basic spread-spectrum concepts are introduced.



**ECE 411 Information Theory 3 Credits**

Introduction to information theory. Topics covered include: development of information measures for discrete and continuous spaces study of discrete-stochastic information courses, derivation of noiseless coding theorems, investigation of discrete and continuous memoryless channels, development of noisy channel coding theorems.

**ECE 412 Advanced Digital Signal Processing 3 Credits**

Design and analysis of signal processing algorithms, number theoretic foundations of algorithm design, bilinear algorithms, computational techniques for digital filtering and convolution, Fourier transform and its algorithms, number theoretic transforms and applications to digital filtering, general and special purpose signal processor designs, application specific techniques in signal processing.

**ECE 414 Signal Detection and Estimation 3 Credits**

Brief review of probability and random process theory. Hypothesis Testing as applied to signal detection. Various optimality criterion including Bayes and Neyman-Pearson and their applications in digital communications, radar, and sonar systems. Optimum and locally optimum detection schemes for Gaussian and non-Gaussian noise. Estimation of unknown signal parameters. Topics of current interest including, distributed signal detection, robust signal detections and quantization for detection as time permits. Prerequisites as noted below.

**Prerequisites:** ECE 108 and MATH 231 or MATH 309

**ECE 415 Numerical Processors 3 Credits**

Design strategies for numerical processors, cellular array adders and multipliers, conditional sum and carry-save asynchronous processors, data recoding and Booth's algorithms, use of alternate numerical bases, CORDIC trigonometric calculator, accumulator orientations, bit slice and bit-sequential processors, pipelining and parallel processing considerations.

**ECE 416 VLSI Signal Processing 3 Credits**

The fundamentals of performance-driven VLSI systems for signal processing. Analysis of signal processing algorithms and architectures in terms of VLSI implementation. VLSI design methodology. Includes a design project which requires use of a set of tools installed on SUN workstations for behavioral simulation, structural simulation, circuit simulation, layout, functional simulation, timing and critical path analysis, functional testing, and performance measurement.

**ECE 417 Pattern Recognition 3 Credits**

Decision-theoretic, structural, and neural network approaches to pattern recognition. Pattern vectors and feature extraction. Classifiers, decision regions, boundaries and discriminant functions. Clustering and data analysis. Statistical pattern recognition, parametric and nonparametric approaches. Syntactic pattern recognition. Introduction to neural networks, with examples of back propagation and self-organization algorithms.

**ECE 420 Advanced Circuits and Systems 3 Credits**

Review of the fundamentals of Circuits and Systems theory, including the time and frequency domain response of linear time-invariant circuits. Equation formulation for general lumped circuits, including node voltage and loop current analysis. Basic graph theoretic properties of circuits including Tellegen's Theorem. Discussion of passivity and reciprocity including multiport network properties. State space formulation and solution of general circuits (and systems). Modern filter concepts, including synthesis techniques for active filters and externally linear filters, such as Log Domain filters. Techniques for the analysis of weakly nonlinear systems, as time permits. Must have graduate standing. Prerequisites as noted below.

**Prerequisites:** ECE 125

**ECE 423 Digital Image Processing 3 Credits**

Fundamentals of imaging acquisition and geometry. Fourier, Hadamard, Walsh and Wavelet Transforms and their usage in image segmentation and understanding. High-pass and low-pass filtering in frequency and spatial domains. Multiresolution analysis and spatial scale filtering. Shape and texture representation and recognition.

**ECE 425 Semiconductor Lasers I 3 Credits**

Review of elementary solid-state physics. Relationships between Fermi energy and carrier density and leakage. Introduction to optical waveguiding in simple doubleheterostructures. Density of optical modes, Blackbody radiation and the spontaneous emission factor. Modal gain, modal loss, and confinement factors. Einstein's approach to gain and spontaneous emission. Periodic structures and the transmission matrix. Ingredients. A phenomenological approach to diode lasers. Mirrors and resonators for diode lasers. Gain and current relations. This course, a version of ECE 325 for graduate students, requires research projects and advanced assignments. Credit will not be given for both ECE 325 and ECE 425. Prerequisites as noted below.

**Prerequisites:** ECE 203

**ECE 426 Semiconductor Lasers II 3 Credits**

Continuation of Semiconductor Lasers I. Topics covered include: Gain and current relations; dynamic effects; perturbation and coupled-mode theory; dielectric waveguides; and photonic integrated circuits. This course, a version of ECE326 for graduate students, requires research projects and advanced assignments. Credit will not be given for both ECE 326 and ECE 426.

**Prerequisites:** ECE 203

**ECE 431 Topics in Switching Theory 3 Credits**

Emphasis on structural concepts motivated by recent advances in integrated circuit technology. Major topics include: logical completeness, decomposition techniques, synthesis with assumed network forms, systolic architectures, systolic lemma and its applications, bit serial architectures.

**ECE 432 Spread Spectrum and CDMA 3 Credits**

Fading and dispersive channel model, direct sequence spread spectrum, frequency hopping spread spectrum, DS-CDMA, FH-CDMA, spread sequences and their properties, multi-user detection, PN code acquisition, wireless communication systems, industrial standards (IS-95, WCDMA, CDMA2000).

**ECE 433 State Space Control 3 Credits**

State-space methods of feedback control system design and design optimization for invariant and time-varying deterministic, continuous systems; pole positioning, observability, controllability, modal control, observer design, the theory of optimal processes and Pontryagin's Maximum Principle, the linear quadratic optimal regulator problem, Lyapunov functions and stability theorems, linear optimal open loop control; introduction to the calculus of variations; introduction to the control of distributed parameter systems. Intended for engineers with a variety of backgrounds. Examples will be drawn from mechanical electrical and chemical engineering applications. Prerequisites as noted below or consent of instructor.

**Prerequisites:** ME 343 or ECE 212 or CHE 386

**ECE 434 Multivariable Process Control 3 Credits**

A state-of-the-art review of multivariable methods of interest to process control applications. Design techniques examined include loop interaction analysis, frequency domain methods (Inverse Nyquist Array, Characteristic Loci and Singular Value Decomposition) feed forward control, internal model control and dynamic matrix control. Special attention is placed on the interaction of process design and process control. Most of the above methods are used to compare the relative performance of intensive and extensive variable control structures. Prerequisites as noted below or consent of instructor.

**Prerequisites:** CHE 433 or ME 433 or ECE 433

**ECE 435 Error-Correcting Codes 3 Credits**

Error-correcting codes for digital computer and communication systems. Review of modern algebra concentrating on groups and finite fields. Structure and properties of linear and cyclic codes for random or burst error correction covering Hamming, Golay, Reed-Muller, BCH and Reed-Solomon codes. Decoding algorithms and implementation of decoders. Prerequisites as noted below.

**Prerequisites:** CSE 261

**ECE 436 Systems Identification 3 Credits**

The determination of model parameters from time-history and frequency response data by graphical, deterministic and stochastic methods. Examples and exercises taken from process industries, communications and aerospace testing. Regression, quasilinearization and invariant-embedding techniques for nonlinear system parameter identification included. Prerequisites as noted below or consent of instructor.

**Prerequisites:** ECE 433 or ME 433 or ECE 433

**ECE 437 Stochastic Control 3 Credits**

Linear and nonlinear models for stochastic systems. Controllability and observability. Minimum variance state estimation. Linear quadratic Gaussian control problem. Computational considerations. Nonlinear control problem in stochastic systems. Prerequisites as noted below or consent of instructor.

**Prerequisites:** ME 433 or CHE 433 or ECE 433

**ECE 438 Quantum Electronics 3 Credits**

Electromagnetic fields and their quantization. propagation of optical beams in homogeneous and lens-like media. Modulation of optical radiation. Coherent interactions of radiation fields and atomic systems. Introduction to nonlinear optics-second-harmonic generation. Parametric amplification, oscillation, and fluorescence. Third-order optical nonlinearities. This course, a version of ECE 338 for graduate students, requires research projects and advanced assignments. Credit will not be given for both ECE 338 and ECE 438.

**ECE 441 Fundamentals of Wireless Communications 3 Credits**

Characterization of mobile radio channels. Wireless information transmission: modulation/demodulation, equalization, diversity combining, coding/decoding, multiple access methods. Overview of cellular concepts and wireless networking. This course, a version of ECE341 for graduate students, requires research projects and advanced assignments. Credit will not be given for both ECE 341 and ECE 441. Prerequisites as noted below.

**Prerequisites:** ECE 342 or ECE 342

**ECE 443 RF Power Amplifiers for Wireless Communications 3 Credits**

Review of linear power amplifier design. Discussion of major nonlinear effects, such as high-efficiency amplifiers modes, matching network design for reduced conduction angle, overdrive and limiting effects, and switching mode amplifiers. Discussion of other nonlinear effects, efficiency enhancement and linearization techniques. Companion course to ECE463.

**ECE 447 Introduction to Integrated Optics 3 Credits**

Theory of dielectric waveguides (ray and wave approach). Modes in planar slab optical guides and in waveguides with graded index profiles. Coupled-mode formalism and periodic structures. Coupling of optical beams to planar structures. Switching and modulation of light in dielectric guides: phase, frequency and polarization modulators; electro-optic, acousto-optic and magneto-optic modulators. Semiconductor lasers. Fabrication of semiconductor components. Recent advances. The course is an extension of ECE 347 for graduate students and it will include research projects and advanced assignments. Prerequisites as noted below.

**Prerequisites:** ECE 202 and ECE 203

**ECE 448 Lightwave Technology 3 Credits**

Overview of optical fiber communications. Optical fibers, structures and waveguiding fundamentals. Signal degradation in fibers arising from attenuation, intramodal and intermodal dispersion. Optical sources, semiconductor lasers and LEDs. Rate equations and frequency characteristics of a semiconductor laser. Coupling efficiency of laser diodes and LEDs to single-mode and multimode fibers. PIN and avalanche photodetectors. Optical receiver design. Transmission link analysis. The course is an extension of ECE 348 for graduate students and it will include research projects and advanced assignments.

**ECE 450 Special Topics 1-3 Credit**

Selected topics in electrical and computer engineering not covered in other courses. May be repeated for credit.

**Repeat Status:** Course may be repeated.

**ECE 451 Physics of Semiconductor Devices 3 Credits**

Crystal structure and space lattices, crystal binding, lattice waves and vibrations, electrons and atoms in crystal lattices. Quantum mechanics and energy band theory, carrier statistics, Boltzmann transport theory, interaction of carriers with scattering centers, electronic and thermal conduction. Magnetic effects. Generation and recombination theory. Application to p-n junctions. Prerequisites as noted below.

**Repeat Status:** Course may be repeated.

**Prerequisites:** ECE 126

**ECE 452 Advanced Semiconductor Diode and Transport Theory 3 Credits**

Properties of metal-semiconductor contacts, Schottky barriers, ohmic contacts, hot electrons, intervalley scattering, velocity saturation, secondary ionization, avalanche breakdown. Applications to microwave devices such as avalanche and Gunn diodes, Schottky barrier diodes, tunnel diodes and PIN diodes.

**ECE 454 Turbo Codes and Iterative Decoding 3 Credits**

Capacity-approaching error correcting codes. Soft-in soft-out iterative decoding. Parallel/serial/hybrid concatenated convolutional codes—and turbo-like codes. Iterative decoding algorithms and performance analysis of parallel/serial turbo codes. Low density parity check (LDPC) codes and product codes. Code graph and message passing decoding algorithms. Turbo and LDPC code design and construction. Performance analysis using density evolution and extrinsic information transfer charts. Applications of turbo and LDPC codes.

**ECE 455 Theory of Metal Semiconductor and Heterojunction Transistors 3 Credits**

Physics of metal semiconductor and heterojunction field effect transistors (MESFET and HEMT). Theory of semiconductor heterojunctions. Properties of heterojunction bipolar transistors (HBT): Equivalent circuits, applications to microwave amplifiers, oscillators, and switching circuits.

**ECE 460 Engineering Project 3-6 Credits**

Project work in an area of student and faculty interest. Selection and direction of the project may involve interaction with industry. Consent of department required.

**ECE 461 Theory of Electrical Noise 3 Credits**

Definitions: noise temperature, spectral density. Noise sources: quantum, thermal, shot, generation-recombination, flicker noise. Representation and optimization of noisy networks.

**ECE 463 Design of Microwave Solid State Circuits 3 Credits**

Equivalent circuit modeling and characterization of microwave semiconductor devices, principles of impedance matching, noise properties and circuit interaction, introduction to the design of high power and non-linear circuits.

**ECE 464 Introduction to Cryptography and Network Security 3 Credits**

Introduction to cryptography, classical cipher systems, cryptanalysis, perfect secrecy and the one time pad, DES and AES, public key cryptography covering systems based on discrete logarithms, the RSA and the knapsack systems, and various applications of cryptography. This graduate version of ECE 364 requires additional work. May not be taken with ECE 364 for credit. Must have graduate student status.

**ECE 465 VLSI Implementation of Error Control Coding 3 Credits**

Error control coding, finite field arithmetic, encoding and decoding of BCH and Reed-Solomon codes, efficient iterative decoders for convolutional and Turbo codes, message passing and high performance decoders for low-density parity-check codes. Prerequisites as noted below.

**Prerequisites:** (ECE 435)

**ECE 469 Process Modeling for Semiconductor Devices 3 Credits**

Students will design and “manufacture” a Si or GaAs transistor through process simulation of ion implantation, epitaxial growth, diffusion and contact formation, etc. I-V characteristics and small signal parameters, suitable for digital and microwave circuit simulation programs, will be derived. Complimentary to ECE 463 and 471.

**ECE 471 Optical Information Processing 3 Credits**

Introduction to optical information processing and applications. Interference and diffraction of optical waves. 2D optical matched filters that use lenses for Fourier transforms. Methods and devices for modulating light beams for information processing, communications, and optical computing. Construction and application of holograms for optical memory and interconnections. The course is an extension of ECE 371 for graduate students and it will include research projects and advanced assignments. Prerequisites as noted below.

**Prerequisites:** (ECE 108)

**ECE 472 Optical Networks 3 Credits**

Study the design of optical fiber local, metropolitan, and wide area networks. Topics include: passive and active photonic components for optical switching, tuning, modulation and amplification; optical interconnection switches and buffering; hardware and software architectures for packet switching and wavelength division multiaccess systems. This class is supported with a laboratory. The course is an extension of ECE 372 for graduate students and it will include research projects and advanced assignments. Prerequisites as noted below.

**Prerequisites:** ECE 081

**ECE 474 Analog CMOS VLSI Design 3 Credits**

The fundamentals of analog circuit design with CMOS linear IC techniques. Discrete Analog Signal Processing (DASP) is accomplished with switched-capacitor CMOS circuits. Analog building blocks include operational amplifiers, S/H circuits, comparators and voltage references, oscillators, filters, modulators, phase detectors/shifters, charge transfer devices, etc. Analog sub-system applications are phase-locked loops (PLL's), A/D and D/A converters, modems, sensors, adaptive filters and equalizers, etc. The emphasis is on the physical operation of analog CMOS integration circuits and the design process.

**ECE 476 Analysis and Design of Analog Integrated Circuits 3 Credits**

Device and circuit models of bipolar and field effect transistors; bipolar and MOS integrated circuit technology; passive components; parasitic and distributed elements; amplifier gain stages; subthreshold gain stages; current sources and active loads; temperature and supply independent biasing; output stage design; frequency response and slew rate limitation; operational amplifier and analog multiplier design. Circuit simulation using SPICE.

**ECE 478 Analysis and Design of Digital Integrated Circuits 3 Credits**

Large signal models and transient behavior of MOS and bipolar transistors. Basic inverter and logic gate circuits. Noise margins, operating speed, and power consumption of various logic families, including MOS, CMOS, saturated logic TTL, ECL, and IIL. Regenerative logic circuits and digital memories. Circuit design and computer-aided circuit analysis for LSI and VLSI circuits.

**ECE 479 Advanced MOS VLSI Design 3 Credits**

The design of very large scale NMOS and CMOS integrated circuits. Strong emphasis on device physics, and on novel circuit design approaches for VLSI implementation. Examination of second-order effects involved in designing high performance MOS digital integrated circuits, with the goal of pushing the design process to the limits determined by our current understanding of semiconductor device physics and of the currently available technologies. The topics include device physics (subthreshold conduction, short channel effects), important circuit innovations (substrate bias generators, sense amplifiers), systems aspects (clocking, timing, array structures), as well as static and dynamic circuit implementations. Design project, using VLSI design automation tools.

**ECE 483 Advanced Semiconductor Devices for VLSI Circuits 3 Credits**

Theory of small geometry devices for VLSI circuits. Emphasis of MOS bipolar device static and dynamic electrical characteristics. Carrier injection, transport, storage, and detection in bulk and interfacial regions. Limitations of physical scaling theory for VLSI submicron device structures. MOS physics and technology, test pattern device structures, charge-coupled devices, MNOS nonvolatile memory devices, and measurement techniques for device and process characterization. The influence of defects on device electrical properties.

**ECE 485 Heterojunction Materials and Devices 3 Credits**

Material properties of compound semiconductor heterojunctions, quantum wells and superlattices. Strained layer epitaxy and band-gap engineering. Theory and performance of novel devices such as quantum well lasers, resonant tunneling diodes, high electron mobility transistors, and heterojunction bipolar transistors. Complementary to ECE 452. Prerequisites as noted below.

**Prerequisites:** ECE 451

**ECE 486 Integrated Solid-State Sensors 3 Credits**

The physical operation of sensor-based, custom integrated circuits. Emphasis on the integration of sensors, analog, and digital circuits on a silicon chip with CMOS technology. Sensors include photocells, electrochemical transducers, strain gauges, temperature detectors, vibration and velocity sensors, etc. Analysis of sensor-circuit performance limits including signal-to-noise, frequency response, temperature sensitivity, etc. Examples of sensor-based, custom I.C.'s are discussed and analyzed with CAD modeling and layout.

**ECE 490 Thesis 1-6 Credit****ECE 491 Research Seminar 1-3 Credit**

Regular meetings focused on specific topics related to the research interests of department faculty. Current research will be discussed. Students may be required to present and review relevant publications. May be repeated for credit up to a maximum of three (3) credits. Consent of instructor required.

**Repeat Status:** Course may be repeated.

**ECE 492 Independent Study 1-3 Credit**

An intensive study, with report, of a topic in electrical and computer engineering which is not treated in other courses. May be repeated for credit. Consent of instructor required.

**Repeat Status:** Course may be repeated.

**ECE 493 Solid-State Electronics Seminar 3 Credits**

Discussion of current topics in solid-state electronics. Topics selected depend upon the interests of the staff and students and are allied to the research programs of the Sherman Fairchild Laboratory for Solid State Studies. Student participation via presentation of current research papers and experimental work. Consent of instructor required. May be repeated for credit.

**Repeat Status:** Course may be repeated.

**ECE 499 Dissertation 1-15 Credit**

**Repeat Status:** Course may be repeated.

**Engineering**

See additional information on the P.C. Rossin College of Engineering and Applied Science (p. 293).

**Engineering Minor**

See additional information on the Engineering Minor under the heading of the P.C. Rossin College of Engineering and Applied Science (p. 293).

**Core Prerequisites to begin the program**

MATH 051	Survey of Calculus I (or equivalent) <sup>1</sup>
PHY 005	Concepts In Physics (or equivalent) <sup>1</sup>

**Required Courses**

EMC 001	Macro and Micro View of Engineering	3
EMC 002	Engineering Practicum	3

**Electives**

Select three of the following: <sup>2</sup> 9

**Group A - Engineering Fundamentals**

EMC 105	Engineering Structures and Motion
EMC 110	Energy Engineering
EMC 115	Engineering Materials and Electronics
EMC 120	Systems Engineering

**Group B - Integrated Engineering**

EMC/CSE 042	Game Design
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EMC 150	Information and Knowledge Engineering	
EMC 155	Enterprise Engineering	
EMC 156	Embedded Systems	
EMC 160	Computer Aided Engineering and Control Systems	
EMC/IE 168	Production Analysis	
EMC 170	Software Engineering and Collaborative Environments	
EMC/CHE/CEE/ES 171	Fund of Environmental Technology	
EMC 174	Process Engineering	
<b>Total Credits</b>		<b>15</b>

1 May be taken concurrently with EMC 001 and EMC 002.

2 Three electives are required and must include one from the Engineering Fundamentals course group and one from the Integrated Engineering course group. The student is free to choose the third elective from either group.

Number of credits to fulfill minor is 15 credits

**Note: The Minor in Engineering is not open to RCEAS students.**

#### Engineering Minor Course Courses

##### EMC 001 Macro and Micro View of Engineering 3 Credits

A course designed to be exciting and stimulate a student's further interest in the engineering minor. Hands-on experience with engineering problem solving, modeling, simulation, and analysis tools. Macro view of what engineering is and what engineers do. Interaction with practicing engineers; visits to local engineering facilities.

##### EMC 002 Engineering Practicum 3 Credits

Techniques and processes used in the creation of engineered products. Exposure to engineering tasks and processes in a hands-on laboratory; mechanical and electronic manufacturing and fabrication techniques. Disassembly and reassembly of common engineered products to assess how they work and are manufactured.

##### EMC 042 Game Design 3 Credits

From the early text-based, one-player computer games to the modern 3D games with thousands of gamers sharing the same virtual gaming world simultaneously, computer games have gone through a remarkable evolution. Despite this evolution, principles of computer game design are not well understood. In this course we will study the broad issue of game design, particularly tailored towards video games. We will present an experimental model for game design and analyze various modern computer games from the perspective of this model.

##### EMC 105 Engineering Structures and Motion 3 Credits

Practical limits imposed on stationary or moving structures; why exceeding these limits can lead to failure. Basic principles governing both stationary structures; e.g. buildings and bridges, and things that move, e.g. cars and satellites, and how these principles apply in engineering practice. How a stationary structure effectively supports both its own weight and the weight of its users and why a structure will undergo deflections and deformations during use. How forces and energy are associated with a moving structure and how these affect the motion of the structure.

##### EMC 110 Energy Engineering 3 Credits

The amount of energy used by a modern society is quite staggering, and a clear understanding of energy processes and constraints is essential knowledge for every citizen. The basics of energy, its measurement, principles governing its use and conversion, methods of production, and the associated consequences on the environment. Fossil, nuclear, and renewable, energy sources. Energy utilization developed in a simple form and employed to examine the use of energy in large and small engineering systems and products, from power plants to air conditioners.

##### EMC 115 Engineering Materials and Electronics 3 Credits

"Materials" are the "stuff" from which we build TV's, cell phones, cars, skyscrapers, etc., and affect design, performance, costs, and environmental impacts. How electronics, communications, and structures depend on advances in materials engineering: materials behavior, modeling and simulation of materials properties and performance; methods and databases for materials selection; and engineering processes to control material composition and structure.

##### EMC 120 Systems Engineering 3 Credits

Systems approach to problem solving in fields such as environmental planning, large-scale infrastructure systems, manufacturing, telecommunication, and delivery of services. Systems analysis concepts and their relation to the determination of preferred plans and designs of complex, large-scale engineering systems. Performance and cost in project engineering decisions that balance resource investments across the major stages of life of an engineering system. Development of functional requirements and satisfactory designs.

##### EMC 150 Information and Knowledge Engineering 3 Credits

How computers manage information for making decisions automatically or for advising decision makers. Characterization of database systems, of web technologies, of multimedia, and of the relationships among them. Representations of knowledge and the use of artificial intelligence techniques. Automated help-desk systems and computer generation of project plans.

##### EMC 155 Enterprise Engineering 3 Credits

The key elements of modeling and engineering the corporation. Enterprise engineering, decision analysis, application of quantitative methods to facilities planning, engineering economy, production planning and control, forecasting, material requirements planning, and agile business practices. Prerequisites as noted below.

**Prerequisites:** EMC 001 or EMC 002

**Can be taken Concurrently:** EMC 001, EMC 002

##### EMC 156 Embedded Systems 3 Credits

Use of small computers embedded as part of other machines. Limited resource microcontrollers and state machines from high-level description language. Embedded hardware: RAM, ROM, flash, timers, UARTs, PWM, A/D, multiplexing, debouncing. Development and debugging tools running on host computers. Real-Time Operating System (RTOS) semaphores, mailboxes, queues. Task priorities and rate monotonic scheduling. Software architectures for embedded systems. Prerequisites as noted below.

**Prerequisites:** EMC 001 or EMC 002

**Can be taken Concurrently:** EMC 001, EMC 002

##### EMC 160 Computer Aided Engineering and Control Systems 3 Credits

Use of computer-based technologies to design and manufacture products. The design cycle to create product concepts. Analysis of product design. Specifications for the control of manufacturing processes. How control systems are used in creating agile manufacturing environments: discrete and analog signals, analog to digital conversion, and application case studies. Hands-on application(s) and sample exercises from real world examples.

##### EMC 168 Production Analysis 3 Credits

A course for students not majoring in industrial engineering. Engineering economy; application of quantitative methods to facilities analysis and planning, operations planning and control, work measurement, and scheduling.

##### EMC 170 Software Engineering and Collaborative Environments 3 Credits

Discover why building large software systems is very different from using large databases, or designing products such as automobiles with CAD, etc. Design and implementation of a large team project involving complex data management in a collaborative environment. Learn why and how collaborative environments are becoming essential to modern engineering projects and require the tools and techniques of software engineering to succeed. Prerequisites as noted below.

**Prerequisites:** EMC 001 or EMC 002

**Can be taken Concurrently:** EMC 001, EMC 002

**EMC 171 Fund of Environmental Technology 4 Credits**

Water and air quality; water, air, and soil pollution. Chemistry of common pollutants. Water purification, wastewater treatment, solid and hazardous waste management, environmental remediation, and air quality control. Global changes, energy, and the environment. Constraints of environmental protection on technology development and applications. Constraints of economic development on environmental quality. Environmental life cycle analysis and environmental policy.

**EMC 174 Process Engineering 3 Credits**

Semiconductor process engineering, including technology to process raw silicon wafer to electronics integrated circuits (ICs). Crystal growth, thin film deposition, photolithography, doping technology. Prerequisites as noted below.

**Prerequisites:** EMC 001 or EMC 002

**Can be taken Concurrently:** EMC 001, EMC 002

**EMC 252 Computers, the Internet, and Society 3 Credits**

An interactive exploration of the current and future role of computers, the Internet, and related technologies in changing the standard of living, work environments, society and its ethical values. Privacy, security, depersonalization, responsibility, and professional ethics; the role of computer and Internet technologies in changing education, business modalities, collaboration mechanisms, and everyday life.

**Attribute/Distribution:** SS

**Engineering Courses****ENGR 005 Introduction to Engineering Practice 2 Credits**

First year practical engineering experience; introduction to concepts, methods and principles of engineering practice. Problem solving, design, project planning, communication, teamwork, ethics and professionalism; innovative solution development and implementation. Introduction to various engineering disciplines and degree programs. Mandatory for and open only for first year RCEAS students.

**ENGR 010 Applied Engineering Computer Methods 2 Credits**

Introduction to programming for engineering tasks. Use of Matlab to program and solve engineering problems. Interfacing sensors and actuators to a microcontroller board and programming to interact with the world. Computer lab setting. Final project controls engineering equipment. Mandatory for and open only for first year RCEAS students.

**Attribute/Distribution:** ND

**ENGR 050 Directed Study 1-3 Credit**

Engineering project work either as an individual or team member. Projects directed by faculty within the Rossin College of Engineering and Applied Science with possible interaction from outside consultants, community and industry leaders. Written report required. May be repeated for credit. RCEAS permission required.

**Repeat Status:** Course may be repeated.

**ENGR 130 Engineering Communications 1 Credit**

Experience and theory in oral and written communications preparing students for their first Co-Op work assignments. Required of all Engineering Co-Op students. Prerequisites as noted below.

**Prerequisites:** ENGR 200 or ENGR 198

**Can be taken Concurrently:** ENGR 200, ENGR 198

**ENGR 160 Engineering Internship 1-3 Credit**

Offers students who have attained at least Jr2 standing an opportunity to complement coursework with a work experience. Detailed rules can be obtained from the Associate Dean of Engineering. Report required. P/F grading.

**ENGR 200 Engineering Co-op 3 Credits**

Supervised cooperative work assignment to obtain practical experience. Must have acceptance into the program. P/F grading.

**Repeat Status:** Course may be repeated.

**ENGR 211 Integrated Product Development (IPD) 1 3 Credits**

Business, engineering, and design arts students work in cross disciplinary teams of 4-6 students on conceptual design including marketing, financial and economic planning, economic and technical feasibility of new product concepts. Teams work on industrial projects with faculty advisors. Oral presentations and written reports. Must have junior standing in engineering, business or arts and science. Mechanical Engineering students must register for ME 211.

**ENGR 212 Integrated Product Development (IPD) II 2 Credits**

Business, engineering and design arts students work in cross disciplinary teams of 4-6 students on the detailed design including fabrication and testing of a prototype of the new product designed in the IPD course 1. Additional deliverables include a detailed production plan, marketing plan, detailed base-case financial models, project and product portfolio. Teams work on industrial projects with faculty advisors. Oral presentations and written reports. Prerequisites as noted below.

**Prerequisites:** ENGR 211

**ENGR 300 Apprentice Teaching 1-3 Credit****ENGR 400 Engineering Co-op for Graduate Students 1-3 Credit**

Supervised cooperative work assignment to obtain practical experience in field of study. Requires consent of department chairperson. When on a cooperative assignment, the student must register for this course to maintain continuous student status. Limit to at most three credits per registration period. No more than six credits may be applied towards a master's program and no more than nine credits may be used throughout a student's entire graduate study at Lehigh.

**Repeat Status:** Course may be repeated.

**ENGR 401 Teaching/Presentation Skills 1 Credit**

Development of teaching and presentation skills for scientific professionals. Presentation effectiveness, teaching/presentation methodologies, classroom management, course development/content preparation, lecture/presentation development and lecture/presentation delivery. Individualized undergraduate course specific modules selected by student. Enrollment limited to Rossin Doctoral Fellows.

**ENGR 402 Preparing for the Professoriate 1 Credit**

Overview of the job search, research program development and service skills for graduate students entering academic careers. Transition from graduate student to faculty responsibilities, the post-doctoral experience, time management, CV/resume preparation, faculty search process, tenure and promotion, research leadership and program development, research proposal preparation and research sponsorship. Enrollment limited to Rossin Doctoral Fellows.

**ENGR 452 Mathematical Methods in Engineering 3 Credits**

Analytical techniques are developed for the solution of engineering problems described by algebraic systems, and by ordinary and partial differential equations. Topics covered include: linear vector spaces; eigenvalues, eigen-vectors, and eigenfunctions. First and higher-order linear differential equations with initial and boundary conditions; Sturm-Liouville problems; Green's functions. Special functions; Bessel, etc. Qualitative and quantitative methods for nonlinear ordinary differential equations; phase plane. Solutions of classical partial differential equations from the physical sciences; transform techniques; method of characteristics.

**ENGR 490 Thesis (Moc) 1 Credit****ENGR 499 Dissertation (Moc) 1 Credit****Engineering Mathematics**

The Division of Engineering Mathematics was established within the Department of Mechanical Engineering and Mechanics to foster interdisciplinary research in the application of mathematics to the engineering and physical sciences. Interaction with industry is actively encouraged, and appropriate programs are designed for part-time students.

Division faculty are responsible for the graduate degree programs in computational and engineering mechanics as well as courses in engineering mathematics (see mechanical engineering and mechanics).

**Healthcare Systems Engineering**

The Masters of Engineering in Healthcare Systems Engineering (HSE) program produces graduates with strong fundamental skills in industrial and systems engineering and a strong background in healthcare delivery systems and processes. Graduates will be ideally positioned for skilled professional management roles aimed at improving quality, streamlining processes and improving efficiency in healthcare systems. This concentrated degree program is designed to prepare graduate students for engineering and management careers in firms engaged

in delivering healthcare and health related products and services. The need for professionals in this area is strong and growing due to the aging of the population and a national crisis of rapidly increasing healthcare costs. Graduates will be well positioned for employment in the following types of organizations

- Healthcare delivery organizations such as hospitals and clinics
- Healthcare finance organizations such as insurance companies and HMOs
- Healthcare product suppliers such as pharmaceutical companies and manufacturers of Healthcare products
- Management and benefits consulting firms
- Policy organizations at various levels of government and trade associations

Students seeking to enroll to the program should have a bachelor's degree in engineering, mathematics, science, or business. Students should be quantitatively oriented and have completed a calculus based probability and statistics course at the level of ISE 328. A candidate lacking certain background may be required to take background courses.

The program consists of 30 credit hours of course work including a 3-credit HSE capstone project. Full-time in-residence students can complete the program in a fall-spring-summer semester sequence as shown in the table below.

**Professors.** Keith M Gardiner, PhD (University of Manchester); Robert H. Storer, PhD (Georgia Institute of Technology); Tamas Terlaky, PhD (Eotvos Lorand University); Szu-Yung D. Wu, PhD (The Pennsylvania State University); Emory W. Zimmers, Jr., PhD (Lehigh University)

**Associate Professors.** Eugene Perevalov, PhD (University Texas Austin); Louis J. Plebani, Jr., PhD (Lehigh University); Theodore K. Ralphs, PhD (Cornell University); Katya Scheinberg, PhD (Columbia University); Lawrence V Snyder, PhD (Northwestern University); Aurelie Thiele, PhD (Massachusetts Institute of Technology); Gregory L. Tonkay, PhD (The Pennsylvania State University); George R. Wilson, PhD (The Pennsylvania State University)

**Assistant Professors.** Frank E. Curtis, PhD (Northwestern University); Boris Defourny, PhD (Universite de Liege); Luis Zuluaga, PhD (Carnegie Mellon University)

**Professors Of Practice.** Hisham Abu-Nabaa, MSEE (Wilkes University); Pasquale J. Costa, BA (The Pennsylvania State University); Derya Pamukcu, PhD (Louisiana State University)

**Emeriti.** John W. Adams, PhD (University of North Carolina); Mikell P. Groover, PhD (Lehigh University); John C Wiginton, PhD (Carnegie Mellon University)

#### Recommended sequence of courses in the HSE M.Eng. program

Number	Title	Credit Hours
Fall		
ISE 470	Introduction to Healthcare Systems	3
ISE 471	Quality and Process Improvement in Healthcare	3
ISE 410	Design and Analysis of Experiments	3
	Technical Elective	3
	Fall Total	12
Spring		
ISE 426	Optimization Modeling	3
ISE 473	Information Technology in Healthcare	3
ISE 472	Financial Management in Healthcare	3

ISE 404 or ISE 429	Simulation or Stochastic Models and Applications	3
	Spring Total	12
Summer		
ISE 474	Healthcare Systems Engineering Capstone Project	3
	Technical Elective	3
	Summer Total	6
	Program Total	30

Elective courses come from various sectors of systems and engineering as well as accounting, business, and economics. The pool of elective courses is listed below.

- Accounting Information Systems
- Financial Accounting
- Cost Accounting
- Project Management
- Human Resource Management
- Strategic Supply Management
- Technology, Operations, and Competitive Strategy
- Managerial Economics
- Econometrics
- Health Economics
- Management of Information Systems
- Quality Control
- Data Communications Systems
- Systems Engineering Design
- Queuing Systems
- Advanced Database Analysis and Design
- Advanced Data Communications Systems
- Analysis and Design
- Discrete Event Dynamic Systems
- Financial Optimization
- Game Theory
- Healthcare Systems Project

The HSE Program Director must approve all course work including technical electives. No more than 9 credit hours may be taken from the College of Business and Economics.

Additional information about the program may be obtained by calling the HSE Program at (610) 758-5867 or from the HSE program website: <http://lehigh.edu/hse>

#### HSE Course Descriptions

##### Introduction to Healthcare Systems (ISE 470)

The state of Healthcare from economic, systems, quality, and historical perspectives. Components of the Healthcare system including, facilities, delivery and treatment systems, and personnel. System costs, reimbursement methods and financial aspects in Healthcare. Healthcare policy, laws and ethics. System performance measures including access, cost effectiveness and quality of care.

##### Quality and Process Improvement in Healthcare (ISE 471)

The dimensions of Healthcare quality and their definitions, quality metrics, accreditation and other benchmarking and evaluation methods. Change management, project planning and team management. Continuous improvement tools including "lean", "six-sigma", and "TQM"

**Financial Management in Healthcare (ISE 472)**

Engineering economics in Healthcare; value metrics (net present value, return on investment, etc.), cost-benefit analysis, capital projects and improvements. Accounting methods in Healthcare systems. Reimbursement methods, organizations, and alternatives. Financial strategy, planning, pricing and capital formation in “for”, and “not for” profit settings.

**Information Technology in Healthcare (ISE 473)**

Introduction to information systems in Healthcare. Components of the system; electronic medical records, patient monitoring and data collection (clinical information systems), ancillaries (lab, pharmacy, radiology), imaging and digital technology, financial, inventory and management information systems. Enterprise systems in Healthcare, IT driven cost, efficiency and treatment quality metrics. Data warehousing, sharing, mining, protection and privacy issues.

**Healthcare Systems Engineering Capstone Project (ISE 474)**

A three credit hour “capstone” project to be completed in collaboration with industry partners and under the supervision of faculty. Students will work in small groups on projects in the Healthcare industry. The Professor of Practice is the general advisor for the capstone project course.

**Healthcare Systems Project (ISE 475)**

A one to three credit hour project to be completed in collaboration with industry partners and under the supervision of faculty. Intensive study of an area of healthcare systems engineering with emphasis upon design and application. Written report is required.

Courses to build or refresh background knowledge of those who need to refresh, or build quantitative knowledge base and skills.

**ISE 328. Engineering Statistics (3)**

Random variables, probability functions, expected values, statistical inference, hypothesis testing, regression and correlation, analysis of variance, introduction to design of experiments, and fundamentals of quality control. The credits for this course cannot be applied to any undergraduate or graduate degree offered by the Industrial & Systems Engineering Department or the Healthcare Systems Engineering master’s program. Prerequisite: MATH 23 or equivalent.

**ISE 357. Introduction to Industrial Engineering Mathematics (3)**

A review of linear algebra and an introduction to quantitative analysis, manipulation of matrices, core concepts associated with systems of linear equations and linear optimization, algebraic and geometric models. The credits for this course cannot be applied to any undergraduate or graduate degree offered by the Industrial & Systems Engineering Department or the Healthcare Systems Engineering master’s program. Credit will not be given for both ISE 357 and Math 205. Prerequisite: Departmental Approval.

**Industrial and Systems Engineering****Mission Statement**

*To pursue excellence and national prominence in the areas of manufacturing, operations research, information technology and related fields of industrial and systems engineering through innovative teaching, distinguished research and scholarship, and active professional leadership. Building on its unique strength and national reputation in undergraduate education and industrial research, the department strives for leadership in educational innovation, multidisciplinary research, and industrial partnership. Our ultimate mission is to produce leaders who have learned to think critically and analytically, have the skills and techniques to comprehend and create new knowledge, and are willing to serve and inspire others.*

**Physical Facilities**

The industrial and systems engineering department is located in the Harold S. Mohler Laboratory at 200 West Packer Avenue at the northwest corner of the Lehigh University Asa Packer campus. The Mohler Lab building contains the classrooms, laboratories, and faculty offices of the department. Labs in the Mohler Laboratory building include:

*Computational Optimization Research @ Lehigh (COR@L) Lab.* The COR@L lab consists of high performance computer workstations, each equipped with state-of-the-art commercial and noncommercial software for large-scale numerical optimization. COR@L is used for both research and instruction.

*Enterprise Systems Center Laboratories.* The ESC Laboratories contain a variety of computer systems and software in support of agility in Computer Integrated Manufacturing (CIM) and in engineering logistics and distribution problem solving, including: Computer Aided Design (CAD) and Engineering (CAE), discrete event simulation, linear and nonlinear optimization, Finite Element Analysis (FEA), facilities design, process design, process control, and analytics software, such as the SAS software suite.

*Manufacturing Technology Laboratory (MTL).* The MTL contains equipment for instruction and research in manufacturing processes, numerical control (NC), NC part programming, material handling and storage, industrial control systems, and metrology.

*Automation and Robotics Laboratory.* This lab is located in the MTL, it contains a variety of industrial robots and other automated systems to provide students with hands-on experience in the planning and use of this kind of equipment.

*Work Systems Laboratory.* This classroom/laboratory affords the opportunity for undergraduate students to analyze and plan human work activities for individual workstations and worker team situations. A full scale manual assembly line is available for study. Considerable use is made of university computer facilities in ISE coursework. ISE/computing center PC laboratories containing 38 and 16 PCs, respectively, are located in the Mohler Laboratory building.

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**B.S. in Industrial & Systems Engineering**

Industrial & Systems Engineering (ISE) is concerned with the analysis, design, and implementation of integrated systems of people, materials, information, and equipment to accomplish useful work.

**Career Opportunities**

ISE graduates are sought by nearly all industrial corporations as well as government agencies and other service institutions. Major employers of our graduates include management consulting firms, manufacturing companies, banks, hospitals, railroads, the postal service, and transportation/logistics services. A typical career path of an industrial and systems engineer is to start in an entry level engineering position or as a technical analyst and to progress through various management positions in the firm or institution. Significant numbers of industrial and systems engineers ultimately become chief executive officers, chief operating officers, and chief technology officers in their respective organizations.

### Production Systems Career Opportunities

The discipline of industrial & systems engineering is applicable in nearly all industries, whether the industry involves manufacturing of a product or delivery of a service. Job functions performed by ISEs include: systems analysis, cost estimation, capital equipment selection, engineering economy, facilities planning, production planning and scheduling, inventory control, quality control, project management, operations management, engineering management, as well as methods analysis and work measurement. Manufacturing systems engineering (MSE) is a specialty field associated with industrial and systems engineering that emphasizes functions and technologies such as process planning, plant layout design, manufacturing resource planning, production management, production line design, automation, robotics, flexible manufacturing systems, and computer integrated manufacturing.

### Information Systems Career Opportunities

The Industrial & Systems Engineering program can also produce graduates who understand the complex facets of modern information systems, and the integration of these systems in industrial, service and financial organizations. The ISE student has an opportunity to focus on three important areas that are key to a successful information systems-oriented career. (1) Information Economics, (2) Quantitative Systems Analysis, and (3) Information Technology. These areas are coupled with general engineering and business background courses. Information economics studies the formulation, structure, and operational dynamics of information-centric systems in the context of industrial organizations, service sector economics, and financial institutions. Quantitative systems analysis studies operations research and computational tools for analyzing complex systems and their information components. Information technology and applications studies computer and communication technologies needed to design and implement information system applications. Topic areas include the applications of information technology in manufacturing and business environments, including electronic commerce, supply chain and enterprise information systems, manufacturing information systems, and financial enterprises.

### **ISE Curriculum**

The ISE curriculum is designed to provide graduates with the skills and knowledge that employers expect of young industrial and systems engineers beginning their professional careers, and to instill the ability for lifetime learning. It includes the basic mathematical, physical, and social sciences, together with the principles and methods of engineering analysis and design that are specific to industrial and systems engineering. These principles and methods include probability and statistics, engineering economy, cost accounting, operations research, computer simulation, work methods and measurement, manufacturing processes, production and inventory control, and information technology.

In the junior year, an ISE student may elect to specialize more in production systems by choosing a course in modern manufacturing methods. Alternatively, a student may elect to specialize more in information systems by choosing a course in computer algorithm design. An ISE student must choose at least one of these courses, but may elect to choose both for a broader preparation for a career.

Specialized ISE electives in the senior year include: advanced optimization models, stochastic models, operations research, operations management, organization planning and control, statistical quality control, database design, web technologies, and data communications technologies. Electives related to manufacturing systems engineering include: industrial robotics, facilities planning and material handling, logistics and supply chain, and production engineering.

### **Program Educational Objectives**

The set of key, over-arching objectives of the Industrial and Systems Engineering program are to prepare our students, within the first several years of the beginning of their careers, to

1. meet the expectations of employers of industrial and systems engineers,
2. pursue advanced study, if desired,
3. be active leaders in their profession and/or community.

Specifically, these general objectives can be met by graduates that

1. recognize and analyze problems, design innovative solutions, and lead their implementation,
2. excel as industrial and systems engineering professionals who are able to operate effectively in a global, culturally diverse society,
3. communicate effectively using written, oral, and electronic media,
4. pursue life-long learning and professional growth as ethical and responsible members of society,
5. form, lead, and participate on multi-disciplinary teams that solve problems in engineering and business.

In each course in the Industrial & Systems Engineering program, a subset of the student outcomes, listed below, are pursued to prepare students to achieve the Industrial and Systems Engineering program's stated objectives. This list of student outcomes articulated by the Engineering Accreditation Commission of ABET, <http://www.abet.org>, have been adopted by the program and are as follows:

- a) An ability to apply knowledge of mathematics, science, and engineering
- b) An ability to design and conduct experiments, as well as to analyze and interpret data
- c) An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
- d) An ability to function on multidisciplinary teams
- e) An ability to identify, formulate, and solve engineering problems
- f) An understanding of professional and ethical responsibility
- g) An ability to communicate effectively, both orally and in writing
- h) The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
- i) A recognition of the need for, and an ability to engage in life-long learning
- j) A knowledge of contemporary issues
- k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

### **ISE Major Requirements**

The ISE degree requires a minimum of 130 credit hours.

See freshman year requirements, section III. An HSS course is assumed to be taken in the freshman year in the following semester course plans.

#### ===== **sophomore year, first semester (18 credit hours)**

ISE 111 Engineering Probability (3)  
ISE 112 Computer Graphics (1)  
MATH 23 Calculus III (4)  
PHY 21, 22 Introductory Physics II and Laboratory (5)  
ER Engineering Elective Requirement (3)\*\*\*  
CSE 2 Fundamentals of Programming (2)

#### **sophomore year, second semester (16-17 credit hours)**

ISE 121 Applied Engineering Statistics (3)  
ISE 131 Work Systems and Operations Management (3)  
ISE 132 Work Systems Laboratory (1)  
MATH 205 Linear Methods (3)  
[[ HSS Humanities/Social Sciences elective (3-4)\* or ECO 1 Principles of Economics (4) ]]  
[[ MAT 33 Engineering Materials and Processes (3) or CSE 17 Programming and Data Structures (3) ]]

#### **junior year, first semester (16-18 credit hours)**

HSS Humanities/Social Science Electives (6-8)\*  
ER Engineering Elective Requirement (3) \*\*\*  
ISE 230 Introduction to Stochastic Models in Operations Research (3)  
[[ ISE 215 Fundamentals of Modern Manufacturing (3) and ISE 216 Manufacturing Laboratory (1) or ISE 172 Algorithms in Systems Engineering (4) ]]

#### **junior year, second semester (18 credit hours)**



ISE 240 Introduction to Deterministic Optimization Models in Operations Research (3)

ISE 224 Information Systems Analysis and Design (3)

ER Engineering Elective Requirement (3)\*\*\*

ISE 305 Simulation (3)

ISE 226 Engineering Economy and Decision Analysis (3)

FE Free elective (3)

#### **summer**

ISE 100 Industrial Employment (0)

#### **senior year, first semester (15-16 credit hours)**

ISE 251 Production and Inventory Control (3)

ISE technical electives (6)\*\*

[[ ISE 154 Senior Project (3) or HSS Humanities/Social Sciences elective (3-4)\* ]]

ACCT 108 Fundamentals of Accounting (3)

#### **senior year, second semester (15-16 credit hours)**

[[ ISE 154 Senior Project (3) or HSS Humanities/Social Sciences elective (3-4)\* ]]

ISE technical electives (6)\*\*

FE Free electives (6)

#### **Notes:**

\* HSS elective credit totals must satisfy the college HSS program requirements

\*\* **ISE Technical Electives** include all ISE 300-level courses (except ISE 305, which is required), ISE 275, the CSE 2XX and 3XX courses, the BIS 3XX courses, Math 230, and Math 251. In addition, ISE 215 can be used as a technical elective, if ISE 172 is selected as a core course. Conversely, if ISE 215/ISE 216 are selected as core courses, ISE 172 can be used as a technical elective. Of the 4 ISE Technical electives that must be taken, at least 2 must be ISE courses.

\*\*\* **Engineering Electives list:** ME 104, MECH 2(3), ECE 83(81), CEE 170, CHE 44, MAT 33 (required if ISE 215/216 taken), CSE 17 (required if ISE 172 taken). A course selected from this list is denoted "Engineering Elective Requirement" in the program descriptions.

#### **Special Opportunities for ISE students**

The following special opportunities are available to majors in industrial and systems engineering:

**Nontechnical Minor.** Students may choose to pursue a nontechnical minor in an area of the humanities, social sciences, business, or entrepreneurship. Students in the business minor can satisfy the ACCT 108 requirement by completing BUS 127.

**Technical Minor.** Technical minors such as engineering leadership, materials science, environmental engineering, and computer science are available through departments in the P. C. Rossin College of Engineering and Applied Science. Consult the specific department for more details.

**Graduate Courses.** Seniors in industrial and systems engineering can petition to take up to two graduate ISE courses (400-level) to satisfy two of their four 300-level elective ISE course requirements. The petitioning senior must have a good scholastic record (generally above a 3.0 GPA).

**Senior Thesis Option.** Students interested in continuing on to graduate school or performing research are encouraged to take the senior thesis option. In this option a student takes ISE 155 as an engineering or free elective. After ISE 155, ISE 156 is taken as the thesis is written. The sequence of these 2 courses can replace ISE 154.

#### **Technical Minor in Engineering Leadership**

The minor in engineering leadership provides students with the background and practice to become more effective leaders. The minor consists of 5 courses that explore different aspects of leadership. Additional details can be found on the Engineering Leadership Minor website (<http://lehigh.edu/~inleader/>).

#### **Technical Minor in Manufacturing Systems Engineering**

The minor in manufacturing systems engineering provides a concentration of courses in the manufacturing and production areas. This minor is not available to students majoring in industrial and systems engineering. It requires 16 credits.

#### **Graduate Programs**

Several programs leading to master's and doctoral degrees are offered by the Department of Industrial and Systems Engineering. Each program has core requirements. Core requirements can be satisfied by previous coursework upon petition of the ISE graduate committee. All core course prerequisites must also be satisfied. Prerequisites may be satisfied by (1) previous course work, (2) completing the prerequisite course without graduate credit, or (3) passing the final examination of the prerequisite course with a grade of B or better.

A Ph.D. student is required to complete core requirements with grades of B or better before being formally admitted to Ph.D. candidacy.

Further information about graduate programs is contained in an ISE graduate brochure available from the department. In addition, documents are available from the department that describe the requirements of each graduate program.

#### **Certificate in Quality Engineering**

The quality engineering certificate program provides students with the background necessary to analyze, propose and implement changes to improve the quality of products or the efficiency of service systems. The certificate requires four courses from a specified list of courses. Details can be found on the ISE Department website and in the ISE office.

#### **M.S. in Industrial and Systems Engineering**

The minimum program for the master of science degree in Industrial and Systems Engineering consists of 24 credit hours of approved coursework and completion of a satisfactory thesis. Courses in other departments for which the student has the prerequisites may be integrated into this program. Subject to advisor approval, up to nine credit hours of 300 and 400-level courses from other departments may be included in the Industrial and Systems Engineering masters program. The other department courses usually include other engineering disciplines, mathematics, computer science, and business and economics.

#### **M.Eng. in Industrial and Systems Engineering**

This program of study is for those students whose interests are toward engineering design rather than research. The program provides opportunity to gain greater breadth of field through 30 credit hours of coursework (which can include a 3-credit-hour project).

#### **M.S. in Management Science and Engineering**

See separate catalog listing under Management Science and Engineering.

#### **M.Eng. in Management Science and Engineering**

See separate catalog listing under Management Science and Engineering.

#### **M.S. in Manufacturing Systems Engineering**

This is an interdisciplinary graduate program leading to the master of science degree in manufacturing systems engineering. See separate catalog listing under Manufacturing Systems Engineering.

#### **M.Eng. in Healthcare Systems Engineering**

This concentrated degree program is designed to prepare graduate students for engineering and management careers in firms engaged in delivering healthcare and health related products and services. See separate catalog listing under Healthcare Systems Engineering.

#### **M.S. in Analytical Finance**

The Masters in Analytical Finance program combines key concepts in financial theory, mathematical finance and engineering decision making to produce professionals instrumental in creating innovative solutions to real financial issues. See separate catalog listing under Interdisciplinary Graduate Study and Research.

## Ph.D. in Industrial Engineering

The graduate program leading to the doctor of philosophy (Ph.D.) degree is organized to meet the individual goals and interests of graduate students whose professional plans include teaching, consulting, or research in an educational, governmental, or industrial environment. Each doctoral candidate is required to demonstrate: (1) a high level of proficiency in one or more fields of industrial and systems engineering, and (2) a capacity for independent research through the preparation of a dissertation related to his/her field of specialization.

This is to be facilitated as follows. During the first year of study, all Ph.D. students must complete the following core courses (or a substitute approved by the Ph.D. program coordinator): ISE 406, ISE 429, Math 301, and Math 338 or ECO 416. At the end of the first year, each student must declare one of the following two methodological fields of study:

- Optimization, or
- Applied Probability and Statistics

and an applied field, such as

- Financial Engineering,
- Computational Engineering,
- Manufacturing, Production and Logistics,
- A custom-designed program in another applied field (with approval of the Ph.D. program coordinator).

In addition to the core courses, three courses in each of the two declared fields of study are required. Following the first year, an initial review, consisting of faculty evaluation, classroom performance, and a qualifier exam, must be passed. A review by the student's dissertation committee must be passed in each subsequent year, along with the required dissertation proposal and general exam.

### Courses

#### IE 100 Industrial Employment 0 Credits

Usually following the junior year, students in the industrial engineering curriculum are required to do a minimum of eight weeks of practical work, preferably in the field they plan to follow after graduation. A report is required. Must have sophomore standing.

#### IE 111 Engineering Probability 3 Credits

Random variables, probability models and distributions. Poisson processes. Expected values and variance. Joint distributions, covariance and correlation. Prerequisites as noted below.

**Prerequisites:** MATH 022 or MATH 032 or MATH 052

#### IE 112 Computer Graphics 1 Credit

Introduction to interactive graphics and construction of multiview representations in two and three dimensional space. Applications in industrial engineering. Must have sophomore standing in industrial engineering.

**Prerequisites:** ENGR 001

#### IE 121 Applied Engineering Statistics 3 Credits

The application of statistical techniques to solve industrial problems. Regression and correlation, analysis of variance, quality control, and reliability. Prerequisites as noted below.

**Prerequisites:** IE 111 or MATH 231

#### IE 131 Work Systems and Operations Management 3 Credits

Workermachine systems, work flow, assembly lines, logistics and service operations, and project management. Operations analysis, methods engineering, work measurement, lean production, and six sigma. Workplace ergonomics, plant layout design, and work management. Prerequisites as noted below.

**Prerequisites:** IE 111 or MATH 231

**Can be taken Concurrently:** IE 111, MATH 231

#### IE 132 Work Systems Laboratory 1 Credit

Laboratory exercises, case studies, and projects in operations analysis, methods engineering, work measurement, and plant layout design. Prerequisites as noted below.

**Prerequisites:** IE 131

**Can be taken Concurrently:** IE 131

#### IE 154 Senior Project 3 Credits

The use of industrial engineering techniques to solve a major problem in either a manufacturing or service environment. Problems are sufficiently broad to require the design of a system. Human factors in system design. Laboratory. Must have senior standing in industrial engineering.

#### IE 155 Senior Thesis I 3 Credits

In depth study of a research topic in industrial engineering supervised by an ISE department faculty member. Requires completion of a formal research proposal and a public presentation of the proposal at the end of the semester. Must have senior standing.

#### IE 156 Senior Thesis II 3 Credits

Continued in depth study of a research topic in industrial engineering supervised by an ISE department faculty member. Requires a formal thesis and public presentation of the results. IE 156 can be substituted for IE 154 in the IE curriculum when taken in sequence after IE 155.

Prerequisites as noted below.

**Prerequisites:** IE 155

#### IE 168 Production Analysis 3 Credits

A course for students not majoring in industrial engineering. Engineering economy; application of quantitative methods to facilities analysis and planning, operations planning and control, work measurement, and scheduling. Prerequisites as noted below.

**Prerequisites:** MATH 021 or MATH 031 or MATH 051 or MATH 075 or MATH 076

#### IE 172 Algorithms in Systems Engineering 4 Credits

Use of computers to solve problems arising in systems engineering. Design and implementation of algorithms for systems modeling, systems design, systems analysis, and systems optimization. Computer systems, basic data structures, the design and implementation of efficient algorithms, and application of algorithms to the design and optimization of complex systems such as those arising in transportation, telecommunications, and manufacturing. Weekly laboratory with exercises and projects. Prerequisites as noted below.

**Prerequisites:** CSE 017 or CSE 018

#### IE 215 Fundamentals of Modern Manufacturing 3 Credits

Manufacturing processes and systems. Metal machining and forming, polymer shape processes, powder metallurgy, assembly and electronics manufacturing. Introduction to automation, numerical control, and industrial robots. Prerequisites as noted below.

**Prerequisites:** MAT 033

#### IE 216 Manufacturing Laboratory 1 Credit

Laboratory exercises and experiments in manufacturing processes and systems. Prerequisites as noted below.

**Prerequisites:** (IE 215)

**Can be taken Concurrently:** IE 215

#### IE 224 Information Systems Analysis and Design 3 Credits

An introduction to the technological as well as methodological aspects of computer information systems. Content of the course stresses basic knowledge in database systems. Database design and evaluation, query languages and software implementation. Students that take CSE 241 cannot receive credit for this course.

#### IE 226 Engineering Economy and Decision Analysis 3 Credits

Economic analysis of engineering projects; interest rate factors, methods of evaluation, depreciation, replacement, breakeven analysis, aftertax analysis. decision-making under certainty and risk. Prerequisites as noted below.

**Prerequisites:** IE 111 or MATH 231

**Can be taken Concurrently:** IE 111, MATH 231

#### IE 230 Introduction to Stochastic Models in Operations Research 3 Credits

Formulating, analyzing, and solving mathematical models of real-world problems in systems exhibiting stochastic (random) behavior. Discrete and continuous Markov chains, queueing theory, inventory control, Markov decision process. Applications typically include traffic flow, call centers, communication networks, service systems, and supply chains. Prerequisites as noted below.

**Prerequisites:** IE 111 or MATH 231

**IE 240 Introduction to Deterministic Optimization Models in Operations Research 3 Credits**

Formulating, analyzing, and solving mathematical models of real-world problems in systems design and operations. A focus on deterministic optimization models having parameters that are known and fixed. Algorithmic approaches for linear, integer, and nonlinear problems. Solving optimization problems utilizing specialized software. Prerequisites as noted below or consent of instructor.

**Prerequisites:** MATH 205

**IE 251 Production and Inventory Control 3 Credits**

Techniques used in the planning and control of production and inventory systems. Forecasting, inventory models, operations planning, and scheduling.

**Prerequisites:** IE 121 and (IE 220 or (IE 230 and IE 240), )

**IE 275 Fundamentals of Web Applications 3 Credits**

Introduction to web technologies required to support the development of client side and server side components of Internet based applications. Students will be exposed to the problems of design, implementation, and management by way of assigned readings, class discussion, and project implementation. Term project. Prerequisites as noted below.

**Prerequisites:** IE 224 or CSE 241

**Can be taken Concurrently:** IE 224, CSE 241

**IE 281 Leadership Project 1-3 Credit**

Application of leadership principles through team projects with industry. Written report required. Prerequisites as noted below or consent of instructor.

**Repeat Status:** Course may be repeated.

**Prerequisites:** IE 382

**IE 300 Apprentice Teaching 1-4 Credit****IE 305 Simulation 3 Credits**

Applications of discrete and continuous simulation techniques in modeling industrial systems. Simulation using a highlevel simulation language. Design of simulation experiments. Prerequisites as noted below.

**Prerequisites:** IE 121

**IE 316 Optimization Models and Applications 3 Credits**

Modeling and analysis of operations research problems using techniques from mathematical programming. Linear programming, integer programming, multicriteria optimization, stochastic programming, and nonlinear programming using an algebraic modeling language. Prerequisites as noted below.

**Prerequisites:** IE 220 or IE 240 or IE 221 or IE 222

**IE 319 Facilities Planning and Material Handling 3 Credits**

Facilities planning including plant layout design and facility location. Material handling analysis including transport systems, storage systems, and automatic identification and data capture. Prerequisites as noted below or consent of department chair.

**Prerequisites:** IE 131

**IE 321 Independent Study in Industrial & Systems Engineering 1-3 Credit**

Experimental projects in selected fields of industrial engineering, approved by the instructor. A written report is required. May be repeated for academic credit. Department permission required.

**Repeat Status:** Course may be repeated.

**IE 324 Industrial Automation and Robotics 3 Credits**

Introduction to robotics technology and applications. Robot anatomy, controls, sensors, programming, work cell design, part handling, welding, and assembly. Laboratory exercises. Must have senior standing. Prerequisites as noted below.

**Prerequisites:** (MECH 003 or MECH 195 and MATH 205)

**IE 328 Engineering Statistics 3 Credits**

Random variables, probability functions, expected values, statistical inference, hypothesis testing, regression and correlation, analysis of variance, introduction to design of experiments, and fundamentals of quality control. This course cannot be taken by IE undergraduates. Prerequisites as noted below.

**Prerequisites:** MATH 023

**IE 332 Product Quality 3 Credits**

Introduction to engineering methods for monitoring, control, and improvement of quality. Statistical models of quality measurements, statistical process control, acceptance sampling, and quality management principles. Some laboratory exercises. Prerequisites as noted below.

**Prerequisites:** IE 121

**IE 334 Organizational Planning and Control 3 Credits**

Design of organization and procedures for managing functions of industrial engineering. Analysis and design of resources planning and control, including introduction of change in man-machine systems; manpower management and wage administration. Must have junior standing.

**IE 339 Stochastic Models and Applications 3 Credits**

Introduction to stochastic process modeling and analysis techniques and applications. Generalizations of the Poisson process; renewal theory and applications to inventory theory, queuing, and reliability; Brownian motion and stationary processes. Prerequisites as noted below.

**Prerequisites:** IE 220 or IE 230

**IE 340 Production Engineering 3 Credits**

Development of process plans for manufacturing of discrete parts. Emphasis on machining processes planning and design manufacturing interface. Economic analysis of process design alternatives. Concurrent engineering topics. Introduction to mechanization, automation, and flexible manufacturing systems. Fundamentals of group technology and cellular manufacturing Term project. Laboratory. Prerequisites as noted below.

**Prerequisites:** IE 215

**IE 341 Data Communication Systems Analysis and Design 3 Credits**

An introduction to the hardware as well as performance evaluation of data communication networks. Emphasis on data transmission, encoding, data link control, communication networking techniques, and queuing/simulation analysis of network performance.

**Prerequisites:** or (IE 230 and IE 240), )

**IE 344 Metal Machining Analysis 3 Credits**

Intensive study of metal cutting emphasizing forces, energy, temperature, tool materials, tool life, and surface integrity. Abrasive processes. Laboratory and project work. Prerequisites as noted below.

**Prerequisites:** IE 215 or ME 240 or MAT 206

**IE 345 Manufacturing Information Systems 3 Credits**

A study of contemporary Information Technology solutions used to support the manufacturing function from product concept and design through production planning, manufacture, and delivery. Emphasis will be placed on information exchange protocol standards used to improve the overall integration of manufacturing systems.

**IE 347 Financial Optimization 3 Credits**

Making optimal financial decisions under uncertainty. Financial topics include asset/liability management, option pricing and hedging, risk management and portfolio optimization. Optimization techniques covered include linear and nonlinear optimization, discrete optimization, dynamic programming and stochastic optimization. Emphasis on use of modeling languages and solvers in financial applications. Requires basic knowledge of linear optimization and probability. Credit will not be given for both IE 347 and IE 447. Prerequisites as noted below.

**Prerequisites:** IE 316

**IE 355 Optimization Algorithms and Software 3 Credits**

Basic concepts of large families of optimization algorithms for both continuous and discrete optimization problems. Pros and cons of the various algorithms when applied to specific types of problems; information needed; whether local or global optimality can be expected. Participants practice with corresponding software tools to gain hands-on experience. Credit will not be given for both IE 355 and IE 455. Prerequisites as noted below or consent of instructor.

**Prerequisites:** IE 220 or IE 240

**IE 356 Introduction to Systems Engineering and Decision Analysis 3 Credits**

Systems Engineering modeling techniques. Architectures for large scale systems design. Includes physical, functional, and operational architectures. Requirements engineering, interface and integration issues, graphical modeling techniques. Additional topics may include: decision analysis techniques for systems, uncertainty analysis, utility functions, multiattribute utility functions and analysis, influence diagrams, risk preference, Analytical Hierarchy and Node Processes in decision making. Prerequisites as noted below or consent of instructor.

**Prerequisites:** IE 220 or (IE 230 and IE 240)

**IE 357 Introduction to Industrial Engineering Mathematics 3 Credits**

A review of linear algebra and an introduction to quantitative analysis, manipulation of matrices, core concepts associated with systems of linear equations and linear optimization, algebraic and geometric models. The credits for this course cannot be applied to any undergraduate degree offered by the Industrial & Systems Engineering Department. Consent of department required.

**IE 358 Game Theory 3 Credits**

A mathematical analysis of how people interact in strategic situations. Applications include strategic pricing, negotiations, voting, contracts and economic incentives, and environmental issues. Prerequisites as noted below.

**Prerequisites:** (MATH 021 or MATH 031 or MATH 051 or MATH 076) and (ECO 105 or ECO 146 or ECO 146)

**IE 362 Logistics and Supply Chain Management 3 Credits**

Modeling and analysis of supply chain design, operations, and management. Analytical framework for logistics and supply chains, demand and supply planning, inventory control and warehouse management, transportation, logistics network design, supply chain coordination, and financial factors. Students complete case studies and a comprehensive final project. Prerequisites as noted below or consent of instructor.

**Prerequisites:** (IE 220 and IE 251) or (IE 230 and IE 240)

**IE 365 Applied Data Mining 3 Credits**

Introduction to the data mining process including business problem understanding, data understanding and preparation, modeling and evaluation, and model deployment. Emphasis on hands-on data preparation and modeling using techniques from statistics, artificial intelligence, such as regression, decision trees, neural networks, and clustering. A number of application areas are explored. This course is an undergraduate version of IE 465. Credit will not be given for both IE 365 and IE 465. Prerequisites as noted below.

**Prerequisites:** IE 121 or IE 328

**IE 372 Systems Engineering Design 3 Credits**

Analysis, design, and implementation of solutions to problems in manufacturing and service sectors using information technology. Emphasis on problem identification and the evaluation of proposed solutions and implementations. Term Project.

**Prerequisites:** (IE 220 or (IE 230 and IE 240), ) and IE 275

**IE 382 Leadership Development 3 Credits**

Exploration and critical analysis of theories, principles, and processes of effective leadership. Managing diverse teams, communication, and ethics associated with leadership. Application of knowledge to personal and professional life through projects and team assignments. Must be a junior or senior.

**IE 404 Simulation 3 Credits**

Applications of discrete and continuous simulation techniques in modeling industrial systems. Simulation using a highlevel simulation language. Design of simulation experiments. This course is a version of IE 305 for graduate students, with research projects and advanced assignments. Prerequisites as noted below.

**Prerequisites:** IE 121 or IE 328

**IE 405 Special Topics in Industrial & Systems Engineering 3 Credits**

An intensive study of some field of industrial & systems engineering.

**IE 406 Introduction to Mathematical Optimization 3 Credits**

Algorithms and techniques for the solution and analysis of deterministic linear optimization models used in operations research. Linear and integer linear optimization problems. Modeling techniques and fundamental algorithms and their complexity properties. Available open source and commercial solvers discussed.

**IE 407 Computational Methods in Optimization 3 Credits**

Introduction to a wide range of topics related to computational methods encountered in the implementation of optimization algorithms. Lectures focus primarily on theoretical aspects of computation, but with the goal of understanding computation in practice. Assigned exercises focus on employing computational methods in real-world applications. Topical coverage will include data structures, design and analysis of algorithms (sequential and parallel), programming paradigms and languages, development tools and environments, numerical analysis, and matrix computations.

**IE 408 Management of Information Systems 3 Credits**

Philosophies and methods for systematic planning, development, and implementation of management information systems. Concepts of information resource management, and strategic and longrange planning of information systems and services.

**IE 409 Time Series Analysis 3 Credits**

Theory and applications of an approach to process modeling, analysis, prediction, and control based on an ordered sequence of observed data. Single or multiple time series are used to obtain scalar or vector difference/ differential equations describing a variety of physical and economic systems.

**IE 410 Design of Experiments 3 Credits**

Experimental procedures for sorting out important causal variables, finding optimum conditions, continuously improving processes, and trouble shooting. Applications to laboratory, pilot plant and factory. Must have some statistical background and experimentation in prospect. Prerequisites as noted below.

**Prerequisites:** IE 121 or IE 328

**IE 411 Networks and Graphs 3 Credits**

This course examines the theory and applications of networks and graphs. Content of the course stresses on the modeling, analysis and computational issues of network and graph algorithms. Complexity theory, trees and arborescences, path algorithms, network flows, matching and assignment, primaldual algorithms, Eulerian and Hamiltonian walks and various applications of network models. Prerequisites as noted below.

**Prerequisites:** IE 406

**IE 412 Quantitative Models of Supply Chain Management 3 Credits**

Analytical models for logistics and supply chain coordination. Modeling, analysis, and computational issues of production, transportation, and other planning and decision models. Logistics network configuration, risk pooling, stochastic decision-making, information propagation, supply chain contracting, and electronic commerce implication. Prerequisites as noted below.

**Prerequisites:** IE 316 and IE 339

**IE 413 Advanced Engineering Economy and Replacement Analysis 3 Credits**

Measuring economic worth, economic optimization under constraints, analysis of economic risk and uncertainty. Emphasis on analytical methods to evaluate the economic desirability of replacement and retirement options in capital investment. Prerequisites as noted below.

**Prerequisites:** IE 230 or IE 240

**IE 414 Heuristic Methods in Combinatorial Optimization 3 Credits**

Heuristic methods for solving combinatorial and discrete optimization problems such as routing, scheduling, partitioning and layout. Introduction to NP-completeness theory, exact and inexact methods, performance analysis, fast and greedy heuristics, Lagrangean heuristics, and various search techniques including simulated annealing, genetic algorithms, Tabu search and iterative constructive heuristics.

**IE 416 Dynamic Programming 3 Credits**

The principle of optimality and recursive solution structure; multidimensional problems; reduction of dimensionality and approximation; stochastic control; nonserial systems; relationship to calculus of variation; applications. Prerequisites as noted below.

**Prerequisites:** IE 316

**IE 417 Nonlinear Programming 3 Credits**

Advanced topics in mathematical optimization with emphasis on modeling and analysis of nonlinear problems. Convex analysis, unconstrained and constrained optimization, duality theory, Lagrangian relaxation, and methods for solving nonlinear optimization problems, including descent methods, Newton methods, conjugate gradient methods, and penalty and barrier methods. Prerequisites as noted below.

**Prerequisites:** IE 406

**IE 418 Integer Programming 3 Credits**

Advanced topics in mathematical optimization with emphasis on modeling and analysis of optimization problems with integer variables. Polyhedral theory, theory of valid inequalities, duality and relaxation, computational complexity, and methods for solving discrete optimization problems, such as branch and bound.

**IE 419 Planning and Scheduling in Manufacturing and Services 3 Credits**

Models for the planning and scheduling of systems that produce goods or services. Resource allocation techniques utilizing static and dynamic scheduling methods and algorithms. Application areas include manufacturing and assembly systems, transportation system timetabling, project management, supply chains, and workforce scheduling.

**IE 422 Measurement and Inspection Systems 3 Credits**

Study of measurement instruments and sensors for manufactured products. Metrology standards, performance characteristics of measuring devices, calibration, error analysis, and gaging. Mechanical, optical, and other techniques. Online monitoring and control for product quality, and sensor integration and fusion.

**IE 424 Robotic Systems and Applications 3 Credits**

Detailed analysis for robotic systems in manufacturing and service industries. Task planning and decomposition, motion trajectory analysis, conveyor tracking, error detection and recovery, end effector design, and systems integration.

**IE 425 Advanced Inventory Theory 3 Credits**

Advanced analytical, algorithmic, and heuristic methods for optimizing and managing inventory systems. Economic order quantity model and extensions; power-of-two policies; base-stock and other policies for stochastic systems; the Clark-Scarf model; assembly and distribution systems; proofs of policy optimality.

**IE 426 Optimization Models and Applications 3 Credits**

Modeling and analysis of operations research problems using techniques from mathematical programming. Linear programming, integer programming, multicriteria optimization, stochastic programming and nonlinear programming using an algebraic modeling language. This course is a version of IE 316 for graduate students, with research projects and advanced assignments. Closed to students who have taken IE 316. Prerequisites as noted below.

**IE 429 Stochastic Models and Applications 3 Credits**

Introduction to stochastic process modeling and analysis techniques and applications. Generalization of the Poisson process; renewal theory, queueing, and reliability; Brownian motion and stationary processes. This course is a version of IE 39 for graduate students, with research projects and advanced assignments. Closed to students who have taken IE 339. Prerequisites as noted below.

**Prerequisites:** IE 220 or IE 230

**IE 430 Management Science Project 3 Credits**

Analysis of a management problem and design of its solution incorporating management science techniques. An individual written report is required. Recommended to be taken in the last semester of the program.

**IE 431 Operations Research Special Topics 3 Credits**

Extensive study of selected topics in techniques and models of operations research.

**IE 433 Manufacturing Engineering Special Topics 3 Credits**

Extensive study of selected topics in the research and development of manufacturing engineering techniques.

**IE 437 Advanced Database Analysis and Design 3 Credits**

Intensive treatment of design and application of modern database technology, including information modeling and logical design of databases. Emphasis on applications to the manufacturing environment. Prerequisites as noted below.

**Prerequisites:** IE 224

**IE 438 Advanced Data Communication Systems Analysis and Design 3 Credits**

Study of technological development, operational algorithms and performance analysis in data networks. Emphasis on recent developments in communication technologies, modeling and simulation of largescale networks, routing models and algorithms, and flow control issues.

**IE 439 Queueing Systems 3 Credits**

Queueing theory and analysis of manufacturing, distribution, telecommunications, and other systems subject to congestion. Design and analysis of queueing networks; approximation methods such as mean value analysis, uniformization, fluid and diffusion interpretations; numerical solution approaches.

**IE 441 Financial Engineering Projects 3 Credits**

Analysis, design and implementation of solutions to problems in financial services using information technology, mathematical modeling, and other financial engineering techniques. Emphasis on realworld problem solving, problem definition, implementation and solution evaluation.

**IE 442 Manufacturing Management 3 Credits**

Study of factors affecting the development of a manufacturing management philosophy; decision-making process in areas of organization, planning, and control of manufacturing. The principles and techniques of TQM, Deming and others; metrics, costs, benchmarking, quality circles, and continuous improvement. Influence of the social, technical, and economic environment upon manufacturing management decisions. Case studies.

**IE 443 Automation and Production Systems 3 Credits**

Principles and analysis of manual and automated production systems for discrete parts and products. Cellular manufacturing, flexible manufacturing systems, transfer lines, manual and automated assembly systems, and quality control systems. Prerequisites as noted below.

**Prerequisites:** IE 215

**IE 445 Assembly Processes and Systems 3 Credits**

Joining processes including welding, brazing, soldering, and adhesive bonding. Mechanical assembly methods. Manual assembly lines and line balancing. Automated assembly. Product design considerations including Design for Assembly.

**IE 446 Discrete Event Dynamic Systems 3 Credits**

Modeling of Discrete Event Dynamic systems (DEDS) particularly as applied to industrial systems. Modeling procedures with focus on Petri Nets. Hierarchical Petri Net modeling, performance analysis, behavioral and structural properties, and various synthesis and analytical techniques. Relationships to state space concepts, simulation, and finite state automata are introduced. Emphasis on use of such nets for the control of industrial systems. Consent of instructor required.

**IE 447 Financial Optimization 3 Credits**

Making optimal financial decisions under uncertainty. Financial topics include asset/liability management, option pricing and hedging, risk management, and portfolio optimization. Optimization techniques covered include linear and nonlinear programming, integer programming, dynamic programming, and stochastic programming. Emphasis on use of modeling languages and solvers in financial applications. Requires basic knowledge of linear programming and probability. This course is a version of IE 347 for graduate students and requires advanced assignments. Credit will not be given for both IE 347 and IE 447. Prerequisites as noted below.

**Prerequisites:** IE 426 and IE 316

**IE 448 Industrial Control Systems for Manufacturing 3 Credits**

Techniques used to control manufacturing systems: numerical control, digital control, programmable logic controllers, and sensors.

**IE 449 Advanced Computer Aided Manufacturing 3 Credits**

Numerical control in manufacturing; CAD/CAM systems; computer monitoring and control of manufacturing operations; adaptive control of manufacturing operations. Manufacturing resource planning, computeraided process planning, and shop floor control.

**IE 451 Intelligent Manufacturing Systems 1-3 Credit**

Informational and control structures, architectures, and analysis techniques for autonomous and semiautonomous manufacturing systems. System architectures and techniques, knowledge based systems in production, and techniques based on fuzzy systems and neural networks. Applications in manufacturing systems control, process planning, and design and management problems in newly developing manufacturing and production systems. Consent of instructor required.

**IE 455 Optimization Algorithms and Software 3 Credits**

Basic concepts of large families of optimization algorithms for both continuous and discrete optimization problems. Pros and cons of the various algorithms when applied to specific types of problems; information needed; whether local or global optimality can be expected. Participants practice with corresponding software tools to gain hands-on experience. This course is a version of IE 355 for graduate students and requires advanced assignments. Credit will not be given for both IE 355 and IE 455. Prerequisites as noted below or consent of instructor.

**Prerequisites:** IE 220 or IE 240

**IE 458 Topics in Game Theory 3 Credits**

A mathematical analysis of how people interact in strategic situations. Topics include normalform and extensiveform representations of games, various types of equilibrium requirements, the existence and characterization of equilibria, and mechanism design. The analysis is applied to microeconomic problems including industrial organization, international trade, and finance. Must have two semesters of calculus. Prerequisites as noted below or consent of instructor.

**Prerequisites:** ECO 412 and ECO 413

**IE 460 Engineering Project 1-3 Credit**

Intensive study of an area of industrial engineering with emphasis upon design and application. A written report is required.

**IE 461 Readings 1-3 Credit**

Intensive study of some area of industrial engineering that is not covered in general courses.

**IE 465 Applied Data Mining 3 Credits**

Introduction to the data mining process including business problem understanding, data understanding and preparation, modeling and evaluation, and model deployment. Emphasis on hands-on data preparation and modeling using techniques from statistics, artificial intelligence, such as regression, decision trees, neural networks, and clustering. A number of application areas are explored. This course is a graduate version of IE 365 possessing some advanced assignments. Credit will not be given for both IE 365 and IE 465. Prerequisites as noted below.

**Prerequisites:** IE 121 or IE 328

**IE 470 Introduction to Healthcare Systems 3 Credits**

The state of Healthcare from economic, systems, quality, and historical perspectives. Components of the Healthcare system including, facilities, delivery and treatment systems, and personnel. System costs, reimbursement methods and financial aspects in Healthcare. Healthcare policy, laws and ethics. System performance measures including access, cost effectiveness and quality of care.

**IE 471 Quality and Process Improvement in Healthcare 3 Credits**

The dimensions of Healthcare quality and their definitions, quality metrics, accreditation and other benchmarking and evaluation methods. Change management, project planning and team management. Continuous improvement tools including "lean", "six-sigma", and "TQM".

**IE 472 Financial Management in Healthcare 3 Credits**

Engineering economics in Healthcare; value metrics (net present value, return on investment, etc.), cost-benefit analysis, capital projects and improvements. Accounting methods in Healthcare systems. Reimbursement methods, organizations, and alternatives. Financial strategy, planning, pricing and capital formation in "for", and "not for" profit settings.

**IE 473 Information Technology in Healthcare 3 Credits**

Introduction to information systems in Healthcare. Components of the system; electronic medical records, patient monitoring and data collection (clinical information systems), ancillaries (lab, pharmacy, radiology), imaging and digital technology, financial, inventory and management information systems. Enterprise systems in Healthcare, IT driven cost, efficiency and treatment quality metrics. Data warehousing, sharing, mining, protection and privacy issues.

**IE 474 Healthcare Systems Engineering Capstone Project 3 Credits**

A three credit hour "capstone" project to be completed in collaboration with industry partners and under the supervision of faculty. Students will work in small groups on projects in the Healthcare industry. The Professor of Practice is the general advisor for the capstone project course.

**IE 475 Healthcare Systems Project 1-3 Credit**

Intensive study of an area of healthcare systems engineering with emphasis upon design and application. Written report is required.

**IE 490 Thesis 1-6 Credit****IE 499 Dissertation 1-15 Credit****Management Science and Engineering**

The Management Science and Engineering program is directed toward integrating scientific methods with the functional aspects of organizations by investigating the application of quantitative methodology and systems analysis in the context of decision making, risk analysis, economics and cost analysis, production management, and supply chain logistics. This integration provides the students with a broader perspective toward managerial decision-making in both private enterprise and public administration.

Midcareer professionals and recent graduates with a background in engineering, mathematics, and physical sciences who intend to seek managerial, consulting or systems analyst positions are appropriate candidates. In particular, those candidates who intend to seek positions demanding both technical and management skills find the management science background advantageous in dealing with the complex problems of industrial, commercial, and public service organizations.

The Industrial and Systems Engineering Department administers the Management Science and Engineering program. To be admitted to the program a candidate must demonstrate basic competence in calculus, statistics, linear algebra, introductory operations research, accounting, production and economics. A candidate lacking a certain background may be required to take background courses. The minimum program consists of 30 credit hours of course work, of which at least 18 credit hours must be in the 400-level. The ISE graduate faculty coordinator must approve all course work. No more than 9 credit hours may be taken from the College of Business and Economics.

**Professors.** Keith M Gardiner, PhD (University of Manchester); Robert H. Storer, PhD (Georgia Institute of Technology); Tamas Terlaky, PhD (Eotvos Lorand University); Szu-Yung D. Wu, PhD (The Pennsylvania State University); Emory W. Zimmers, Jr., PhD (Lehigh University)

**Associate Professors.** Eugene Perevalov, PhD (University Texas Austin); Louis J. Plebani, Jr., PhD (Lehigh University); Theodore K. Ralphs, PhD (Cornell University); Katya Scheinberg, PhD (Columbia University); Lawrence V Snyder, PhD (Northwestern University); Aurelie Thiele, PhD (Massachusetts Institute of Technology); Gregory L. Tonkay, PhD (The Pennsylvania State University); George R. Wilson, PhD (The Pennsylvania State University)

**Assistant Professors.** Frank E. Curtis, PhD (Northwestern University); Boris Defourny, PhD (Universite de Liege); Luis Zuluaga, PhD (Carnegie Mellon University)

**Professors Of Practice.** Hisham Abu-Nabaa, MSEE (Wilkes University); Pasquale J. Costa, BA (The Pennsylvania State University); Derya Pamukcu, PhD (Louisiana State University)

**Emeriti.** John W. Adams, PhD (University of North Carolina); Mikell P. Groover, PhD (Lehigh University); John C Winton, PhD (Carnegie Mellon University)

### M.S. in Management Science and Engineering

The minimum program for the master of science degree in Management Science & Engineering consists of 24 credit-hours of approved courses and completion of a satisfactory 6 credit thesis. A faculty member must supervise the thesis. Courses from outside the ISE department usually include other engineering disciplines, mathematics, computer science, and business and economics.

### M.Eng. in Management Science and Engineering

The minimum program for the master of engineering degree in Management Science & Engineering consists of 30 credit-hours of coursework (which can include a 3 credit-hour project). This program of study is for those students whose interests are geared toward engineering design rather than research. A faculty member must supervise the project.

### Management Science and Engineering Core Courses

Each student is required to complete at least 12 credit hours of courses selected from the following set of Management Science and Engineering Core Courses.

Select four of the following:<sup>1</sup> 12

IE/ECO 358	Game Theory
IE 404	Simulation
IE 409	Time Series Analysis
IE 410	Design of Experiments
IE 414	Heuristic Methods in Combinatorial Optimization
IE 416	Dynamic Programming
IE 419	Planning and Scheduling in Manufacturing and Services
IE 412	Quantitative Models of Supply Chain Management
IE 426	Optimization Models and Applications
IE 429	Stochastic Models and Applications
IE 439	Queueing Systems
IE 447	Financial Optimization
IE 458/ECO 463	Topics in Game Theory
MATH 311	Graph Theory
MATH 312	Statistical Computing and Applications
MATH 334	Mathematical Statistics
MATH 338/STAT 438	Linear Models in Statistics with Applications
MATH 467	Financial Calculus I
MATH 468	Financial Calculus II

ECO 412 Mathematical Economics

ECO 415 Econometrics I

Total Credits 12

<sup>1</sup> At least 6 credits must be IE courses.

### Areas of Concentration

A student may elect to concentrate coursework in specific areas, but there is no requirement to do so. A set of recommended courses in each of eight areas can be found in materials for the Management Science and Engineering program available at the ISE office and on the department website.

### Materials Science and Engineering

As science and technology advance in the 21st century, progress in many fields will depend on the discovery and development of new materials, processed in more complex ways, and with new kinds of properties. It is widely recognized that the progress of history has been divided into periods characterized by the materials that mankind has used, e.g., the stone age, the bronze age, the iron age. Today, materials science and engineering is critical to all other fields of engineering, and advances in other fields are often limited by advances in materials.

Interest in new materials for solid-state devices, space technology, and superconductivity, as well as a better understanding of the behavior of materials in the design of structures, automobiles and aircraft, plant processing equipment, electronic devices, biomedical devices, etc., have increased the need for people trained in science and technology of materials.

Education for this field of engineering requires basic studies in mathematics, chemistry, physics and mechanics, plus a general background in engineering principles, followed by intensive training in the application of these principles to the development and use of materials in a technological society.

**Professors.** Helen M. Chan, PhD (Imperial College London); John N. DuPont, PhD (Lehigh University); Martin P. Harmer, DSC (University of Leeds); Himanshu Jain, PhD (Columbia University); Christopher J. Kiely, PhD (University of Bristol); Charles E. Lyman, PhD (Massachusetts Institute of Technology); Wojciech Z. Misiolek, PhD (University of Mining & Metallurgy); Raymond A. Pearson, PhD (University of Michigan Ann Arbor); Jeffrey M. Rickman, PhD (Carnegie Mellon University); Richard P. Vinci, PhD (Stanford University)

**Associate Professor.** Masashi Watanabe, PhD (Kyushu University)

**Assistant Professors.** Xuanhong Cheng, PhD (University of Washington); Sabrina S. Jedlicka, PhD (Purdue University); Nicholas Strandwitz, PhD (University of California Santa Barbara)

**Emeriti.** Betzalel Avitzur, PhD (University of Michigan Ann Arbor); Sidney R. Butler, PhD (The Pennsylvania State University); G. Slade Cargill, III, PhD (Harvard University); Ye T. Chou, PhD (Carnegie Mellon University); John Alwyn Eades, PhD (University of Cambridge); Richard W. Hertzberg, PhD (Lehigh University); Arnold R. Marder, PhD (Lehigh University); Michael R. Notis, PhD (Lehigh University); Alan W. Pense, PhD (Lehigh University); Donald M. Smyth, PhD (Massachusetts Institute of Technology); Leslie H. Sperling, PhD (Duke University); Stephen K. Tarby, PhD (Carnegie Mellon University); David A. Thomas, DSC (Massachusetts Institute of Technology); David B. Williams, PhD (University of Cambridge)

### B.S. in Materials Science and Engineering

The undergraduate program is designed to prepare graduates for research, development, operations, management, and sales careers in industry or for graduate study in various specialties of the field, including the improvement of properties in metals, ceramics, polymers, composites, and electronic materials. While some graduates go directly into materials-producing companies, most serve as engineers in the transportation, electronics, chemical, communications, space, and other industries. A number of students pursue graduate study leading to careers in research and teaching, medicine, or the law.

Materials Science and Engineering majors have opportunities to gain valuable experience in related fields, including other areas

of engineering or science, by choosing to concentrate elective courses in one of these areas. Requirements for the Minor include acquiring at least 15 course credits in that area, which may be taken as technical or free electives in the student's major. It is particularly straightforward for students to obtain a minor in Chemical Engineering, in Manufacturing Engineering, in Nanotechnology, or in Polymer Science and Engineering.

Materials Science and Engineering majors can also participate in undergraduate research at universities in Great Britain and elsewhere during the summer between the Junior and Senior years. The Materials Science and Engineering Industrial Option program enables students to gain work experience during the Senior Year. The Materials Science and Engineering Research Option program provides senior undergraduates with research experience.

Five-Year programs are available to broaden the Materials Science and Engineering undergraduate experience. One such program is the Arts-Engineering Program, in which students can earn both the Bachelor of Science degree in Materials Science and Engineering and the Bachelor of Arts degree in some area within the College of Arts and Sciences, such as biology, physics, chemistry, or history. Another is the B.S./M.Ed. Program, which leads (in five years of study and internships) to the B.S. degree in Materials Science and Engineering and a masters degree (M.Ed.) in Education, with elementary or secondary teacher certification.

#### Minor in Materials Science and Engineering

The Department of Materials Science and Engineering offers minors to students majoring in other subjects. The Department is enthusiastic in its support of students who wish to broaden their education by taking a minor. To obtain a minor in Materials Science and Engineering, a student must complete:

MAT 033	Engineering Materials and Processes	3
Four other three-credit courses that may be chosen from a long list of 200 and 300 level courses relevant to various engineering disciplines		12
<b>Total Credits</b>		<b>15</b>

#### Minor in Nanotechnology

Materials for nanotechnology applications have new properties unavailable in bulk materials. The synthesis, processing, and characterization of these materials require facility with concepts beyond those needed for typical engineering materials. This minor requires:

MAT 355	Materials for Nanotechnology	3
One course on crystallography and band theory		3
Additional electives		9
<b>Total Credits</b>		<b>15</b>

#### Educational Mission and Program Objectives

The Materials Science and Engineering undergraduate program's mission is to provide its students an excellent education in a scholarly environment.

Our Program Educational Objectives are that graduates have the knowledge and experience needed to advance to successful careers and, where appropriate, for graduate study in materials-related fields. Successful careers will be reflected in continuing employment, personal satisfaction, professional recognition, and advancement in responsibilities. Success in graduate studies will be indicated by admission to highly ranked graduate programs, timely completion of degree requirements, and recognition by competitive fellowships and other awards.

#### Student Outcomes

The MS&E undergraduate Student Outcomes declare that graduates should have:

- an ability to apply knowledge of mathematics, science, and engineering;
- an ability to design and conduct experiments, as well as to analyze and interpret data;
- an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic,

environmental, social, political, ethical, health and safety, manufacturability, and sustainability;

- an ability to function on multidisciplinary teams;
- an ability to identify, formulate, and solve engineering problems;
- an understanding of professional and ethical responsibility;
- an ability to communicate effectively;
- the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context;
- a recognition of the need for, and an ability to engage in life-long learning;
- a knowledge of contemporary issues;
- an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

#### Major Requirements

The recommended sequence of courses is shown below. A total of 132 credits or more is required to graduate.

##### First Year

First Semester	CR	Second Semester	CR
ENGL 001	3	ENGL 002	3
MATH 021	4	MATH 022	4
ENGR 005	2	PHY 011 <sup>1</sup>	4
ENGR 010	2	PHY 012 <sup>1</sup>	1
CHM 030 <sup>1</sup>	4	Select one of the following:	4
		ECO 001	4
		Humanities or Social Sciences Elective	4
	<b>15</b>		<b>16</b>

##### Second Year

First Semester	CR	Second Semester	CR
MAT 033 <sup>2</sup>	3	MAT 020	3
MAT 010	2	MAT 203	4
MATH 023	4	MAT 205	3
PHY 021	4	MATH 205	3
PHY 022	1	MECH 003	3
Select one of the following:	4		
ECO 001	4		
Humanities or Social Sciences Elective	4		
	<b>18</b>		<b>16</b>

##### Third Year

First Semester	CR	Second Semester	CR
MAT 201	3	MAT 204	3
MAT 216	3	MAT 206	3
MAT 218	3	ENGR 211	3
MAT 101	2	MAT 214	3
Humanities or Social Sciences Elective	4	Humanities or Social Sciences Elective	3
Free Elective	3	Free Elective	3
	<b>18</b>		<b>18</b>

##### Fourth Year

First Semester	CR	Second Semester	CR
ENGR 212	2	MAT 338	3
MAT 302	3	CHE 280	3
Engineering Science Elective	3	ECE 083	3
Engineering Science Elective	3	ECE 162	1
Humanities/Social Sciences Elective	4	Approved Elective	3



Free Elective	3
<b>15</b>	<b>16</b>

Total Credits: 132

- 1 Required natural science courses, one taken fall semester and the other taken in spring
- 2 MAT 033 is taught in both the fall and spring semesters

Electives for the sophomore, junior, and senior years must be distributed as follows:

Humanities and Social Sciences: 13-15 credit hours.

Free Electives: 9 credit hours in any department.

Approved Elective (3 credit hours) and Engineering Science Electives (6 credit hours) must be selected from a specific list supplied by the Materials Science and Engineering Department. The list includes the Industrial Option and the Research Option.

#### Industrial Option

MAT 327	Industrial Project	4
MAT 329	Industrial Project	4

#### Research Option

MAT 240	Research Techniques	3
MAT 291	Undergraduate Research	3

The Industrial Option introduces students to the work of materials engineers in industry. The emphasis is a team approach to the solution of actual plant problems. The courses are conducted in cooperation with local industries. 20 hours per week are spent at the plant of the cooperating industry on investigations of selected problems. The option is limited to a small group of seniors, selected by the Department from those who apply. Summer employment is provided when possible for those who elect to initiate the program during the summer preceding the senior year.

The Research Option is offered for students interested in research and development. Financial support may be available for students who elect to initiate a research program during the summer preceding the senior year. The option is limited to a small group of students, selected by the Department from those who apply.

#### For Graduate Students

The department offers graduate degrees in Materials Science and Engineering at both masters (M.S. and M. Eng.) and doctoral levels (Ph.D.). Specialized masters degree programs are also available in Photonics, in Polymers, and in Business Administration and Engineering (MBA&E). The M.S. Degree in Photonics is an interdisciplinary degree for broad training in such topics as fiber optics, light-wave communications, and optical materials, to prepare students for work in industry or for further graduate research at the Ph.D. level. The program requires a total of 30 credits of graduate work, including a 15-credit core of courses in materials, electrical engineering, and physics. The Polymer Science and Engineering Program offers interdisciplinary M.S. and Ph.D. degrees through several departments, including Materials Science and Engineering. The program includes courses in materials, chemical engineering, chemistry, physics, and mechanical engineering. The MBA&E is an interdisciplinary degree program in business and engineering designed primarily for students with an undergraduate degree in engineering and two years or more of relevant work experience. The curriculum consists of an MBA core and electives (23 credits) and an engineering core and electives (18 credits), plus other electives and a project which integrates business and engineering (4 credits). Students wishing to have the engineering core in Materials Science and Engineering may enter this program through the Materials Science and Engineering Department.

#### Special Programs and Opportunities

The department has established specific recommended programs for the M.S., the M.Eng., and the Ph.D., emphasizing the following areas: metals processing and performance, ceramics and glass processing and properties, electronic and photonic materials and packaging, electron microscopy and microstructural characterization, and archaeometallurgy.

These programs are flexible and often interdisciplinary.

#### Major Requirements

The requirements are explained in section IV. A candidate for the M.S. completes a thesis, unless fully funded by industry, in which case a thesis is not required. M.S. thesis research normally represents six of the 30 semester hours required for this degree. Candidates for the M.Eng. complete a three-credit engineering project.

A candidate for the Ph.D. prepares a preliminary program of courses and research, providing for specialization in some field (largely through research) in consultation with the adviser. Prior to formal establishment of the doctoral program by the special committee and its approval by the college, the student passes a qualifying examination that must be taken in the first or second year of doctoral work. The department does not require a foreign language. It does require preparation and defense of a research proposal as a portion of the general examination.

Of the courses listed only those in the 300 series are available for graduate credit. There are many additional offerings in materials under the listings of other departments.

Most graduate students receive some form of financial aid. Several kinds of fellowships and assistantships are available. This type of aid generally provides for tuition, and a stipend. For details of graduate scholarships, fellowships, and assistantships, please refer to section IV.

#### Research Activities

Graduate students conduct their research in facilities located in the Department, or the Center for Advanced Materials and Nanotechnology, or other centers and institutes. The following list describes current Materials Science and Engineering research activities:

#### Metals Processing and Performance

Joining of metals and alloys, laser engineered net shaping, solidification modeling, corrosion and coatings, deformation processing, grain boundary cohesion, bulk metallic glasses.

#### Ceramics and Glass Processing and Properties

Fundamental studies of sintering and grain growth, novel reaction-based processing for bulk and thin film ceramics, microstructure and properties of oxides for environmental coatings, growth of single crystal piezoelectric ceramics, creep and grain boundary chemistry of alumina, dielectric and electrical properties of glasses, corrosion of glass.

#### Electronic and Photonic Materials and Packaging

Electromigration, degradation processes in light-emitting semiconductors, mechanical behavior of thin metal films, reliability of MEMS materials, processing and performance of advanced solder alloys, polymer packaging materials, glass nanostructure and chemistry, glasses for nonlinear optical applications, transparent glassceramics, photoinduced phenomena.

#### Microstructural Characterization

Transmission electron microscopy, scanning electron microscopy, nanoscale compositional mapping, cathodoluminescence microscopy and spectroscopy, x-ray diffraction and fluorescence, x-ray microanalysis, electron-loss spectrometry, extended x-ray absorption and electron energy loss fine structure (EXAFS and EXELFS).

#### Archaeometallurgy

Reconstruction of ancient smelting and fabrication processes, artifact analysis using modern analytical methods, history of materials.

#### Courses

##### MAT 010 Materials Laboratory 2 Credits

Introduction to experimental methods used to fabricate and measure the structure and properties of materials. Thermal and mechanical processing and properties are emphasized. Specimen preparation and examination by light optical microscopy. Prerequisites as noted below.

**Prerequisites:** MAT 033

**Can be taken Concurrently:** MAT 033

**MAT 020 Computational Methods in Materials Science 3 Credits**

The use of computers and computational methods to solve problems in materials science and engineering. Students will employ both commercial packages and their own code in order to complete assignments. Students will utilize word processing and display packages to present results of projects. Prerequisites as noted below.

**Prerequisites:** ENGR 010

**MAT 033 Engineering Materials and Processes 3 Credits**

Application of physical and chemical principles to understanding, selection, and fabrication of engineering materials. Materials considered include metals, polymers, ceramics, composites, and electronic materials. Case studies of materials used range from transportation systems to microelectronic devices.

**MAT 101 Professional Development 2 Credits**

The role and purpose of engineering in society; the meaning of being a professional; engineering ethics; environmental issues; safety issues; communications and decision-making in the engineering process; expectations and problems of young engineers; personal goals; choosing a career. Required reading. Written reports based on library research. Must have junior standing.

**MAT 107 Special Topics in Materials 1-3 Credit**

A study of selected topics in materials science and engineering not covered in other formal courses. Consent of instructor required.

**MAT 201 Physical Properties of Materials 3 Credits**

Basic concepts of modern physics and quantum mechanics needed for an understanding of electrons in solids. The experimental development leading to wave mechanics is emphasized. Uses of the Schrodinger equation as the basis for the free electron theory of metals and band theory. Optical properties are developed leading to a discussion of lasers. Prerequisites as noted below.

**Prerequisites:** (PHY 021 and MAT 033 and MATH 205)

**MAT 203 Materials Structure at the Nanoscale 4 Credits**

The structure of metals, ceramics, semiconductors, and polymers at the atomic scale. Crystalline, semicrystalline, liquid crystalline and amorphous (glassy) states. Fundamental aspects of formal crystallography and crystal structures. Point, line, and planar crystal defects. Materials characterization by x-ray diffraction, light microscopy, electron microscopy, and other techniques. Prerequisites as noted below.

**Prerequisites:** (CHM 030 and MAT 033) and MAT 010

**Can be taken Concurrently:** MAT 033

**MAT 204 Processing and Properties of Polymeric Materials 3 Credits**

The structure-property relationships in polymers will be developed, emphasizing the glass transition, rubber elasticity, crystallinity, and mechanical behavior. Elements of polymer processing. Extrusion of plastics and films, and fiber spinning operations. Prerequisites as noted below.

**Prerequisites:** MAT 033

**MAT 205 Thermodynamics of Macro/Nanoscale Materials 3 Credits**

The three laws of thermodynamics. Gibbs free energy and conditions of equilibrium. Effects of scale on material behavior. Binary and ternary equilibrium phase diagrams. Application of thermodynamics to materials problems, with examples from nanotechnology, biotechnology, and structural materials. Prerequisites as noted below.

**Prerequisites:** MATH 023 and MAT 033

**Can be taken Concurrently:** MATH 023, MAT 033

**MAT 206 Processing and Properties of Metals 3 Credits**

The production and purification of metals, their fabrication, and control of their properties. Includes topics such as precipitation hardening, hot and cold working, and casting. Prerequisites as noted below.

**Prerequisites:** (MAT 218 and MAT 216)

**MAT 214 Processing and Properties of Ceramic Materials 3 Credits**

General overview of the compositions, properties and applications of ceramic materials. The theory and practice of fabrication methods for ceramics and glasses. Methods of characterization. Selected properties of ceramic materials. Prerequisites as noted below.

**Prerequisites:** MAT 033

**MAT 216 Diffusion and Phase Transformations 3 Credits**

Fundamental diffusion equations; liquid-solid transformations; solid-solid transformations; transformation kinetics; metastable transformations; diffusionless transformations; examples of various transformations in different materials and their effect on properties. Prerequisites as noted below.

**Prerequisites:** (MAT 203 and MAT 205)

**MAT 218 Mechanical Behavior of Macro/Nanoscale Materials 3 Credits**

Elasticity, plasticity, and fracture of metals, ceramics, polymers, and composites. The roles of defects and size scale on mechanical response. Strengthening and toughening mechanisms in solids. Statics and time-dependent failures from microstructural and fracture mechanics viewpoints. Lectures and laboratories. Prerequisites as noted below or consent of instructor.

**Prerequisites:** MECH 003 and MAT 033 and MAT 010

**MAT 221 Materials in the Development of Man 3 Credits**

Development of materials technology and engineering from the stone age to atomic age as an example of the interaction between technology and society. In-class demonstration laboratories on composition and structure of materials. Term projects using archaeological materials and alloys. Course intended for, but not limited to, students in the humanities and secondary science education. Engineering students may not use this course for engineering science or technical elective credit.

**MAT 240 Research Techniques 3 Credits**

Study and application of research techniques in materials science and engineering. Research opportunities, design of experimental programs, analysis of data, presentation of results. Selection of research topic and preparation and defense of research proposal. Restricted to a small number of students selected by the department from those who apply.

**MAT 291 Undergraduate Research 3 Credits**

Application of research techniques to a project in materials science and engineering selected in consultation with the faculty. Normally preceded by MAT 240.

**MAT 300 Apprentice Teaching 3 Credits****MAT 302 Electronic Properties of Materials 3 Credits**

The electronic structure of materials, i.e., band and zone theory, is presented from a physical point of view. Electrical conductivity in metals, semiconductors, insulators and superconductors is discussed. Simple semiconductor devices reviewed. Magnetic properties are examined in the context of domain theory and applications are discussed. Optical and dielectric properties of semiconductors and ferroelectrics are considered. Prerequisites as noted below.

**Prerequisites:** (MAT 201 and MAT 203)

**MAT 309 Composite Materials 3 Credits**

The principles and technology of composite materials. Processing, properties, and structural applications of composites, with emphasis on fiber-reinforced polymers. Lectures and some field trips or laboratories. Prerequisites as noted below.

**Prerequisites:** (MAT 033 or MECH 003)

**MAT 310 Independent Study in Materials 1-3 Credit**

Provides an opportunity for advanced, independent study of selected topics in materials science and engineering not covered in other formal courses. Must have consent of department including email from supervisor to department associate chair.

**Repeat Status:** Course may be repeated.

**MAT 312 Fundamentals of Corrosion 3 Credits**

Corrosion phenomena and definitions. Electrochemical aspects including reaction mechanisms, thermodynamics, Pourbaix diagrams, kinetics of corrosion processes, polarization, and passivity. Nonelectrochemical corrosion including mechanisms, theories, and quantitative descriptions of atmospheric corrosion. Corrosion of metals under stress. Cathodic and anodic protection, coatings, alloys, inhibitors, and passivators. Prerequisites as noted below.

**Prerequisites:** MAT 205 or CHM 342

**MAT 314 Metal Forming Processes 3 Credits**

Mechanical metallurgy and mechanics of metal forming processes. Yield criteria. Workability. Friction and lubrication. Engineering analysis of forging, extrusion, wire and tube drawing, rolling, sheet forming and other processes. Recent developments in metal forming. Credit is not given for both MAT 314 and MAT 414. Prerequisites as noted below or consent of instructor.

**Prerequisites:** MAT 206

**MAT 315 Physical Properties of Structural and Electronic Ceramics 3 Credits**

Structure-property relationships in ceramics. Mechanical behavior including plasticity, hardness, elasticity, strength and toughening mechanisms. Thermal behavior including specific heat, thermal expansion, thermal conduction and thermal shock. Electrical behavior including application of tensors and crystal physics to electroceramics. Prerequisites as noted below or consent of instructor.

**Prerequisites:** MAT 214

**MAT 316 Optical Properties of Materials 3 Credits**

Interaction of electromagnetic waves with solid, liquid, and gaseous matter: reflection, refraction, polarization, diffraction, scattering, absorption, and luminescence. Factors determining the perceived color of metals, ceramics, polymers, semiconductors, biomaterials, and various nanostructured materials. Overview of the technological applications of optical materials in coatings, lighting, display technologies, lasers, solar cells, and optical communications. Credit will not be given for both MAT 316 and MAT 416. Prerequisites as noted below.

**Prerequisites:** MAT 033

**MAT 317 Imperfections in Crystals 3 Credits**

The major types of crystal defects and their role in controlling the properties of materials. Point, line and planar defects, their atomic configurations and experimental techniques to study their characteristics. Emphasis on the role of dislocations and grain boundaries in the control of mechanical properties. Prerequisites as noted below or consent of instructor.

**Prerequisites:** MAT 203

**MAT 319 Current Topics in Materials Science 3 Credits**

Selected topics of current interest in the field of materials engineering but not covered in the regular courses. May be repeated for credit with consent of the department chair. Consent of department required.

**Repeat Status:** Course may be repeated.

**MAT 320 Analytical Methods in Materials Science 3 Credits**

Selected topics in modern analysis and their application to materials problems in such areas as thermodynamics, crystallography, deformation and fracture, diffusion. Prerequisites as noted below.

**Prerequisites:** MATH 231 or MATH 205

**MAT 324 Introduction to Organic Biomaterials 3 Credits**

Property, characterization, fabrication and modification of organic materials for biomedical and biological applications; host responses to biomaterials on the molecular, cellular and system level; general introduction to biosensors, drug delivery devices and tissue engineering. Consent of instructor required. Prerequisites as noted below.

**Prerequisites:** BIOE 110 or MAT 204

**MAT 325 Inorganic Biomaterials 3 Credits**

The structure, function, properties and use of biopolymers, biocomposites, and biominerals. Chemical structure and macromolecular architecture of these materials, including collagen, tissue, silk, wool, spider's thread, shell, etc. The marriage of structure and function and how this marriage can be manipulated in the development of "intelligent" materials (materials which can adapt to their environment or have the ability to alter their properties as required). Biomimetic materials design, including colloids, interfaces, macromolecules, and applications of such materials. Environmental and ethical considerations, such as degradation products when using biomimetic materials.

**Prerequisites:** (BIOE 110 or MAT 033)

**MAT 326 Biomimetic and Bio-enabled Materials 3 Credits**

The structure, function, properties and use of biopolymers, biocomposites, and biominerals. Chemical structure and macromolecular architecture of these materials, including collagen, tissue, silk, wool, spider's thread, shell, etc. The marriage of structure and function and how this marriage can be manipulated in the development of "intelligent" materials (materials which can adapt to their environment or have the ability to alter their properties as required). Biomimetic materials design, including colloids, interfaces, macromolecules, and applications of such materials. Environmental and ethical considerations, such as degradation products when using biomimetic materials.

**Prerequisites:** MAT 033 or BIOE 110

**Attribute/Distribution:** ND

**MAT 327 Industrial Project 4 Credits**

Restricted to a small group of seniors and graduate students selected by the department from those who apply. Two full days per week are spent on development projects at the plant of an area industry, under the direction of a plant engineer and with faculty supervision.

**MAT 329 Industrial Project 4 Credits**

To be taken concurrently with MAT 327. Course material is the same as MAT 327.

**MAT 332 Basics of Materials Science and Engineering 3 Credits**

Physical and chemical principles applied to understanding the structure, properties, selection, fabrication, and use of engineering materials: metals, polymers, ceramics, composites and electronic materials. Case studies of materials used ranged from transportation systems to microelectronic devices. Lectures and individual study assigned by graduate advisor. Must have graduate student status. Consent of department required. Not available to students who have taken MAT 033 or equivalent.

**MAT 333 Crystallography and Diffraction 3 Credits**

Introduction to crystal symmetry, point groups, and space groups. Emphasis on materials characterization by x-ray diffraction and electron diffraction. Specific topics include crystallographic notation, stereographic projections, orientation of single crystal, textures, phase identification, quantitative analysis, stress measurement, electron diffraction, ring and spot patterns, convergent beam electron diffraction (CBED), and space group determination. Applications in mineralogy, metallurgy, ceramics, microelectronics, polymers, and catalysts. Lectures and laboratory work. Prerequisites as noted below or senior standing in chemistry.

**Prerequisites:** MAT 203 or EES 133

**MAT 334 Electron Microscopy and Microanalysis 4 Credits**

Fundamentals and experimental methods in electron optical techniques including scanning electron microscopy (SEM), conventional transmission (TEM) and scanning transmission (STEM) electron microscopy. Specific topics covered will include electron optics, electron beam interactions with solids, electron diffraction and chemical microanalysis. Applications to the study of the structure of materials are given. Consent of department required.

**MAT 338 Failure Analysis Reports 3 Credits**

Application of chemical and mechanical failure concepts, microstructural analysis, and fracture surface characterization to the analysis and prevention of engineering component failures. Conduct laboratory investigations on component failures with written and oral presentations of the results. Must have senior standing. Prerequisites as noted below.

**Prerequisites:** (MAT 204 and MAT 206 and MAT 214 and MAT 302)

**MAT 342 Inorganic Glasses 3 Credits**

Definition, formation and structure of glass; common glass systems; manufacturing processes; optical, mechanical, electrical and dielectric properties; chemical durability; glass fibers and glass ceramics. Lectures and laboratories. Prerequisites as noted below.

**Prerequisites:** MAT 033

**MAT 344 Metal Machining Analysis 3 Credits**

Intensive study of metal cutting emphasizing forces, energy, temperature, tool materials, tool life, and surface integrity. Abrasive processes. Laboratory and project work. Prerequisites as noted below.

**Prerequisites:** IE 215 or ME 240 or MAT 206

**MAT 345 Powder Metallurgy 3 Credits**

Metal powder fabrication and characterization methods. Powder processing including powder compaction, theory of compacting, press and die design, sintering, and hot consolidation. Microstructure and properties of sintered materials and their relationship to processing conditions. Industrial applications. Emerging powder metallurgy technologies. Credit will not be given for both MAT 345 and MAT 445. Prerequisites as noted below or consent of instructor.

**Prerequisites:** MAT 206

**MAT 346 Physical Metallurgy of Welding 3 Credits**

Operational characteristics of welding processes. Application of solidification and solid state transformation theory to understanding microstructural development in welds, and influence of welding on properties. Metallurgical defects in welds. Computational techniques for predicting heat flow and phase transformations in welds of complex engineering alloys. Laboratory demonstrations. Prerequisites as noted below.

**Prerequisites:** MAT 216

**MAT 355 Materials for Nanotechnology 3 Credits**

An introduction to the nanoworld and how we observe the nanoworld through transmission electron microscopy. Other topics include: probing nanosurfaces, carbon as a nanomaterial, fullerenes, carbon nanotubes, metal clusters, metal nanoparticle preparation, and directed self-assembly of nanoparticles. Also discussed are the thermal, chemical, electronic, optical, and magnetic properties of metal nanoparticles, nanowires, semiconductor nanoparticles, and inorganic nanoparticles.

**MAT 356 Strategies for Nanocharacterization 3 Credits**

Lectures describe various nanocharacterization techniques in terms of which technique is best for specific measurements on nanostructures less than 100 nm in extent. Special attention is paid to spatial resolution and detection limits for SEM, TEM, X-ray analysis, diffraction analysis, ion beam techniques, surface techniques, AFM and other SPMs, and light microscopies and spectroscopies.

**MAT 386 Polymer Nanocomposites 3 Credits**

Synthesis, morphology and properties of polymer nanocomposites. Comparisons with traditional particulate composites will be made and models predicting properties will be emphasized. Melt viscosity, mechanical properties, barrier properties and flame retardancy will be discussed. Credit is not given for both MAT 386 and MAT 486. Prerequisites as noted below or consent of department chair.

**Prerequisites:** MAT 204 or MAT 393

**MAT 388 Polymer Synthesis and Characterization Laboratory 3 Credits**

Techniques include: free radical and condensation polymerization; molecular weight distribution by gel chromatography; crystallinity and order by differential scanning calorimetry; pyrolysis and gas chromatography; dynamic mechanical and dielectric behavior; morphology and microscopy; surface properties. Must have senior level standing in chemical engineering, chemistry, or materials science and engineering, or consent of instructor.

**MAT 393 Physical Polymer Science 3 Credits**

Structural and physical aspects of polymers (organic, inorganic, natural). Molecular and atomic basis for polymer properties and behavior. Characteristics of glassy, crystalline states (including viscoelastic and relaxation behavior) for single- and multicomponent systems. Thermodynamics and kinetics of transition phenomena. Structure, morphology and behavior. Must have senior level standing in chemical engineering, chemistry, or materials science and engineering, or consent of instructor.

**MAT 396 Chemistry of Nonmetallic Solids 3 Credits**

Chemistry of ionic and electronic defects in nonmetallic solids and their influence on chemical and physical properties. Intrinsic and impurity-controlled defects, nonstoichiometric compounds, defect interactions. Properties to be discussed include: diffusion, sintering, ionic and electronic conductivity, solid-state reactions, and photoconductivity. Prerequisites as noted below.

**Prerequisites:** CHM 187 or MAT 205

**MAT 401 Thermodynamics and Kinetics 4 Credits**

Integrated treatment of the fundamentals of thermodynamics, diffusion and kinetics, as related to materials processes including both hard and soft materials. Laws of thermodynamics, conditions of equilibrium, free energies, statistical thermodynamics, thermodynamics of surfaces, bulk and grain-boundary diffusion, nucleation, spinodal decomposition, and reaction kinetics.

**MAT 402 Advanced Manufacturing Science 3 Credits**

The course focuses on the fundamental science-base underlying manufacturing processes, and applying that science base to develop knowledge and tools suitable for industrial utilization. Selected manufacturing processes representing the general classes of material removal, material deformation, material phase change, material flow, and material joining are addressed. Students create computer-based process simulation tools independently as well as utilize leading commercial process simulation packages. Laboratory experiences are included throughout the course.

**MAT 403 Structure/Property Relations 4 Credits**

Structure of materials and relationship to properties. Crystal structures and crystalline defects, structure in biological systems, amorphous materials, microstructure, and relationships to mechanical and other properties.

**MAT 406 Solidification 3 Credits**

Structure, theory and properties of liquids. Homogeneous and heterogeneous nucleation theory and experimental results. Solidification phenomena in pure, single and multiphase materials including the nature of the freezing interface, segregation, constitutional super-cooling, dendritic growth, crystallographic effects, the origin of defects, crystal growing, zone processes. Consent of department chair required.

**MAT 409 Current Topics in Materials 3 Credits**

Recent practical and theoretical developments in materials. This course may be repeated for credit if new material is covered. Consent of department required.

**Repeat Status:** Course may be repeated.

**MAT 415 Mechanical Behavior of Ceramic Solids 3 Credits**

Strength, elasticity, creep, thermal stress fracture, hardness, abrasion and high-temperature deformation characteristics of single- and multicomponent brittle ceramic solids. Statistical theories of strength, static and cyclic fatigue, crack propagation, fracture toughness. Correlation of mechanical behavior, microstructure, and processing parameters.

**MAT 416 Optical Properties of Materials 3 Credits**

Interaction of electromagnetic waves with solid, liquid, and gaseous matter: reflection, refraction, polarization, diffraction, scattering, absorption, and luminescence. Factors determining the perceived color of metals, ceramics, polymers, semiconductors, biomaterials, and various nanostructured materials. Overview of the technological applications of optical materials in coatings, lighting, display technologies, lasers, solar cells, and optical communications. Additional coursework work will be required of students seeking the graduate level MAT 416 qualification. Credit will not be given for both MAT 316 and MAT 416. Prerequisites as noted below.

**Prerequisites:** MAT 033

**MAT 423 Advanced Transmission Electron Microscopy 4 Credits**

The theory and practice of operation of the transmission and scanning transmission electron microscope. Techniques covered include bright field, high resolution and weak-beam dark field, lattice imaging, diffraction pattern indexing and Kikuchi line analysis. The theory of diffraction contrast is applied to the interpretation of electron micrographs. Specimen preparation techniques. Prerequisites as noted below.

**Prerequisites:** MAT 344

**MAT 424 Introduction to Organic Biomaterials 3 Credits**

Property, characterization, fabrication, and modification of organic materials for biomedical and biological applications; host responses to biomaterials on the molecular, cellular, and system level; general introduction to biosensors, drug delivery, and tissue engineering. Graduate version of MAT 324 requiring additional assignments. Credit is not given for both MAT 324 (BioE 324) and MAT 424 (BioE 424). Prerequisites as noted below or consent of instructor.

**Prerequisites:** MAT 033

**MAT 425 Inorganic Biomaterials 3 Credits**

The structure, function, properties and use of biopolymers, biocomposites, and biominerals. Chemical structure and macromolecular architecture of these materials, including collagen, tissue, silk, wool, spider's thread, shell, etc. The marriage of structure and function and how this marriage can be manipulated in the development of "intelligent" materials (materials which can adapt to their environment or have the ability to alter their properties as required). Biomimetic materials design, including colloids, interfaces, macromolecules, and applications of such materials. Environmental and ethical considerations, such as degradation products when using biomimetic materials. Credit is not given for both MAT 326 and MAT 426.

**Prerequisites:** MAT 033

**MAT 426 Biomimetic and Bio-enabled Materials 3 Credits**

This course is a graduate version of MAT 326 (BIOE 326). While the lecture content will be the same as the 300-level course, students enrolled in MAT 426 (BIOE 426) will have more advanced assignments. Closed to students who have taken MAT 326 (BIOE 326). Requirements: Graduate standing in Bioengineering or Materials Science and Engineering, or permission of the instructor.

**Attribute/Distribution:** ND

**MAT 427 Advanced Scanning Electron Microscopy 4 Credits**

The theory and practice of operation of the scanning electron microscope and electron microprobe. Techniques covered will include high-resolution scanning, quantitative electron probe microanalysis. Electron beam sample interactions, X-ray spectrometry, and electron optics will be discussed in detail. Prerequisites as noted below.

**Prerequisites:** MAT 334

**MAT 430 Glass Science 3 Credits**

Definition and formation of glass. Structure of common inorganic (including metallic) and polymeric glass systems. Methods of glass making. Phase separation of devitrification. Physical properties including diffusion, electrical conductivity, chemical durability, and optical and mechanical properties. Special products including glass ceramics, optical fibers, photosensitive glasses, etc. Visit to a glass manufacturing plant may also be included.

**MAT 431 Sintering Theory and Practice 3 Credits**

Science and technology of the sintering of solid-state materials. Driving force and variables. Critical review of the sintering models. Coverage of single phase, multiphase and composite systems. Special sintering techniques such as fast firing, rate controlled sintering, hot pressing and transient second-phase sintering. Sintering of specific ceramic and metal systems.

**MAT 442 Inorganic Glasses 3 Credits**

Definition, formation and structure of glass; common glass systems; manufacturing processes; optical, mechanical, electrical and dielectric properties; chemical durability; glass fibers and glass ceramics. Lectures and laboratories. Credit is not given for both MAT 342 and MAT 442.

**MAT 443 Solid-State Chemistry 3 Credits**

Crystal structure, diffraction in crystals and on surfaces, bonding and energy spectra in solids, dielectrics, surface states and surface fields in crystals. Must have completed one course in linear algebra and one course in quantum mechanics.

**MAT 445 Powder Metallurgy 3 Credits**

Metal powder fabrication and characterization methods. Powder processing including powder compaction, theory of compacting, press and die design, sintering, and hot consolidation. Microstructure and properties of sintered materials and their relationship to processing conditions. Industrial applications. Emerging powder metallurgy technologies. Graduate version of MAT 345 requiring additional assignments. Credit is not given for both MAT 345 and MAT 445.

**MAT 455 Materials for Nanotechnology 3 Credits**

An introduction to the nanoworld and how we observe the nanoworld through transmission electron microscopy. Other topics include: probing nanosurfaces, carbon as a nanomaterial, fullerenes, carbon nanotubes, metal clusters, metal nanoparticle preparation, and directed self-assembly of nanoparticles. Also discussed are the thermal, chemical, electronic, optical, and magnetic properties of metal nanoparticles, nanowires, semiconductor nanoparticles, and inorganic nanoparticles.

**MAT 456 Strategies for Nanocharacterization 3 Credits**

Lectures describe various nanocharacterization techniques in terms of which technique is best for specific measurements on nanostructures less than 100 nm in extent. Special attention is paid to spatial resolution and detection limits for SEM, TEM, X-ray analysis, diffraction analysis, ion beam techniques, surface techniques, AFM and other SPMs, and light microscopies and spectroscopies.

**MAT 460 Engineering Project 1-3 Credit**

In-depth study of a problem in the area of materials engineering or design. The study is to lead to specific conclusions and be embodied in a written report. Intended for candidates for the M.Eng. May be repeated for a total of three credit hours.

**Repeat Status:** Course may be repeated.

**MAT 462 Independent Study 1-3 Credit**

An intensive study, with report, of a topic in materials science and engineering which is not treated in other courses. May be repeated for credit. Consent of instructor required.

**Repeat Status:** Course may be repeated.

**MAT 482 Mechanical Behaviors of Polymers 3 Credits**

A treatment of the mechanical behavior of polymers. Characterization of experimentally observed viscoelastic response of polymeric solids with the aid of mechanical model analogs. Topics include time-temperature superposition, experimental characterization of large deformation and fracture processes, polymer adhesion, and the effects of fillers, plasticizers, moisture and aging on mechanical behavior.

**MAT 485 Polymer Blends and Composites 3 Credits**

Synthesis, morphology, and mechanical behavior of polymer blends and composites. Mechanical blends, block and graft copolymers, interpenetrating polymer networks, polymer impregnated concrete, and fiber and particulate reinforced polymers are emphasized. Must have completed any introductory polymer course or equivalent.

**MAT 486 Polymer Nanocomposites 3 Credits**

Synthesis, morphology and properties of polymer nanocomposites. Comparisons with traditional particulate composites will be made and models predicting properties will be emphasized. Melt viscosity, mechanical properties, barrier properties and flame retardancy will be discussed. This course is a version of MAT 386 for graduate students, with additional research projects and advanced assignments. Closed to students who have taken MAT 386. Credit is not given for both MAT 386 and MAT 486. Prerequisites as noted below or consent of department chair.

**Prerequisites:** MAT 204 or MAT 393

**MAT 490 Thesis 1-6 Credit**

**Repeat Status:** Course may be repeated.

**MAT 492 Topics in Polymer Science 1-3 Credit**

Intensive study of topics selected from areas of current research interest such as morphology and mechanical behavior, thermodynamics and kinetics of crystallization, new analytical techniques, molecular weight distribution, non-Newtonian flow behavior, second-order transition phenomena, novel polymer structures. Credit above three hours is granted only when different material is covered.

**MAT 499 Dissertation 1-15 Credit****Repeat Status:** Course may be repeated.**Mechanical Engineering and Mechanics****Educational Mission**

The Department of Mechanical Engineering and Mechanics prepares our students to be learners, and agents in both the application and development of technology to better serve the needs of society.

**Program Educational Objectives**

Mechanical engineering is one of the core disciplines in the P.C. Rossin College of Engineering and Applied Science (RCEAS). The department is committed to serving the overall mission of the RCEAS, and of the University, by providing education and training to undergraduate and graduate students, by developing new knowledge and engineering methodology, and by providing service to industry and society at large. To achieve our Educational Mission, the Department of Mechanical Engineering has established a set of Program Educational Objectives (PEOs), which are to educate engineers who:

1. Apply fundamental engineering principles for product design and mechanical systems.
2. Use basic sciences and mathematics for solving mechanical engineering problems.
3. Design components and systems and validate their applicability with computational and experimental techniques.
4. Communicate effectively and are able to participate in multidisciplinary teams.
5. Understand and exercise their professional and ethical responsibilities in an ever-changing world.
6. Nurture a desire for continuous learning, professional development, and leadership.

The undergraduate program in mechanical engineering is configured to prepare our students for employment and continued professional development and growth. The above PEOs are targets for students 3-5 years after graduation. The program provides students with the basic education they will need to function in an engineering environment, pursue graduate studies, continue their professional development and growth, and develop an awareness of the culture and society in which we live. Due to technological innovations and the long term demands of global competition, the program also seeks to prepare students to adapt to rapid advances and changes in technology and to provide leadership in effecting these changes.

Achievement of the student outcomes is served first through a sound education in mathematics and those physical and engineering sciences that are of greatest relevance to the design and analysis of mechanical systems; second, by exposure to the engineering process (creation, innovation, analysis and judgment) through design courses, projects, laboratories, and a choice of technical electives that permits a degree of specialization; and third, by the development of cultural awareness through courses in humanities and social sciences. Students may take elective courses that transcend traditional disciplinary lines, while satisfying the basic requirements for mechanical engineering.

Design and engineering practices are integrated with the engineering science aspects of the program including projects requiring teamwork. Through a broadening of the design sequence to include hands-on manufacturing and multidisciplinary collaborations, the program seeks to emphasize the integration of design, manufacturing, business, and aesthetics in modern technological enterprises, and to prepare our students to function in an increasingly interdisciplinary environment. Through a comprehensive set of laboratory courses, which ultimately focus on the design and planning of laboratory experiences by the students (rather than carrying out rote experiments), opportunities are provided for students to learn and employ the processes and skills for solving hands-on engineering problems.

**Professors.** Patrick V. Farrell, PhD (University of Michigan Ann Arbor); Joachim L. Grenestedt, PhD (Royal Institute of Technology); D. Gary Harlow, PhD (Cornell University); Jacob Y. Kazakia, PhD (Lehigh University); Sudhakar Neti, PhD (University of Kentucky Lexington); Herman F. Nied, PhD (Lehigh University); John B. Ochs, DA (The Pennsylvania State University); Tulga M. Ozsoy, PhD (Istanbul Technical University); Alparslan Oztekin, PhD (University of Illinois Urbana); Donald O. Rockwell, Jr., DSC (Lehigh University); Arkady Voloshin, PhD (Tel Aviv University)

**Associate Professors.** Meng-Sang Chew, PhD (Columbia University); John P. Coulter, Ph.D., PhD (University of Delaware); Yaling Liu, PhD (Northwestern University); Robert A. Lucas, PhD (Lehigh University); Noel Duke Pereira, PhD (University of California Los Angeles); Eugenio Schuster, PhD (University of California San Diego); Edmund B. Webb, III, PhD (Rutgers University)

**Assistant Professors.** Arindam Banerjee, PhD (Texas A&M University); Justin Jaworski, PhD (Duke University); Brandon A. Krick, PhD (University of Florida); Keith W. Moore, III, PhD (University of Virginia); Nader Motee, PhD (University of Pennsylvania); Natasha Vermaak, PhD (University of California Santa Barbara); Xiaohui Zhang, PhD (University of Miami)

**Professors Of Practice.** David C. Angstadt, PhD (Lehigh University); Marc de Vinck, BFA (Parsons School of Design); Terry J. Hart, MS (Rutgers University); Michael Lehman, MBA (University of Leeds); Murat Ozturk, PhD (Lehigh University)

**Emeriti.** Russell E. Benner, PhD (Lehigh University); Philip A Blythe, PhD (University of Manchester); Forbes T. Brown, DSC (Massachusetts Institute of Technology); Terry J. Delph, PhD (Stanford University); Fazil Erdogan, PhD (Lehigh University); Ronald J. Hartranft, PhD (Lehigh University); Stanley H. Johnson, PhD (University of California Berkeley); Arturs Kalnins, PhD (University of Michigan Ann Arbor); Edward K. Levy, SCD (Massachusetts Institute of Technology); Jerzy A Owczarek, PhD (University of London); Richard Roberts, PhD (Lehigh University); Robert G. Sarubbi, PhD (Lehigh University); Kenneth N. Sawyers, PhD (Brown University); George C. Sih, PhD (Lehigh University); Charles R. Smith, PhD (Stanford University); Gerald F. Smith, PhD (Brown University); Theodore A. Terry, PhD (Lehigh University); Dean P. Updike, PhD (Brown University); Eric Varley, PhD (Brown University); Robert P. Wei, PhD (Princeton University)

**B.S. in Mechanical Engineering**

Mechanical engineering is one of the broadest of the engineering professions, dealing generally with systems for energy conversion, material transport and the control of motions and forces.

Mechanical engineers may choose from among many different activities in their careers, according to their interests and the changing needs of society. Some concentrate on the conversion of thermal, nuclear, solar, chemical and electrical energy, or on the problems of air, water, and noise pollution. Some concentrate on the design of mechanical systems used in transportation, manufacturing or health care industries or by individual consumers. Some will be working, a decade from now, in fields that do not yet exist. Most will be engaged with concepts involving all four dimensions of space and time.

The curriculum leading toward the bachelor of science in mechanical engineering combines a broad base in mathematics, physical sciences, and the engineering sciences (mechanics of solids, materials, dynamics and fluid, thermal and electrical sciences), including laboratory. Special emphasis is placed on the practice of modern Integrated Product Development, combining state-of-the-art computer aided design and manufacturing methods in a business oriented framework. Several specific application fields are chosen toward the end of the program in the form of four or more courses elected from a wide variety of 300-level offerings. Courses in mechanical engineering and engineering mechanics are equally available.

The course requirements for a B.S. degree in mechanical engineering are listed below. In addition to required mathematics, physics, chemistry and basic engineering courses, the program includes a minimum of seven courses in humanities and social sciences (see humanities/social

sciences), two free electives and five approved electives. The total graduation requirement is 129 credits.

**Undergraduate Curriculum in Mechanical Engineering**

**First Year**

First Semester	CR	Second Semester	CR
ENGL 001		3 ENGL 002	3
MATH 021		4 MATH 022	4
Select one of the following:		4-5 ENGR 010	2
ENGR 010		2 Select one of the following:	4-5
CHM 030 <sup>1</sup>		4 CHM 030 <sup>1</sup>	4
PHY 011		5 PHY 011	5
& PHY 012 <sup>1</sup>		& PHY 012 <sup>1</sup>	
		<b>22-23</b>	<b>22-23</b>

**Second Year**

First Semester	CR	Second Semester	CR
ME 010		3 ME 104	3
MECH 003		3 MECH 012	3
MAT 033		3 PHY 021 & PHY 022	5
MATH 023		4 MATH 205	3
elective		3-4 elective	3-4
		<b>16-17</b>	<b>17-18</b>

**Third Year**

First Semester	CR	Second Semester	CR
ME 021		1 ME 121	1
ME 231		3 ME 211	3
MECH 102		3 ME 240	3
Select one of the following:		3 ME 242 or 245	3
ME 215		3 ME 252	3
MATH 208		3 ECE 083	3
MATH 230		3 ECE 162	1
MATH 231		3	
elective		6-8	
		<b>28-30</b>	<b>17</b>

**Fourth Year**

First Semester	CR	Second Semester	CR
ME 111 (fall only)		1 ME 207	2
ME 212 (fall only)		2 ME 321	3
electives		12-14 electives	10-12
		<b>15-17</b>	<b>15-17</b>

Total Credits: 152-162

<sup>1</sup> Required natural science courses, one taken fall semester and the other taken in spring

\*Co-op students must take ME 021 sophomore year, second semester (18-19 credit hours). Co-op students will take a MATH elective (3), ME 231 (3), MECH 102(3), and a HSS elective (3-4) during the summer after the sophomore year (12-13 credit hrs.). See Co-op program for details

The total number of credits required for graduation is 129. A total of 38 credits in electives must be taken. These electives are of five types:

**Mechanical Engineering Electives**

**Humanities/Social Sciences**

ECO 001	Principles of Economics	4
13 credits of electives in humanities and social science <sup>1</sup>		13

**ENGR. Elective A**

Select one of the following:		3
MECH 302	Advanced Dynamics	
MECH 305	Advanced Mechanics of Materials	
ME 304	Thermodynamics II	
ME 322	Gas Dynamics	

ME 331	Advanced Fluid Mechanics	
ME 343	Control Systems	

**ENGR. Elective B**

One 3credit course from any ME 300- or MECH 300-level course, excluding ME 310 3

**ENGR. Elective C**

Three 3credit courses selected from any ME 300/MECH 300-level course or an engineering/science/mathematics course, as approved by the department chair. <sup>2</sup> 9

**Free Electives**

6 credit hours in any subject area are required 6

**Total Credits** 38

<sup>1</sup> Note that these electives are in addition to the 6 hours of required freshman English. See description of HSS in Section III of this catalog.

**Co-Op Program**

To participate in the Co-op program you must rank in the top third of the engineering class after three semesters of study and attend a summer program between the sophomore and junior years. See your advisor or contact the Co-op Faculty Liaison for further details.

**B.S. in Engineering Mechanics**

The curriculum in engineering mechanics is designed to prepare students for careers in engineering research and development, and is especially appropriate for students wishing to specialize in the analysis of engineering systems. In many industries and governmental laboratories there is a demand for men and women with broad training in the fundamentals of engineering in which engineering mechanics and applied mathematics play an important role.

The first two years of the curriculum is the same as that in mechanical engineering. One of the advantages of the curriculum is the flexibility it offers through 18 credits of technical and six credits of personal electives in the junior and senior years. Beyond the sophomore year there are required courses in dynamics, solid mechanics, fluid mechanics, heat transfer, principles of electrical engineering, mathematics, vibrations, and senior laboratories or projects. It is recommended that the electives be chosen either to concentrate in areas such as applied mathematics and computational mechanics, solid mechanics, engineering materials, and fluid mechanics or to obtain further depth in all areas. The academic advisor for the engineering mechanics program will provide guidance in formulating the student's goals and choosing electives.

In addition to the required and elective courses in mathematics, sciences and engineering, the B.S. degree program in engineering mechanics includes a minimum of seven courses in humanities and social sciences (see humanities/social sciences). The total graduation requirement is 127 credits.

**Undergraduate Curriculum in Engineering Mechanics**

**First Year**

First Semester	CR	Second Semester	CR
ENGL 001		3 ENGL 002	3
MATH 021		4 MATH 022	4
ENGR 010 or 005		2 ENGR 010 or 005	2
Select one of the following:		4-5 Select one of the following:	4-5
CHM 030 <sup>1</sup>		4 CHM 030 <sup>1</sup>	4
PHY 011		5 PHY 011	5
& PHY 012 <sup>1</sup>		& PHY 012 <sup>1</sup>	
		<b>22-23</b>	<b>22-23</b>

**Second Year**

First Semester	CR	Second Semester	CR
ME 010		3 ME 104	3
MECH 003		3 MECH 012	3
MAT 033		3 PHY 021 & PHY 022	5
MATH 023		4 MATH 205	3
elective		3-4 elective	3-4
		<b>16-17</b>	<b>17-18</b>

**Third Year**

First Semester	CR Second Semester	CR
ME 021	1 ME 121	1
ME 231	3 ME 240	3
MECH 102	3 ME 242 or 245	3
MATH 230	3 MATH 208	3
elective	6-8 ECE 083 & ECE 162 elective	4 3-4
	<b>16-18</b>	<b>17-18</b>

**Fourth Year**

First Semester	CR Second Semester	CR
ME 111 (fall only)	1 electives	21-26
ME 207	2	
ME 321	3	
	<b>6</b>	<b>21-26</b>

Total Credits: 137-149

<sup>1</sup> Required natural science courses, one taken fall semester and the other taken in spring

\*Co-op students must take ME 21 sophomore year, second semester (18-19 credit hours). Co-op students will take ME 231 (3), MECH 102(3), and two HSS electives (6-8) during the summer after the sophomore year (12-14 credit hours). See Co-op program for details.

The total number of credits required for graduation is 127. A total of 41 credits in electives must be taken. These electives are of four types:

**Engineering Mechanics Electives****Humanities/Social Sciences**

ECO 001	Principles of Economics	4
13 credits of electives in humanities and social science <sup>1</sup>		13

**ENGR. Elective A**

Select one of the following: 6

MECH 302	Advanced Dynamics	
MECH 305	Advanced Mechanics of Materials	
ME 304	Thermodynamics II	
ME 322	Gas Dynamics	
ME 331	Advanced Fluid Mechanics	
ME 343	Control Systems	

**ENGR. Elective B**

Four, 3 credit courses selected from any ME 300/MECH 300-level course or an engineering/science/mathematics course, as approved by the Department Chair, excluding 310.

**Free Electives**

6 credit hours of any subject area are required

Total Credits 23

<sup>1</sup> Note that these electives are in addition to the 6 hours of required freshman English. See description of HSS in Section III of this catalog.

Typical recommended options:

**Applied Mathematics and Computational Mechanics**

MECH 305	Advanced Mechanics of Materials	3
MECH 312	Finite Element Analysis	3
MATH 309	Theory of Probability	3
MATH 322	Methods of Applied Analysis I	3
MATH 323	Methods of Applied Analysis II	3

**Solid Mechanics**

MECH 305	Advanced Mechanics of Materials	3
MECH 307	Mechanics of Continua	3
MECH 312	Finite Element Analysis	3
MECH 313	Fracture Mechanics	3
MATH 322	Methods of Applied Analysis I	3

**Engineering Materials**

MECH 305	Advanced Mechanics of Materials	3
MECH 313	Fracture Mechanics	3
MAT 218	Mechanical Behavior of Macro/ Nanoscale Materials	3
PHY 031	Introduction to Quantum Mechanics	3
PHY 363	Physics of Solids	3

**Fluid Mechanics**

ME 331	Advanced Fluid Mechanics	3
ME 322	Gas Dynamics	3
MECH 326	Aerodynamics	3
MATH 322	Methods of Applied Analysis I	3

**Minor in Aerospace Engineering**

The minor in aerospace engineering provides a foundation for students who intend to pursue a career in the aerospace industry. This minor will also provide sufficient technical background in aerospace studies for undergraduates who plan to enter graduate programs in this field. The minor requires a minimum of 15 credits from the following course selection:

**Required Courses**

ME 255	Introduction to Aerospace Engineering	3
MECH 326	Aerodynamics	3
MECH 328	Fundamentals of Aircraft Design	3

**Elective Courses**

Select one of the following: 3

ME 309	Composite Materials	
ME 322	Gas Dynamics	
ME 331	Advanced Fluid Mechanics	
ME 333	Propulsion Systems	
ME 343	Control Systems	
ME 348	Computer-Aided Design	
MECH 305	Advanced Mechanics of Materials	
MECH 312	Finite Element Analysis	

Total Credits 12

**Minor in Energy Engineering**

The minor in energy engineering touches upon the technologies associated with the transformation and use of energy in various forms. Since every sector of engineering and the economy require energies of one form or another, the courses included in this minor program will permit student exposure to fossil, nuclear and renewable energy technologies. The mechanical engineering curriculum provides the fundamental knowledge in thermodynamics, fluid mechanics and other related areas leading up to the courses for the energy engineering minor. The courses offer a wide variety of topics including fundamental, analytical and design aspects of energy conservation as well as various forms of energy used in power generation, transportation and industry. The minor in energy engineering requires a minimum of 15 credits, which must be taken from MEM offerings. The minor in energy is primarily intended for ME Majors but students with other majors, particularly Chemical engineering will be able to take some or all the related courses. Four courses are required with some degree of choice and an additional course must be selected from a broader set.

**Required course**

ME 304	Thermodynamics II	3
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**Elective Energy Courses**

Select at least three of the following: 12

ME 360	Nuclear Reactor Engineering	
ME 362	Nuclear Fusion and Radiation Protection	
ME 364	Renewable Energy	
ME 366	Engineering Principles of Clean Coal Technology	

**Additional Electives**

Select one of the following:



CHE 373	Fundamentals of Air Pollution
CHE/ME 376	Energy: Issues & Technology
CHE 386	Process Control
ME 322	Gas Dynamics
ME 331	Advanced Fluid Mechanics
ME 343	Control Systems
Other Energy related 300 level courses with the approval of the ME Dept. Chair.	

Total Credits 15

#### Minor in Mechanics of Materials

The minor in mechanics of materials provides a view of mechanical strength and behavior of materials based on understanding a few basic concepts and using simplified material models. Courses selected for the minor emphasize concepts such as superposition of loadings; relation between external loads and internal stresses; factor of safety; safe design based on allowable stress or allowable loads; allowable deformation; and reliability of structures. Courses offer a wide variety of topics including analytical and numerical methods for solving mechanics problems; manufacturing and polymer processing. The mechanics of materials minor requires a minimum of 15 credits, which must be taken from MEM offerings. Two courses are required; and three additional electives must be selected. The minor is not available for students having a major in the Department of Mechanical Engineering and Mechanics.

#### Required courses

MECH 003	Fundamentals of Engineering Mechanics	3
MECH 012	Strength of Materials	3

#### Electives

Select three of the following:		9
ME 010	Graphics for Engineering Design	
ME 215	Engineering Reliability	
ME 240	Manufacturing	
ME 252	Mechanical Elements	
ME/MAT/IE 344	Metal Machining Analysis <sup>1</sup>	
ME 385	Polymer Product Manufacturing	
MECH 102	Dynamics	
MECH 305	Advanced Mechanics of Materials	
MECH 312	Finite Element Analysis	
MECH 313	Fracture Mechanics	

Total Credits 15

<sup>1</sup> This cross-listed course ME 344 counts as an elective.

#### Graduate Programs

The department offers programs of study leading to the degrees of master of science, master of engineering, and doctor of philosophy degrees in mechanical engineering and computational and engineering mechanics.

Subject to approval, courses from other engineering curricula, such as materials science and engineering, and chemical, electrical, and industrial engineering, together with courses in mathematics and engineering mathematics, may be included in the degree program.

#### Master of Science in Mechanical Engineering

The M.S. degree in mechanical engineering requires 24 credit hours of courses and six credit hours of research, which culminates in a thesis. Core courses that must be taken are:

ME 452	Mathematical Methods In Engineering I	3
ME 453	Mathematical Methods in Engineering II	3
or ME 413	Numerical Methods in Mechanical Engineering	
Select three of the following:		9
ME 423	Heat and Mass Transfer	

ME 430	Advanced Fluid Mechanics
MECH 406	Fundamentals of Solid Mechanics
MECH 425	Analytical Methods in Dynamics and Vibrations
ME 401 or ME 402	Integrated Product Development Advanced Manufacturing Science

Total Credits 15

#### Master of Engineering in Mechanical Engineering

The M.Eng. degree requires 30 credit hours of graduate work. Audit credits may not be used toward the degree. At least 18 credit hours of courses must be at the 400-level, and 15 of these must be in mechanical engineering and mechanics. At least 18 credit hours of courses must be in mechanical engineering and mechanics, and at least 24 credit hours must be at the 300 or 400-level. No course in mechanical engineering and mechanics below the 300-level may be used towards the M.Eng. degree, but two courses (6 credits) outside the department, but in the engineering field, that are at level 200 and above may apply, with approval from a student's advisor and the departmental Graduate Committee.

<sup>1</sup> With approval from a student's advisor and the departmental Graduate Committee.

#### Master of Science in Computational and Engineering Mechanics

All students pursuing a master's degree in computational and engineering mechanics must take a minimum of 30 credit hours of graduate level work, with not less than 24 of these hours being at the 400 level. Their program must include:

#### Required Courses

ME 452	Mathematical Methods In Engineering I	3
ME 453	Mathematical Methods in Engineering II	3
ME 413	Numerical Methods in Mechanical Engineering	3

#### Additional Requirements

Select two of the following:		6
ME 423	Heat and Mass Transfer	
ME 430	Advanced Fluid Mechanics	
MECH 406	Fundamentals of Solid Mechanics	
MECH 425	Analytical Methods in Dynamics and Vibrations	

Select any of the graduate courses in MEM and other approved electives. Both thesis and non-thesis options are available. <sup>1</sup>

Total Credits 30

#### Doctor of Philosophy in Mechanical Engineering

The Ph.D. program in Mechanical Engineering and Mechanics requires innovative research in collaboration with one or more faculty members, along with the completion of 72 credit hours beyond the bachelor's degree (if graduate study is carried out entirely at Lehigh University), or 48 beyond the master's degree (obtained at another university). The first stage of Ph.D. candidacy in Mechanical Engineering and Mechanics is attained by achieving a minimum GPA of 3.35 in five core courses (see core course requirements for Master of Science in Mechanical Engineering). Ph.D. students must also take ME 453, which can either be taken as part of the five core course requirement or taken as an additional course. Completion of a General Examination, which is based on assessment and presentation of a research topic, is required. Formal University candidacy for the Ph.D. is granted upon recommendation of the doctoral committee and approval by the engineering college. Course work for the Ph.D. is determined in consultation with the student's advisor and doctoral committee. To complete the Ph.D. degree, the student must present and defend a dissertation before the doctoral committee.

#### Doctor of Philosophy in Computational and Engineering Mechanics

Students wishing to pursue a Ph.D. in computational and engineering mechanics must take:

**Required Core Courses**

ME 452	Mathematical Methods In Engineering I	3
ME 453	Mathematical Methods in Engineering II	3
ME 413	Numerical Methods in Mechanical Engineering	3

**Additional Requirements**

Select two core courses from the following supplemental list: 6

MECH 419	Asymptotic Methods in the Engineering Sciences	
MECH 418	Finite Element Methods	
MECH 445	Nondeterministic Models in Engineering	
ME 446	Mechanical Reliability	
ME 423	Heat and Mass Transfer <sup>1</sup>	
ME 430	Advanced Fluid Mechanics <sup>1</sup>	
MECH 406	Fundamentals of Solid Mechanics <sup>1</sup>	
MECH 425	Analytical Methods in Dynamics and Vibrations <sup>1</sup>	

Total Credits 15

<sup>1</sup> In addition, before completion of the degree, a student must have received graduate credit for at least two of the four MEM core courses which are designated by a "1" in the above list. If desired, these noted courses may be used as part of the Computational and engineering mechanics core, and hence count towards the core GPA requirement.

A student must attain a GPA of 3.35 for the five required courses taken. All students who satisfy the GPA requirement will be required to take a three-hour written examination in an area (special topic) of the student's choice. This topic is subject to approval by the computational and engineering mechanics graduate committee. For students who start in the program following their bachelor's degree, the written examination must be taken no later than the beginning of the fourth semester after entry. A student who fails the written examination will be allowed a single retake. The retake examination will be given at the end of the semester in which the examination was first attempted.

**Research Facilities**

The department has a wide range of computational, computer graphics and experimental systems. The department's CAD Lab has over 50 computers that include high-end engineering workstations. The university supports networks of hundreds of PCs as well as links to the Internet with thousands of online services.

Experimental facilities include 11 pulsed and continuous laser units for laser diagnostics in the areas of fluid and solid mechanics, four image processing systems, and a number of unique facilities for observing and controlling flow past surfaces and through machines. There are well equipped laboratories for multidisciplinary studies of crack growth in deleterious environments and at elevated temperatures of up to 700C, in conjunction with a number of surface analysis and electron microscopy facilities on campus.

Extensively equipped, interdepartmental robotics, controls, and manufacturing laboratories are also available.

Other facilities include the latest mechanical, electro-dynamic and servocontrolled hydraulic testing machines, photoelastic equipment, and Moire strain measuring instruments.

**Recent Research Activities****Continuum and Solid Mechanics**

Formulation of field equations and constitutive equations in nonlinear elasticity theories; mechanics of viscoelastic solids and fluids, plasticity theory; generalized continuum mechanics; thermo-mechanical and electromechanical interactions; analyses and modeling of manufacturing processes; free vibration and dynamic response of elastic shells, elastic-plastic deformation of shells upon cyclic thermal loading, and applications of shell analysis to nuclear power plant components; optical stress analysis; biomechanics of gait; wave propagation; finite amplitude wave propagation.

**Fracture Mechanics**

Stress analysis of materials containing defects, including viscoelastic, nonhomogeneous, and anisotropic materials; analytical and experimental studies and modeling of crack growth under static, periodic, and random loadings and environmental effects; optimizations of fracture control; crack propagation theories for nonlinear material; influence of cracks on the strength of structural members and of interfaces; hydraulic fracture; applications to reliability and durability of composites, structural and microelectronic components, and to processes for resource recovery.

**Thermofluids**

Structure of turbulent boundary layers, wakes and jets; vortex solid boundary interactions; boundary layers in compressible flow, including hypersonic regimes; vortex breakdown in internal machinery and in flow past wings; drag reduction in turbulent flows; flow induced noise and vibration; flutter of blades in axial-flow turbomachinery and of tails and fins on aircraft; unsteady aerodynamic flows past three dimensional wings and bodies; flow structure and heat transfer at end-wall junctions in rotating machinery and on surfaces of aircraft; flows in micro-hydro-electromechanical systems; convective heat transfer in systems of electronic components; flows through complex components of power generation systems; transport of coal particles; flow and heat transfer in fluidized beds; cycle analysis applied to coal gasifiers; control optimization of heat pumps; laser-Doppler and particle image velocimetry; liquid crystal sensors for heat transfer; Raman spectral techniques applied to two-phase flow; laser diagnostics and image processing of complex flow and heat transfer systems.

**Theoretical Fluid Mechanics**

Vortex boundary layer interaction, modeling of turbulent boundary layers; geophysical flows such as frontal systems and mountain flows; statistical mechanics of plasmas, liquids and shock waves; finite amplitude waves in stratified gases and liquids; shock wave propagation; non-Newtonian flows in flexible tubes with application to hemorheology; magneto-fluid mechanics; wing theory; thermally driven flows.

**Design**

Geometric modeling; tolerance analysis and synthesis; assembly modeling; geometric dimensioning and tolerancing; 3D digitizing; data and information structures; design for manufacturing; design methodology, tools and practices; expert systems in design; industry projects with Integrated Product Development (IPD) focus.

**Manufacturing**

Free-form surface machining; coordinate measuring machine applications to geometric dimensions and tolerances; Taguchi's method; injection molding; sheet metal fabrication; FEA/FEM applications to plastic deformation of metals; rapid prototyping; intelligent manufacturing incorporating process modeling, sensor subsystems for in situ product quality monitoring, and knowledge-based control for real-time process adaptation; blow molding; composites processing; thermoforming; resin transfer molding; spin coating; electronic packaging.

**Systems Dynamics and Controls**

Modeling, simulation and control of dynamic systems including: control of unstable processes, programmed logic control experience, compensator design and construction, issues in digital implementation, state-of-the-industrial art experimental equipment, energy methods and bond graph modeling, methods of model identification from experimental data; application to various mechanisms, vehicles, chemical processes, aircraft systems, chemical processes, hydraulic systems, thermodynamic systems, microelectromechanical actuators; application to mechatronics for the integration of mechanical systems, computer control and programming for the design of smart consumer products and intelligent manufacturing machinery.

**Stochastic Processes**

Modeling of random behavior in mechanical systems; static and time-dependent stochastic fracture mechanics, with particular applications to assessments of reliability and service life prediction.

**Engineering Mathematics**

General research areas within the division include: Analytical and numerical methods for the solution of ordinary and partial differential equations; industrial applications. Asymptotic methods. Finite element

techniques. Wavelets. Nonlinear studies; stability and bifurcation. Navier-Stokes equations; boundary layer theory; turbulence modelling. Non-Newtonian fluids; viscometric flows; materials processing. Geophysical flows. Wave propagation; solutions. Combustion phenomena. Continuum mechanics; large deformation analyses; buckling; fracture mechanics. Thermoelasticity. Applied probability and stochastic processes; stochastic differential equations. Statistical mechanics.

#### Graduate Courses in Engineering Mechanics

Except for core courses, graduate courses are generally offered every third semester.

#### Mechanical Engineering Courses

##### ME 010 Graphics for Engineering Design 3 Credits

Graphical description of mechanical engineering design for visualization and communication by freehand sketching, production drawings, and 3D solid geometric representations. Introduction to creation, storage, and manipulation of such graphical descriptions through an integrated design project using state-of-the art, commercially available computer-aided engineering software. Lectures and laboratory. (ES 1), (ED 2).

##### ME 021 Mechanical Engineering Laboratory I 1 Credit

Experimental methods in mechanical engineering and mechanics. Analysis of experimental error and error propagation. Introduction to elementary instrumentation. Introduction to digital data acquisition. Prerequisites as noted below.

**Prerequisites:** MECH 012

**Can be taken Concurrently:** MECH 012

##### ME 104 Thermodynamics I 3 Credits

Basic concepts and principles of thermodynamics with emphasis on simple compressible substances. First and second law development, energy equations, reversibility, entropy and efficiency. Properties of pure substances and thermodynamic cycles. Co-requisite: MATH 23 and PHY 11. (ES 3), (ED 0).

**Prerequisites:** (MATH 033 or MATH 023) and (PHY 011 or PHY 010)

**Can be taken Concurrently:** MATH 033, MATH 023, PHY 011, PHY 010

##### ME 111 Professional Development 1 Credit

Examination of ethical and professional choices facing mechanical engineers. Written and oral communications. Must have senior standing in Mechanical Engineering and Mechanics.

##### ME 121 Mechanical Engineering Laboratory II 1 Credit

A continuation of ME 21 including use of transducers, advanced instrumentation, and data acquisition. Emphasis on experimental exercises that illustrate, and/or introduce material from thermodynamics, and fluid mechanics. Includes proposal writing and interpretation of results. Prerequisites as noted below.

**Prerequisites:** ME 021 and ME 104 and ME 231

**Can be taken Concurrently:** ME 231

##### ME 207 Mechanical Engineering Laboratory III 2 Credits

Formulation of laboratory experiments through open-ended planning, including decision criteria for laboratory techniques and approaches. Execution of experiments based on individual plans, followed by assessment of experimental results. Prerequisites as noted below.

**Prerequisites:** ME 121

##### ME 211 Integrated Product Development (IPD) I 3 Credits

Business, engineering and design arts students work in cross disciplinary teams of 46 students on conceptual design including marketing, financial and economic planning, economic and technical feasibility of new product concepts. Teams work on industrial projects with faculty advisors. Oral presentations and written reports. Prerequisites as noted below.

**Prerequisites:** ME 010 and MECH 012 and ME 104

##### ME 212 Integrated Product Development (IPD) II 2 Credits

Business, engineering and design arts students work in cross disciplinary teams of 46 students on the detailed design including fabrication and testing of a prototype of the new product designed in the IPD course 1. Additional deliverables include a detailed production plan, marketing plan, detailed base-case financial models, project and product portfolio. Teams work on industrial projects with faculty advisors. Oral presentations and written reports. Prerequisites as noted below.

**Prerequisites:** ME 211 and ME 252

**Can be taken Concurrently:** ME 252

##### ME 215 Engineering Reliability 3 Credits

Applications of reliability methods to engineering problems. Modeling and analysis of engineered components and systems subjected to environmental and loading conditions. Modeling content encompasses mechanistically based probability and experientially based statistical approaches. Concepts needed for design with uncertainty are developed. Principles are illustrated through case studies and projects. Engineering applications software will be extensively utilized for the projects. Prerequisites as noted below.

**Prerequisites:** (MATH 023 or MATH 033) and MECH 012

**Can be taken Concurrently:** MECH 012

##### ME 231 Fluid Mechanics 3 Credits

Kinematics of fluid flow and similarity concepts. Equations of incompressible fluid flow with inviscid and viscous applications. Turbulence. One-dimensional compressible flow, shock waves. Boundary layers, separation, wakes and drag. Prerequisites as noted below.

**Prerequisites:** MATH 205

##### ME 240 Manufacturing 3 Credits

Analytical and technological base for several manufacturing processes and common engineering materials. Processes include metal cutting, metal deformation, injection molding, thermoforming, and composites. Process planning, computer-aided manufacturing, manufacturing system engineering, and quality measurements. Design project. Weekly laboratory. Prerequisites as noted below.

**Prerequisites:** ME 010 and MECH 012

##### ME 242 Mechanical Engineering Systems 3 Credits

The modeling and analysis of mechanical, fluid, electrical and hybrid systems, with emphasis on lumped models and dynamic behavior, including vibrations. Source-load synthesis. Analysis in temporal and frequency domains. Computer simulation of nonlinear models, and computer implementation of the superposition property of linear models. Prerequisites as noted below.

**Prerequisites:** MECH 102 and MATH 205 and ME 231

**Can be taken Concurrently:** ME 231

##### ME 245 Engineering Vibrations 3 Credits

Physical modeling of vibrating systems. Free and forced single and multiple degree of freedom systems. Computer simulations. Engineering applications. Prerequisites as noted below.

**Prerequisites:** MECH 102 and MATH 205

##### ME 252 Mechanical Elements 3 Credits

Methods for the analysis and design of machine elements such as springs, gears, clutches, brakes, and bearings. Motion analysis of cams and selected mechanisms. Projects requiring the design of simple mechanisms of mechanical sub-assemblies. Prerequisites as noted below.

**Prerequisites:** MECH 012 and ME 010 and MECH 102

##### ME 255 Introduction to Aerospace Engineering 3 Credits

Properties of the atmosphere, aircraft design and performance basics including estimation of lift and drag of aerodynamic bodies. Concepts of stall and service ceiling of aircraft along with propulsive forces, stability and control. Prerequisites as noted below.

**Prerequisites:** (PHY 011 and ME 104 and ME 231)

**Can be taken Concurrently:** ME 231

##### ME 299 Special Topics In Mechanical Engineering 1-4 Credit

**Repeat Status:** Course may be repeated.

##### ME 300 Apprentice Teaching 3 Credits

**ME 304 Thermodynamics II 3 Credits**

Availability and Second Law Analysis. Design of gas and vapor power cycles, and refrigeration systems. Generalized property relations for gases and gas-vapor. Combustion and chemical equilibrium. Design of engineering systems and processes incorporating thermodynamic concepts and analysis. Prerequisites as noted below.

**Prerequisites:** ME 104

**ME 309 Composite Materials 3 Credits**

Principles and technology of composite materials. Processing, properties, and structural applications of composites, with emphasis on fiber-reinforced polymers. Prerequisites as noted below.

**Prerequisites:** (MECH 003 and MAT 033)

**ME 310 Directed Study 1-3 Credit**

Project work on any aspect of engineering, performed either individually or as a member of a team made up of students, possibly from other disciplines. Project progress is reported in the form of several planning and project reports. Direction of the projects may be provided by faculty from several departments and could include interaction with outside consultants and local communities and industries. Consent of department required.

**Repeat Status:** Course may be repeated.

**ME 312 Analysis and Synthesis Of Mechanisms 3 Credits**

Types of motion. Degrees of freedom of motion. Position, velocity and acceleration analysis of linkage mechanisms. Systematic approach to the design of linkage mechanisms. Motion generation, path synthesis and function synthesis. Structural synthesis of planar and spatial mechanisms. Static force analysis of mechanisms using virtual work. Prerequisites as noted below.

**Prerequisites:** MATH 205 and MECH 102

**ME 314 Metal Forming Processes 3 Credits**

Mechanical metallurgy and mechanics of metal forming processes. Yield criteria. Workability. Friction and lubrication. Engineering analysis of forging, extrusion, wire and tube drawing, rolling, sheet forming and other processes. Recent developments in metal forming.

**ME 315 Bioengineering Statistics 3 Credits**

Probability and statistics applied to bioengineering problems focusing on modeling and data analysis. Types of data, types of distributions, parametric and nonparametric analyses, goodness-of-fit, regression, power analysis, and multivariate analysis, life models, simulation, cluster analysis, and Bayesian statistics. Projects and case studies. Prerequisites as noted below.

**Prerequisites:** MATH 231

**ME 321 Introduction to Heat Transfer 3 Credits**

Analytical and numerical solutions to steady and transient one-and two-dimensional conduction problems. Forced and natural convection in internal and external flows. Thermal radiation. Thermal design of engineering processes and systems. Prerequisites as noted below.

**Prerequisites:** ME 104 and ME 231

**ME 322 Gas Dynamics 3 Credits**

Flow equations for compressible fluids; thermodynamic properties of gases. Normal shock waves. Steady one-dimensional flows with heat addition and friction. Oblique shock waves. Expansion waves. Nozzle flows. Shock tubes; performance calculations and design. Supersonic wind tunnels; diffuser design. Real gas effects. Prerequisites as noted below.

**Prerequisites:** ME 231 and ME 104 and MATH 205

**ME 323 Reciprocating and Centrifugal Engines 3 Credits**

Thermal analysis and design of internal combustion engines (conventional and unconventional), gas turbine engines, air breathing jet engines, and rockets. Components such as jet nozzles, compressors, turbines, and combustion chambers are chosen to exemplify the theory and development of different types of components. Both ideal fluid and real fluid approaches are considered. Prerequisites as noted below.

**Prerequisites:** ME 104

**ME 331 Advanced Fluid Mechanics 3 Credits**

Kinematics of fluid flow. Conservation equations for inviscid and viscous flows; integral forms of equations. Two-dimensional potential flow theory of incompressible fluids with applications. Boundary layers. Introduction to free shear layer and boundary layer stability and structure of turbulence. Transition from laminar to turbulent boundary layers. Separation of flow. Steady and unsteady stall. Secondary flows. Hydrodynamic lubrication. Measurement techniques. Prerequisites as noted below.

**Prerequisites:** ME 231

**ME 333 Propulsion Systems 3 Credits**

Review of jet and rocket engine technologies. Jet and rocket engine thermodynamic and aerodynamic principles. Performance of turbojet, turbofan, and turboprop jet engines. Rocket engines include liquid, cryogenic, solid, and electric propulsion. Prerequisites as noted below.

**Prerequisites:** ME 104 and (MECH 326 or MECH 322)

**ME 340 Advanced Mechanical Design 3 Credits**

Probabilistic design of mechanical components and systems. Reliability functions, hazard models and product life prediction. Theoretical stress-strength-time models. Static and dynamic reliability models. Optimum design of mechanical systems for reliability objectives or constraints. Prerequisites as noted below or consent of instructor.

**Prerequisites:** MATH 231

**ME 341 Mechanical Systems 3 Credits**

Advanced topics in mechanical systems design. Kinematics and dynamics of planar machinery. Shock and vibration control in machine elements. Balancing of rotating and reciprocating machines. Design projects using commercial computer-aided-engineering software for the design and evaluation of typical machine systems. Prerequisites as noted below.

**Prerequisites:** ME 252

**ME 342 Dynamics of Engineering Systems 3 Credits**

Dynamic analysis of mechanical, electromechanical, fluid and hybrid engineering systems with emphasis on the modeling process. Lumped and distributed-parameter models. Use of computer tools for modeling, design and simulation. Design projects. Prerequisites as noted below.

**Prerequisites:** ME 242

**ME 343 Control Systems 3 Credits**

Linear analyses of mechanical, hydraulic and electrical feedback control systems by root locus and frequency response techniques. A design project provides experience with practical issues and tradeoffs. Prerequisites as noted below.

**Prerequisites:** ME 242 or ECE 125 or ME 295 or ME 245

**ME 344 Metal Machining Analysis 3 Credits**

Intensive study of metal cutting emphasizing forces, energy, temperature, tool materials, tool life, and surface integrity. Abrasive processes. Laboratory and project work. Prerequisites as noted below.

**Prerequisites:** ME 240 or IE 215 or MAT 206

**ME 348 Computer-Aided Design 3 Credits**

Impact of computer-aided engineering tools on mechanical design and analysis. Part geometry modeling and assembly modeling using solid representations. Analysis for mass properties, interference, kinematics, displacements, stresses and system dynamics by using state-of-the-art commercially available computer-aided-engineering software. Integrated design projects. Prerequisites as noted below.

**Prerequisites:** ME 010 and MECH 012 and MECH 102 and MATH 205

**ME 350 Special Topics 1-5 Credit**

A study of some field of mechanical engineering not covered elsewhere. Consent of department chair required.

**Repeat Status:** Course may be repeated.

**ME 355 Spacecraft Systems Engineering 3 Credits**

Systems engineering approach to design, integration, testing, and operations of spacecraft for various missions. Technologies currently used in modern spacecraft bus and payload systems, astrodynamics, launch systems, life-cycle costs, and operational issues. Team works to design a spacecraft that meets a specific set of mission requirements. Prerequisites as noted below.

**Prerequisites:** ME 255

**ME 360 Nuclear Reactor Engineering 3 Credits**

A consideration of the engineering problems related to nuclear reactor design and operation. Topics include fundamental properties of atomic and nuclear radiation, reactor fuels and materials, reactor design and operation, thermal aspects, safety and shielding, instrumentation and control. Course includes several design projects stressing the major topics in the course. Must have senior standing in engineering or physical science.

**ME 362 Nuclear Fusion and Radiation Protection 3 Credits**

Structure of the nucleus. Quantum theory. Nuclear energy release: Fission vs. Fusion. Plasma for fusion. Power balances in fusion plasmas. Magnetic and inertial confinement fusion concepts. Magnetic equilibrium configurations and limitations. The Tokamak. Emerging and alternative concepts. Fusion reactor economics. Radiation sources and Radioactive decay. Interactions of radiation with matter, detectors and protection from radiation. Energy deposition and dose calculations. Applications in dosimetry, imaging and spectroscopy. Must have senior standing in engineering or physical science.

**ME 364 Renewable Energy 3 Credits**

Fundamentals and design aspects of Renewable Energy (RE) technologies; biofuels, hydropower, solar photovoltaic, solar thermal, wind, geothermal energies. Details and difficulties in implementing RE. Prerequisites as noted below and/or senior standing in Engineering.

**Prerequisites:** MATH 205 and ME 104 and ME 231

**ME 366 Engineering Principles of Clean Coal Technology 3 Credits**

Effect of coal properties on plant performance. Design and performance of coal-based electric power generation systems. Technologies to control emissions. Carbon capture and sequestration methods for coal-fired power plants and analysis of CCS options. Must have junior standing in engineering or physical science.

**ME 368 Fundamentals of Energy Efficiency Practicum 3 Credits**

Studies of the plant operation and energy usage. Students work with the Lehigh Industrial Assessment Center to do technical and economic feasibility studies of optimizing energy consumption. Industrial experience. Fundamentals of best practices to save energy, reduce waste, and increase productivity. Consent of instructor required. Prerequisites as noted below.

**Prerequisites:** (MATH 205 and ME 104 and ME 231)

**ME 373 Mechatronics 3 Credits**

Synergistic integration of mechanical engineering with electronics and intelligent computer control in designing and manufacturing machines, products and processes; semiconductor electronics, analog signal processing, with op amps, digital circuits, Boolean algebra, logic network designs, Karnaugh map, flip-flops and applications, data acquisition, A/D and D/A, interfacing to personal computers, sensors and actuators, microcontroller programming and interfacing.

**ME 374 Mechatronics Laboratory 3 Credits**

Experiments and applications utilizing combinations of mechanical, electrical, and microprocessor components. Theory and application of electronic and electromechanical equipment, operation and control of mechatronic systems. Projects integrating mechanical, electronic and microcontrollers.

**ME 376 Energy: Issues & Technology 3 Credits**

Energy usage and supply, fossil fuel technologies, renewable energy alternatives and environmental impacts. The scope will be broad to give some perspective of the problems, but in-depth technical analysis of many aspects will also be developed. Must have college-level introductory courses in chemistry, physics and mathematics. Consent of instructor required.

**ME 385 Polymer Product Manufacturing 3 Credits**

Polymer processes such as injection molding through a combination of theory development, practical analysis, and utilization of commercial software. Polymer chemistry and structure, material rheological behavior, processing kinetics, molecular orientation development, process simulation software development, manufacturing defects, manufacturing window establishment, manufacturing process design, manufacturing process optimization. Must have senior level standing in engineering or science. Credit not given for both ME 385 and ME 485.

**ME 387 Digital Control 3 Credits**

Sampled-data systems; z-transforms; pulse transfer functions; stability in the z-plane; root locus and frequency response design methods; minimal prototype design; digital control hardware; discrete state variables; state transition matrix; Liapunov stability state feedback control (two lectures and one laboratory per week). Prerequisites as noted below or consent of instructor.

**Prerequisites:** CHE 386 or ECE 212 or ME 343

**ME 388 Honors Project for Eckardt Scholar 1-4 Credit**

Opportunity for Eckardt Scholars to pursue an extended project for senior honors. May be repeated for credit up to a maximum 12 credit hours. Transcript will identify department in which project was completed.

**Repeat Status:** Course may be repeated.

**ME 389 Control Systems Laboratory 2 Credits**

Experiments on a variety of mechanical, electrical and chemical dynamic control systems. Exposure to state-of-the-art control instrumentation: sensors, transmitters, control valves, analog and digital controllers. Emphasis on design of feedback controllers and comparison of theoretical computer simulation predictions with actual experimental data. Lab teams will be interdisciplinary. Prerequisites as noted below.

**Prerequisites:** CHE 386 or ECE 212 or ME 343

**ME 401 Integrated Product Development 3 Credits**

An integrated and interdisciplinary approach to engineering design, concurrent engineering, design for manufacturing, industrial design and the business of new product development. Topics include design methods, philosophy and practice, the role of modeling and simulation, decision making, risk, cost, material and manufacturing process selection, platform and modular design, mass customization, quality, planning and scheduling, business issues, teamwork, group dynamics, creativity and innovation. The course uses case studies and team projects. ME402.

**ME 402 Advanced Manufacturing Science 3 Credits**

The course focuses on the fundamental science-base underlying manufacturing processes, and applying that science base to develop knowledge and tools suitable for industrial utilization. Selected manufacturing processes representing the general classes of material removal, material deformation, material phase change, material flow, and material joining are addressed. Students create computer-based process simulation tools independently as well as utilize leading commercial process simulation packages. Laboratory experiences are included throughout the course.

**ME 411 Boundary-Layer Theory 3 Credits**

The course is intended as a first graduate course in viscous flow. An introduction to boundary-layer theory, thermodynamics and heat transfer at the undergraduate level are assumed to have been completed. Topics include the fundamental equation of continuum fluid mechanics, the concept of asymptotic methods and low and high Reynolds number flows, laminar boundary layers, generalized similarity methods, two- and three-dimensional flows, steady and unsteady flows and an introduction to hydrodynamic stability. The material is covered in the context of providing a logical basis as an introduction to a further course in turbulent flows.

**ME 413 Numerical Methods in Mechanical Engineering 3 Credits**

Zeros of functions, difference tables, interpolation, integration, differentiation. Divided differences, numerical solution of ordinary differential equations of the boundary and initial value type. Eigen problems. Curve fitting, matrix manipulation and solution of linear algebraic equations. Partial differential equations of the hyperbolic, elliptic and parabolic type. Application to problems in mechanical engineering.

**ME 415 Flow-Induced Vibrations 3 Credits**

Excitation of streamlined- and bluff-bodies by self-excited, vortex, turbulence, and gust-excitation mechanisms. Analogous excitation of fluid (compressible and free-surface) systems having rigid boundaries. Extensive case studies.

**ME 420 Advanced Thermodynamics 3 Credits**

Critical review of thermodynamics systems. Criteria for equilibrium. Applications to electromagnetic systems. Statistical thermodynamics. Irreversible thermodynamics. Thermoelectric phenomena.

**ME 421 Topics in Thermodynamics 3 Credits**

Emphasis on theoretical and experimental treatment of combustion processes including dissociation, flame temperature calculations, diffusion flames, stability and propagation; related problems in compressible flow involving one-dimensional, oblique shock waves and detonation waves. Methods of measurement and instrumentation.

**ME 423 Heat and Mass Transfer 3 Credits**

This course is a first graduate course in the basic concepts of heat and mass transfer, providing a broad coverage of key areas in diffusion, conduction, convection, heat and mass transfer, and radiation. Topics covered include: the conservation equations, steady and transient diffusion and conduction, periodic diffusion, melting and solidification problems, numerical methods, turbulent convection, transpiration and film cooling, free convection, heat transfer with phase change, heat exchanges, radiation, mixed mode heat and mass transfer.

**ME 424 Unsteady and Turbulent Flow 3 Credits**

Stability of laminar flow; transition to turbulence. Navier-Stokes equations with turbulence. Bounded turbulent shear flows; free shear flows; statistical description of turbulence.

**ME 426 Radiative and Conductive Heat Transfer 3 Credits**

Principles of radiative transfer; thermal-radiative properties of diffuse and specular surfaces; radiative exchange between bodies; radiative transport through absorbing, emitting and scattering media. Advanced topics in steady-state and transient conduction; analytical and numerical solutions; problems of combined conductive and radiative heat transfer.

**ME 428 Boundary Layers and Convective Heat Transfer 3 Credits**

Navier-Stokes and energy equations, laminar boundary layer theory, analysis of friction drag, transfer and separation. Transition from laminar to turbulent flow. Turbulent boundary layer theory. Prandtl mixing length, turbulent friction drag, and heat transfer. Integral methods. Flow in ducts, wakes and jets. Natural convection heat transfer.

**ME 430 Advanced Fluid Mechanics 3 Credits**

This course is a first graduate course in incompressible fluid mechanics, providing a broad coverage of key areas of viscous and inviscid fluid mechanics. Topics covered include: Flow kinematics, differential equations of motion, viscous and inviscid solutions, vorticity dynamics and circulation, vorticity equation, circulation theorems, potential flow behavior, irrotational and rotational flows, simple boundary layer flows and solutions, and real fluid flows and consequences.

**ME 431 Advanced Gas Dynamics 3 Credits**

Method of characteristics. Unsteady continuous flow. Unsteady flows with discontinuities. Shock tubes. Detonation waves. Two-dimensional and axisymmetric supersonic flows. Momentum and energy equation of compressible viscous fluids.

**ME 433 State Space Control 3 Credits**

This course will cover the following topics in control theory: State-space representation of linear systems, linearization, causality, time-variance and linearity properties of systems, review of some of the fundamental concepts in linear algebra, impulse response and transfer functions, solutions to LTV systems, solutions to LTI systems and Jordan form, Lyapunov stability, input-output stability, an introduction to optimal control theory, controllable and reachable subspaces, controllable systems, controllable decompositions, stabilizability, observability, output feedback, minimal realizations, Linear Quadratic Regulator (LQR), the Algebraic Riccati Equation (ARE), frequency domain properties of LQR controller. Several examples will be given from mechanical, electrical and chemical engineering applications.

**ME 434 Multivariable Process Control 3 Credits**

A state-of-the-art review of multivariable methods of interest to process control applications. Design techniques examined include loop interaction analysis, frequency domain methods (Inverse Nyquist Array, Characteristic Loci and Singular Value Decomposition) feed forward control, internal model control and dynamic matrix control. Special attention is placed on the interaction of process design and process control. Most of the above methods are used to compare the relative performance of intensive and extensive variable control structures. Prerequisites as noted below or consent of instructor.

**Prerequisites:** CHE 433 or ME 433 or ECE 433

**ME 436 Systems Identification 3 Credits**

The determination of model parameters from time-history and frequency response data by graphical, deterministic and stochastic methods. Examples and exercises taken from process industries, communications and aerospace testing. Regression, quasilinearization and invariant-embedding techniques for nonlinear system parameter identification included.

**ME 437 Stochastic Control 3 Credits**

Linear and nonlinear models for stochastic systems. Controllability and observability. Minimum variance state estimation. Linear quadratic Gaussian control problem. Computational considerations. Nonlinear control problem in stochastic systems. Prerequisites as noted below or consent of instructor.

**Prerequisites:** CHE 433 or ME 433 or ECE 433

**ME 444 Experimental Stress Analysis in Design 3 Credits**

Fundamental concepts of strain measurements and application of strain gages and strain gage circuits. Two- and three-dimensional photoelasticity, stress separation techniques, birefringent coatings, moiré methods, caustics. Use of image analysis in data acquisition and interpretation. Selected laboratory experiments.

**ME 446 Mechanical Reliability 3 Credits**

Design of mechanical engineering systems to reliability specifications. Probabilistic failure models for mechanical components. Methods for the analysis and improvement of system reliability. Effect of component tolerance and parameter variation on system failure. Reliability testing.

**ME 450 Special Topics 3 Credits**

An intensive study of some field of mechanical engineering not covered in more general courses.

**ME 452 Mathematical Methods In Engineering I 3 Credits**

Analytical techniques relevant to the engineering sciences are described. Vector spaces; eigenvalues; eigenvectors. Linear ordinary differential equations; diagonalizable and non-diagonalizable systems. Inhomogeneous linear systems; variation of parameters. Non-linear systems; stability; phase plane. Series solutions of linear ordinary differential equations; special functions. Laplace and Fourier transforms; application to partial differential equations and integral equations. Sturm-Liouville theory. Finite Fourier transforms; planar, cylindrical, and spherical geometries.

**ME 453 Mathematical Methods in Engineering II 3 Credits**

Theory of complex functions; Cauchy-Riemann relations. Integration in the complex plane, Cauchy's integral formula. Laurent series; singular points; contour integrals; Fourier and Laplace transforms. Evaluation of real integrals; Cauchy principal values. Laplace's equation; conformal mappings; Poisson formulae. Singular integral equations. Classification of partial differential equations. Hyperbolic systems of partial differential equations; uniqueness, shock formation. Nonlinear parabolic equations; Burger's equation.

**ME 458 Modeling of Dynamic Systems 3 Credits**

Modeling of complex linear and nonlinear energetic dynamic engineering systems. Emphasis on subdivision into multiport elements and representation by the bondgraph language using direct, energetic, and experimental methods. Field lumping. Analytical and graphical reductions. Simulation and other numerical methods. Examples including mechanisms, electromechanical transducers, electric and fluid circuits, and thermal systems.

**ME 460 Engineering Project 1-6 Credit**

Project work on some aspect of mechanical engineering in an area of student and faculty interest. Selection and direction of the project could involve interaction with local communities or industries. Consent of department required.

**Repeat Status:** Course may be repeated.

**ME 461 Integrated Product Development (IPD) Projects-1 2 Credits**

Technical and economic feasibility study of new products. Selection and content of the project is determined by the faculty project advisor in consultation with the student, progress and final reports, oral and posters presentations. Consent of the program director and faculty project adviser required. Prerequisites as noted below.

**Prerequisites:** TE 401 or ME 401

**ME 462 IPD: Manufacturing 3 Credits**

Industry sponsored Integrated Product Development Project (IPD) projects. The student works with an industry sponsor to create detailed design specifications, fabricate and test a prototype new product and plan for production. Selection and content of the project is determined by the faculty project advisor in consultation with the industry sponsor. Deliverables include progress and final reports, oral presentations, posters and a prototype. Consent of the department chair and faculty project advisor required.

**ME 464 Computer-Aided Geometric Modeling 3 Credits**

Representation schemes for geometric modeling, computational geometry for curve and surface design, finite-element meshing and NC tool path generation, interfacing different CAD/CAM databases, interactive computer graphics programming.

**ME 466 Fundamentals of Acoustics 3 Credits**

Vibration-induced acoustic radiation, wave equation in planar, cylindrical and spherical coordinates. Sound in tubes, pipes, wave guides, acoustic enclosures. Impedance and source-media-receiver transmission concepts. Noise and its measurements.

**ME 468 Advanced Energy Efficiency Practicum 3 Credits**

Critical assessments of energy management systems. Establishment of framework for industrial facilities to manage energy systems. Fundamentals of best practices for energy efficiencies associated with industrial energy savings. Progress and final reports required. Engineering graduate students only. Consent of instructor required.

**ME 485 Polymer Product Manufacturing 3 Credits**

An exploration of the science underlying polymer processes such as injection molding through a combination of theory development, practical analysis, and utilization of commercial software. Polymer chemistry and structure, material rheological behavior, processing kinetics, molecular orientation development, process simulation software development, manufacturing defects, manufacturing window establishment, manufacturing process design, manufacturing process optimization.

This course is a version of ME 385 for graduate students, with research projects and advanced assignments. Closed to students who have taken ME 385. Must have graduate level standing in engineering or science.

**ME 490 Thesis 1-6 Credit**

**Repeat Status:** Course may be repeated.

**ME 499 Dissertation 1-15 Credit**

**Repeat Status:** Course may be repeated.

**Mechanics Courses****MECH 002 Elementary Engineering Mechanics 3 Credits**

Static equilibrium of particles and rigid bodies. Elementary analysis of simple truss and frame structures, internal forces, stress, and strain. Prerequisites as noted below.

**Prerequisites:** (MATH 022 or MATH 052 or MATH 032) and (PHY 010 or PHY 011 or PHY 090)

**Can be taken Concurrently:** MATH 022, MATH 052, MATH 032

**MECH 003 Fundamentals of Engineering Mechanics 3 Credits**

Static equilibrium of particles and rigid bodies. Analysis of simple truss and frame structures, internal forces, stress, strain, and Hooke's Law, torsion of circular shafts; pure bending of beams. Course is intended as a prerequisite for MECH 12. Credit not given for both Mech 2 and Mech 3. Prerequisites as noted below.

**Prerequisites:** (MATH 022 or MATH 032) and PHY 011

**Can be taken Concurrently:** MATH 022, MATH 032

**MECH 012 Strength of Materials 3 Credits**

Transverse shear in beams. Mohr's circle for stress. Plastic yield criteria. Deflection of beams. Introduction to numerical analysis of simple structures. Fatigue and fracture. Column buckling. Stresses in thick-walled cylinders. Prerequisites as noted below.

**Prerequisites:** (MECH 195 or MECH 003) and (MATH 023 or MATH 033)

**Can be taken Concurrently:** MATH 023, MATH 033

**MECH 102 Dynamics 3 Credits**

Particle dynamics, work-energy, impulse-momentum, impact, systems of particles; kinematics of rigid bodies, kinetics of rigid bodies in plane motion, energy, momentum, eccentric impact. Prerequisites as noted below.

**Prerequisites:** (MECH 002 or MECH 195 or MECH 003) and (MATH 023 or MATH 033)

**Can be taken Concurrently:** MATH 023, MATH 033

**MECH 103 Principles of Mechanics 4 Credits**

Composition and resolution of forces; equivalent force systems; equilibrium of particles and rigid bodies; friction. Kinematics and kinetics of particles and rigid bodies; relative motion; work and energy; impulse and momentum. Prerequisites as noted below.

**Prerequisites:** (MATH 023 or MATH 033) and (PHY 010 or PHY 011)

**MECH 300 Apprentice Teaching 3 Credits****MECH 302 Advanced Dynamics 3 Credits**

Fundamental dynamic theorems and their application to the study of the motion of particles and rigid bodies, with particular emphasis on three-dimensional motion. Use of generalized coordinates; Lagrange's equations and their applications. Prerequisites as noted below.

**Prerequisites:** MATH 205 and (MECH 102 or MECH 103)

**MECH 305 Advanced Mechanics of Materials 3 Credits**

Strength, stiffness, and stability of mechanical components and structures. Fundamental principles of stress analysis: three-dimensional stress and strain transformations, two-dimensional elasticity, contact stresses, stress concentrations, energy and variational methods. Stresses and deformations for rotating shafts, thermal stresses in thick-walled cylinders, curved beams, torsion of prismatic bars, and bending of plates. Projects relate analysis to engineering design. Prerequisites as noted below.

**Prerequisites:** MECH 012 and MATH 205

**MECH 307 Mechanics of Continua 3 Credits**

Fundamental principles of the mechanics of deformable bodies. Study of stress, velocity and acceleration fields. Compatibility equations, conservation laws. Applications to two-dimensional problems in finite elasticity, plasticity, and viscous flows. Prerequisites as noted below.

**Prerequisites:** MECH 305

**MECH 312 Finite Element Analysis 3 Credits**

Basic concepts of analyzing general media (solids, fluids, heat transfer, etc.) with complicated boundaries. Emphasis on mechanical elements and structures. Element stiffness matrices by minimum potential energy. Isoparametric elements. Commercial software packages (ABAQUS, NISA) are used. In addition, students develop and use their own finite element codes. Applications to design. Prerequisites as noted below.

**Prerequisites:** MECH 012

**MECH 313 Fracture Mechanics 3 Credits**

Fracture mechanics as a foundation for design against or facilitation of fracture. Fracture behavior of solids; fracture criteria; stress analysis of cracks; subcritical crack growth, including chemical and thermal effects; fracture design and control, and life prediction methodologies. Prerequisites as noted below or consent of department.

**Prerequisites:** MECH 012 and MATH 205

**MECH 326 Aerodynamics 3 Credits**

Application of fluid dynamics to flows past lifting surfaces. Normal force calculations in inviscid flows. Use of conformal mappings in two dimensional airfoil theory. Kutta condition at a trailing edge; physical basis. Viscous boundary layers. Thin airfoil theory. Section design; pressure profiles and separation. Lifting line theory. Compressible subsonic flows; Prandtl-Glauert Rule. Airfoil performance at supersonic speeds. Prerequisites as noted below.

**Prerequisites:** ME 231

**MECH 328 Fundamentals of Aircraft Design 3 Credits**

Review of aerodynamics; Weight and balance, stability, loads; Basics of propellers; Power and performance; International Standard Atmosphere; Introduction to aerospace composites; Introduction to FAA regulations. Prerequisites as noted below.

**Prerequisites:** MECH 012

**MECH 350 Special Topics 3 Credits**

A study of some field of engineering mechanics not covered elsewhere. Consent of department required.

**MECH 404 Mechanics & Behavior of Structural Members 3 Credits**

Behavior of structural members under a variety of loading conditions in the elastic and inelastic range. Introduction to the theory of elasticity and plasticity. Basics of linear elastic fracture mechanics and fatigue. Analysis of structural member behavior in axial, bending, shear, and torsion. Stability analysis of beam-columns. Beams on elastic foundations. Energy concepts and their use in structural analysis.

**MECH 406 Fundamentals of Solid Mechanics 3 Credits**

An introductory graduate course in the mechanics of solids. Topics to be addressed include: curvi-linear tensor analysis, analysis of strain and nonlinear kinematics, stress, work conjugate stress-strain measures, conservation laws and energy theorems, variational calculus, isotropic and anisotropic linear elasticity, boundary value problems, beam and plate theories.

**MECH 408 Introduction To Elasticity 3 Credits**

This course is a first graduate course in solid mechanics. It addresses: kinematics and statics of deformable elastic solids; compatibility, equilibrium and constitutive equations; problems in plane elasticity and torsion; energy principles, approximate methods and applications.

**MECH 410 Theory of Elasticity II 3 Credits**

Advanced topics in the theory of elasticity. The subject matter may vary from year to year and may include, theory of potential functions, linear thermoelasticity, dynamics of deformable media, integral transforms and complex-variable methods in classical elasticity. Problems of boundary layer type in elasticity; current developments on the microstructure theory of elasticity.

**MECH 411 Continuum Mechanics 3 Credits**

An introduction to the continuum theories of the mechanics of solids and fluids. This includes a discussion of the mechanical and thermodynamical bases of the subject, as well as the use of invariance principles in formulating constitutive equations. Applications of the theories to specific problems are given.

**MECH 413 Fracture Mechanics 3 Credits**

Elementary and advanced fracture mechanics concepts; analytical modeling; fracture toughness concept; fracture toughness testing; calculation of stress intensity factors; elastic-plastic analysis; prediction of crack trajectory; fatigue crack growth and environmental effects; computational methods in fracture mechanics; nonlinear fracture mechanics; fracture of composite structures; application of fracture mechanics to design.

**MECH 415 Stability of Elastic Structures 3 Credits**

Basic concepts of instability of a structure; bifurcation, energy increment, snap-through, dynamic instability. Analytical and numerical methods of finding buckling loads of columns. Postbuckling deformations of cantilever columns. Dynamic buckling with nonconservative forces. Effects of initial imperfections. Inelastic buckling. Instability problems of thin plates and shells.

**MECH 418 Finite Element Methods 3 Credits**

Finite element approximations to the solution of differential equations of engineering interest. Linear and nonlinear examples from heat transfer, solid mechanics, and fluid mechanics are used to illustrate applications of the method. The course emphasizes the development of computer programs to carry out the required calculations. Must have knowledge of a high-level programming language.

**MECH 419 Asymptotic Methods in the Engineering Sciences 3 Credits**

Introductory level course with emphasis on practical applications. Material covered includes: Asymptotic expansions. Regular and singular perturbations; algebraic problems. Asymptotic matching. Boundary value problems; distinguished limits. Multiple scale expansions. W.K.B. Theory. Non-linear wave equations.

**MECH 424 Unsteady Fluid Flows 3 Credits**

Gas dynamics, finite amplitude disturbances in perfect and real gases; channel flows; three-dimensional acoustics; theories of the sonic boom. Motions in fluids with a free surface; basic hydrodynamics, small amplitude waves on deep water; ship waves; dispersive waves; shallow water gravity waves and atmospheric waves. Hemodynamics; pulsatile blood flow at high and low Reynolds number. Models of the interaction of flow with artery walls.

**MECH 425 Analytical Methods in Dynamics and Vibrations 3 Credits**

This course will mainly cover the following topics: coordinate systems, conservation laws, inertial frames, systems of particles, DAE sets, variable-mass systems, transport equation, review of some of the basic concepts from variational calculus, D'Alembert's principle, Hamilton's principle, Lagrange multipliers, generalized momenta, 3D rigid-body motion, Inertia matrices, Euler angles, inertial and elastic coupling, discrete eigenvalue problem, linearization of nonlinear systems, chaotic systems, Hamilton's principle for continuous systems, Torsion, Sturm-Liouville equations, Rayleigh's quotient, finite-element eigen-problems, interpolating functions, combined-effect vibrations, and some other related topics.

**MECH 432 Inelastic Behavior Of Materials 3 Credits**

Time-independent and dependent inelastic material behavior. Time-independent plasticity. Yield criteria in multi-dimensions, J2 incremental plasticity in multi-dimensions with associated flow rule. Numerical integration of plasticity equations by radial return and other methods. Deformation theory of plasticity. Time dependent behavior including linear viscoelasticity and nonlinear creep behavior. Nonlinear material behavior at elevated temperatures.

**MECH 445 Nondeterministic Models in Engineering 3 Credits**

Application of probability and stochastic processes to engineering problems for a variety of applications. Modeling and analysis of common nondeterministic processes. Topics are selected from the following: linear and nonlinear models for random systems; random functions; simulation; random loads and vibrations; Kalman filtering, identification, estimation, and prediction; stochastic fracture and fatigue; probabilistic design of engineering systems; and spatial point processes. Must have advanced calculus and some exposure to probability and statistics.

**MECH 450 Special Problems 3 Credits**

An intensive study of some field of applied mechanics not covered in more general courses.

**Prerequisites:** MECH 312

**MECH 454 Mechanics and Design of Composites 3 Credits**

Mechanics of anisotropic materials. Manufacturing and measurements of mechanical properties. Stress analysis for design of composite structures. Hydrothermal effects and residual stresses. Laminate design, micromechanics of lamina. Bolted and bonded joints. Impact and damage in composites. Lectures and laboratory.

**MECH 490 Thesis 1-6 Credit****MECH 499 Dissertation 1-15 Credit**



## Interdisciplinary Undergraduate Study

The university's interdisciplinary programs are designed to cross the boundaries between colleges to accommodate new and developing fields as well as the interests of students.

### Computer Science and Business Program

The College of Business and Economics and the Computer Science and Engineering department in the P.C. Rossin College of Engineering and Applied Science jointly offer the Computer Science and Business (CSB) program. The mission of the program is to provide rigorous computer science education integrated with in-depth business training that prepares high quality undergraduate students with diverse backgrounds for lifelong learning and to assume positions of leadership in the business community. This carefully crafted 136 credit hour degree integrates technology skills in software development with a solid background in business and economics. Deep immersion in both of these areas distinguishes CSB from programs offered by other universities. At the same time it is well balanced with approximately one third of the courses in liberal arts, one-third in computer science, and one-third in business.

After four years the program leads to a degree in Computer Science and in Business, which is jointly awarded by the College of Business and Economics and the P.C. Rossin College of Engineering and Applied Science. Graduates of the program will be ideal candidates for placement within public accounting firms, consulting companies, and startup companies. This program provides students with the background needed to become the CIO's, decision makers, and general managers of information age corporations.

While honors-like in quality and rigor, the CSB program is open to any student wishing to accept the challenges it offers. Students may matriculate at Lehigh specifically into CSB or enter the program at a later point. Transferring into CSB after freshman year, however, may require students to take additional credits to graduate. The CSB degree is accredited in Business (AACSB International) and is accredited by The Computer Accreditation Commission of ABET, [www.abet.org](http://www.abet.org).

The co-directors of the CSB program are James A. Hall, Peter E. Bennett Chair in Business and Economics ([jah0@lehigh.edu](mailto:jah0@lehigh.edu)) and Henry Korth, Professor of Computer Science and Engineering, [hfk2@lehigh.edu](mailto:hfk2@lehigh.edu).

For additional information visit the CSB web site at: [www.cse.lehigh.edu/csb](http://www.cse.lehigh.edu/csb)

#### Mission for Program

The Computer Science and Business program's mission is to provide its students with a strong education in mathematics, science, business, and computer science fundamentals and to prepare them to be able to adapt to future changes in the practice of Computer Science.

#### Program Educational Objectives

Graduates of the Bachelor of Science in Computer Science and Business Program will:

- Apply their education in computer science to the analysis and solution of business and industrial problems.
- Account for ethical and social issues when solving business and industrial problems.
- Function effectively in a collaborative team and effectively communicate with members of the team.
- Engage in continued education in their field of expertise.
- Attain positions of leadership in their chosen field.
- Apply their training to problems where information technologies and business processes converge.

#### Degree Requirements

The required courses for the CSB degree constitute the fundamentals of structured programming, discrete mathematics, algorithms, computer architecture, programming languages, software engineering, accounting, finance, marketing, management, and economics. None of the program requirements for the CSB major may be taken pass/fail.

The requirements are stated below. To view a number of suggested sequences of courses for satisfying these requirements see Suggested Sequences of Courses below.

#### Required Computer Science courses

CSE 001	Breadth of Computing	2
CSE 002	Fundamentals of Programming	2
CSE 017	Programming and Data Structures	3
CSE 109	Systems Software	4
CSE 202	Computer Organization and Architecture	3
CSE 216	Software Engineering	3
CSE 241	Database Systems and Applications	3
or CSE 341	Database Systems, Algorithms, and Applications	
CSE 261	Discrete Structures	3
CSE 262	Programming Languages	3
CSE 303	Operating System Design	3
CSE 340	Design and Analysis of Algorithms	3
One 300-level course <sup>2</sup>		3-4

#### Required Business courses

BUS 001	Introduction to Business	3
ACCT 151	Introduction to Financial Accounting	3
ACCT 152	Introduction to Managerial Accounting	3
ECO 001	Principles of Economics	4
ECO 029	Money, Banking, and Financial Markets	3
ECO 146	Applied Microeconomic Analysis	3
FIN 125	Introduction to Finance	3
LAW 201	Legal Environment of Business	3
SCM 186	Supply Chain Operations Management	3
MKT 111	Principles of Marketing	3
MGT 301	Strategic Management	3

#### Required Math and Science courses

MATH 021	Calculus I	4
MATH 022	Calculus II	4
MATH 205	Linear Methods	3
MATH 231	Probability and Statistics	3
or ECO 045	Statistical Methods	

#### Natural science courses <sup>1</sup>

#### Required CSB courses

CSB 311	Computer Applications in Business	3
CSB 312	Design of Integrated Business Applications I	3
CSB 313	Design of Integrated Business Applications II	3

#### Required CSB electives

Courses approved by the student's advisor.	9
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#### Humanities and Social Science requirements

ENGL 001	Composition and Literature	3
ENGL 002	Composition and Literature II	3
CSE 252	Computers, the Internet, and Society	3
Humanities (HU) electives		6
Social Sciences (SS) electives		3

#### Free electives

Total Credits	135-137
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<sup>1</sup> Such that one course has an attached laboratory and such that two courses are in a laboratory science with the first course a prerequisite to the second course. See Suggested Sequences of Natural Science Courses (<http://www.cse.lehigh.edu/academics/undergraduate-computer-science/bs-in-computer-science-and-business/2-uncategorised/174-natural-science-course-sequence>).

- <sup>2</sup> Computer Science & Business Electives (<http://www.cse.lehigh.edu/academics/undergraduate-computer-science/bs-in-computer-science-and-business/2-uncategorised/124-csb-choice>) approved list.

### CSB Tracks

Students may choose to use their CSB professional electives to develop areas of concentrations or tracks from courses offered within the CSE department or CBE. In certain cases, the program co-directors may also approve courses from other departments. See some examples of CSB tracks (<http://www.cse.lehigh.edu/academics/undergraduate-computer-science/bs-in-computer-science-and-business/2-uncategorised/122-csb-tracks>). Note: that it is **not** required that a student complete a track, just that students fulfill the 9-credit professional elective requirement.

### Sample Sequences of Courses

Below are several sample course sequences that fulfill the CSB degree requirements. These are only examples and nothing here is intended to suggest implicit requirements. It should be clear in particular that electives can easily be rearranged.

None of these samples assume AP credit. Generally, students with AP move courses in the sequence earlier to leave room for more electives in the junior and/or senior years.

Students contemplating the Lehigh in Prague Internship Program during the summer following their sophomore year should complete ACCT 151 and ACCT 152, CSB 311, and CSE 241 (or CSE 341) by the end of sophomore year. (See Sample B). It is necessary to request an override to be allowed to take ACCT 152 concurrent with CSB 311.

Students not planning to go to Prague, or who plan to go in the summer following their junior year should take CSB 311 in the spring of junior year.

Students contemplating graduate study in computer science or employment at major computing software firms (e.g. Microsoft, Google, Oracle, IBM) should consider taking CSE 340 prior to senior year. (See Sample C).

Sample D shows how a student entering CSB as a sophomore from the engineering college could complete the CSB major in 4 years with overloads in senior year. The overloads can be avoided via AP credit, a summer course, or the Lehigh in Prague program. It is important that students considering a transfer into CSB contact Prof. Hall or Prof. Korh prior to course registration.

First-year students who choose the MATH 075/MATH 076 sequence in place of MATH 021 would have only 16 credits for fall of freshman year with MATH 075 replacing MATH 021. In spring freshman year, they would take MATH 076 in place of MATH 022 and add ECO 045 for a total of 18 credits. In fall of sophomore year these students would take MATH 022 and, since they would already have taken ECO 045, the total credit for fall of sophomore year would be 18.

### Computer Science and Business - SAMPLE A

This is **not** compatible with the participating Lehigh in Prague Program during the summer after sophomore year, though it **is** compatible with participation during the summer after junior year.

#### First Year

First Semester	CR Second Semester	CR
BUS 001	3 CSE 017	3
CSE 001	2 ECO 029	3
CSE 002	2 ENGL 002	3
ECO 001	4 MATH 022	4
ENGL 001	3 Science Elective	4
MATH 021	4	
CBE Excel Competency Exam	0	
	<b>18</b>	<b>17</b>

#### Second Year

First Semester	CR Second Semester	CR
ACCT 151	3 ACCT 152	3
CSE 109	4 CSE 202	3
MATH 231 or ECO 045	3 CSE 241 or 341	3
MKT 111	3 CSE 261	3

Science Elective	4 Science Elective	4
	<b>17</b>	<b>16</b>

#### Third Year

First Semester	CR Second Semester	CR
CSE 303	3 CSB 311	3
CSE 216	3 CSB 312	3
FIN 125	3 CSE 252	3
MATH 205	3 ECO 146	3
SCM 186	3 LAW 201	3
SS elective	3 CSB professional elective	3
	<b>18</b>	<b>18</b>

#### Fourth Year

First Semester	CR Second Semester	CR
CSB 313	3 CSE 340	3
CSE 262	3 MGT 301	3
CSB Professional Elective	3 CSB Professional Elective	3
CSE Elective (See Computer Science & Business Electives below)	3 HU Electives <sup>1</sup>	2
HU Electives <sup>1</sup>	4 Free Electives	5
	<b>16</b>	<b>16</b>

Total Credits: 136

### Computer Science and Business - SAMPLE B

Targeted towards students thinking about spending the summer after sophomore year in the Lehigh in Prague Program. Students not going to Prague need to fit and 3 credits of free elective into the regular semesters.

#### First Year

First Semester	CR Second Semester	CR
BUS 001	3 CSE 017	3
CSE 001	2 ECO 029	3
CSE 002	2 ENGL 002	3
ECO 001	4 MATH 022	4
ENGL 001	3 Science Elective	4
MATH 021	4	
CBE Excel Competency Exam	0	
	<b>18</b>	<b>17</b>

#### Second Year

First Semester	CR Second Semester	CR Summer	CR
ACCT 151	3 ACCT 152	3 CSB 314	3
CSE 109	4 CSB 311 (prerequisite override needed)	3 CSE 252	3
MATH 231 or ECO 045	3 CSE 241 or 341	3	
MKT 111	3 CSE 261	3	
Science Elective	4 Science Elective	4	
	<b>17</b>	<b>16</b>	<b>6</b>

#### Third Year

First Semester	CR Second Semester	CR
CSE 216	3 CSB 312	3
FIN 125	3 CSE 202	3
MATH 205	3 ECO 146	3
SCM 186	3 LAW 201	3
CSE Elective (See Computer Science & Business Electives below)	3 CSB Professional Elective	3
SS Elective	3	
	<b>18</b>	<b>15</b>

**Fourth Year**

First Semester	CR	Second Semester	CR
CSE 262	3	CSE 340	3
CSB 313	3	MGT 301	3
CSE 303	3	CSB Professional Elective	3
CSB Professional Elective	3	HU Elective <sup>1</sup>	2
HU Elective <sup>1</sup>	4	Free Elective	2
	<b>16</b>		<b>13</b>

Total Credits: 136

**Computer Science and Business - SAMPLE C**

Designed for students thinking of graduate study in Computer Science. This sample is compatible with the Lehigh in Prague Program, but assumes the student chooses not to do it. This sample includes some specific choices of course options and CSE electives that are recommended as preparation for graduate study.

**First Year**

First Semester	CR	Second Semester	CR
BUS 001	3	CSE 017	3
CSE 001	2	ECO 029	3
CSE 002	2	ENGL 002	3
ENGL 001	3	MATH 022	4
ECO 001	4	Science Elective	4
MATH 021	4		
CBE Excel Competency Exam	0		
	<b>18</b>		<b>17</b>

**Second Year**

First Semester	CR	Second Semester	CR
ACCT 151	3	ACCT 152	3
CSE 109	4	CSB 311	3
MATH 205	3	CSE 202	3
MATH 231 <sup>2</sup>	3	CSE 261	3
Science Elective	4	CSE 271 (serves as a CSB professional elective)	3
		CSE 341 <sup>3</sup>	3
	<b>17</b>		<b>18</b>

**Third Year**

First Semester	CR	Second Semester	CR
CSE 216	3	CSB 312	3
CSE 303	3	CSE 262	3
CSE 318 (serves as CSE elective from list)	3	CSE 340	3
ECO 146	3	LAW 201	3
FIN 125	3	SCM 186	3
MKT 111	3		
	<b>18</b>		<b>15</b>

**Fourth Year**

First Semester	CR	Second Semester	CR
CSB 313	3	CSE 302 (or CS Independent Study) (serves as CSB professional elective)	3
CSE 252	3	MGT 301	3
CSE 342 (serves as CSB professional elective)	4	SS elective	3
HU Elective <sup>1</sup>	4	HU Elective <sup>1</sup>	2
Science Elective	4	Free elective <sup>4</sup>	1

	Plus 2 other computer science courses <sup>5</sup>	6
		<b>18</b>

Total Credits: 139

**Computer Science and Business - SAMPLE D**

Designed for students entering CSB after first-year in the Rossin College of Engineering and Applied Science. Ideally, students will take ECO 001 in freshman year. This sample is not compatible with the Lehigh in Prague Program; students interested in Prague need CSB 311 in spring of sophomore year as an overload.

**First Year**

First Semester	CR	Second Semester	CR
ENGL 001	3	ENGL 002	3
MATH 021	4	MATH 022	4
ENGR 005	2	ENGR 010 (or in fall term)	2
ENGR 010 (or in spring term)	2	Select one of the following	4-5
Select one of the following	4-5	CHM 030	4
CHM 030	4	PHY 011 & PHY 012	5
PHY 011 & PHY 012	5	CSB Required Courses	2
		CSE 002	2
		CBE Excel Competency Exam	0
	<b>24-25</b>		<b>26-27</b>

**Second Year**

First Semester	CR	Second Semester	CR
ACCT 151	3	ACCT 152	3
CSE 017	3	MATH 231 or ECO 045	3
ECO 001	4	CSE 261	3
ECO 029	3	CSE 109	4
Science Elective (must be PHY or CHM)	4	CSE 241 or 341	3
	<b>17</b>		<b>16</b>

**Third Year**

First Semester	CR	Second Semester	CR
CSE 216	3	CSB 311	3
CSE 262	3	CSB 312	3
ECO 146	3	CSE 202	3
FIN 125	3	CSE 340	3
MATH 205	3	LAW 201	3
MKT 111	3	SCM 186	3
	<b>18</b>		<b>18</b>

**Fourth Year**

First Semester	CR	Second Semester	CR
CSB 313	3	CSB Professional Elective	3
CSE 303	3	CSB Professional Elective	3
CSE 252	3	MGT 301	3
CSB Professional Elective	3	SS Elective	3
HU elective <sup>1</sup>	4	HU elective <sup>1</sup>	2
CSE elective (See Computer Science & Business Electives below)	3	Free elective	5
	<b>19</b>		<b>19</b>

Total Credits: 157-159

1 Note that most HU courses are 4 credits and the credits beyond the total of 6 needed contribute towards satisfying the free elective.

2 The ECO 045 alternative is not recommended for students targeting CS graduate study.

3 CSE 341 is a better choice for students targeting CS graduate study than CSE 241.

- 4 Free elective, but this covered by any HU credits beyond the 2 listed above.
- 5 400-level CSE courses not needed for an undergraduate program can be applied to a Lehigh graduate program via petition.

### Computer Science & Business Electives

In addition to the CSB electives, students are required to take one Computer Science course from the follow

CSE 271	Programming in C and the Unix Environment	3
CSE 302	Compiler Design	3
CSE 313	Computer Graphics	3
CSE 318	Introduction to the Theory of Computation	3
CSE 326	Pattern Recognition	3
CSE 327	Artificial Intelligence Theory and Practice	3
CSE 331	User Interface Systems and Techniques	3
CSE 334	Software System Security	3
CSE 335	Topics on Intelligent Decision Support Systems	3
CSE 336	Embedded Systems	3
CSE 342	Fundamentals of Internetworking	4
CSE 343	Network Security	3
CSE 345	WWW Search Engines	3
CSE 347	Data Mining	3
CSE 348	AI Game Programming	3
CSE 360	Introduction to Mobile Robotics	3
CSE 375	Principles of Practice of Parallel Computing	3

Or other courses as approved by the program co-directors

### Suggested Sequences of Natural Science Courses

The following is an incomplete list of course sequences that satisfy the requirement: "two courses are in a laboratory science with the first course prerequisite to the second course." The exact set of courses depends on what each science department offers each semester.

Any course used for the science requirement must have an "NS" designation in the catalog (and there are some CHM and BIOS courses that are not "NS" but rather "ND", meaning "not designated"). The sum of all the NS-designated science credits must be at least 12.

Special note regarding : EES lists the lab (EES 022) as the prerequisite for many of its 100-level courses. However to satisfy the prerequisite sequence requirement, one cannot take only EES 022 and a follow-on 100-level course. One must also take one of the 000-level courses associated with the EES 022 lab. This is specified in detail below. As an example, one might take EES 002 and EES 022 in one semester and EES 100 in a subsequent semester.

### Biology Sequence

CHM 030 & BIOS 041	Introduction to Chemical Principles and Biology Core I: Cellular and Molecular	7
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### Chemistry Sequences

CHM 030 & CHM 031	Introduction to Chemical Principles and Chemical Equilibria in Aqueous Systems	8
CHM 030 & CHM 110	Introduction to Chemical Principles and Organic Chemistry I (includes lab, CHM 111 optional 1-credit lab) <sup>1</sup>	7
CHM 030 & BIOS 041	Introduction to Chemical Principles and Biology Core I: Cellular and Molecular	7
CHM 040 & CHM 041	Concepts, Models and Experiments I and Concepts, Models and Experiments II (both courses include lab)	8

CHM 040 & CHM 110	Concepts, Models and Experiments I and Organic Chemistry I (includes lab, CHM 111 optional 1-credit lab) <sup>1</sup>	7
CHM 040 & BIOS 041	Concepts, Models and Experiments I and Biology Core I: Cellular and Molecular (includes lab)	7

### Physics Sequences

PHY 011 & PHY 021	Introductory Physics I and Introductory Physics II <sup>2</sup>	8
PHY 010 & PHY 013	General Physics I and General Physics II <sup>2</sup>	7

### Earth and Environmental Science Sequence

EES 022	Exploring Earth	1
Select one of the following:		
EES 002	Introduction to Environmental Science	3
EES 011	Environmental Geology	
EES 012	Glaciers and Glaciation	
EES 014	Lands of the Midnight Sun	
EES 015	Volcanoes and the Ring of Fire	
EES 016	Geology of War	
EES 021	Introduction to Planet Earth	
EES 023	Weather and Climate: Past, Present, and Future	
EES 024	Climate Change	
EES 025	The Environment and Living Systems	
EES 026	Energy – Origins, Impacts, and Options	
EES 027	Natural Hazards: Impacts and Consequences	
EES 028	Conservation and Biodiversity	
EES 031	Introduction to Environmental and Organismal Biology	
EES 032	Oceanography	
EES 089	Geographic Analysis of our Changing World	

Select one of the following:		
EES 100	Earth Systems Science	4
EES 115	Surficial Processes	
EES 131	Introduction to Rocks and Minerals	
EES 152	Ecology	

1 May also take optional 1-credit lab: CHM 111

2 May also take optional 1-credit lab: PHY 012

### Courses

#### CSB 311 Computer Applications in Business 3 Credits

Application of computer technology to business problems. Transaction processing systems that support the revenue, conversion, and expenditure cycles of manufacturing, service, and retail business organizations. Process modeling, data modeling, internal control, corporate IT governance, and IT auditing techniques. Prerequisites as noted below.

**Prerequisites:** ACCT 152 or ACCT 108 and CSE 017

**Can be taken Concurrently:** CSE 017

#### CSB 312 Design of Integrated Business Applications I 3 Credits

Integrated Product Development (IPD) Capstone Course I. Industry-based business information systems design project. Information systems design methodology, user needs analysis, project feasibility analysis of design alternatives, and integrated product development methodology. Formal oral and written presentations to clients. Prerequisites as noted below.

**Prerequisites:** CSB 311

**Can be taken Concurrently:** CSB 311

**CSB 313 Design of Integrated Business Applications II 3 Credits**

Integrated Product Development (IPD) Capstone Course II. This course extends the industry-based project initiated in CSB 312 into its implementation phase. Detailed design, in-house system construction and delivery, commercial software options, and systems maintenance and support. The practical component of the course is supplemented by several classroom-based modules dealing with topics that lie at the boundary of computer science and business. Formal, oral, and written presentations to clients. Prerequisites as noted below.

**Prerequisites:** CSB 312

**CSB 314 International Practicum 1-3 Credit**

A faculty led, foreign-based activity to provide students the opportunity to work on consulting, assurance, or other IT-related projects with business organizations, consulting companies, and public accounting firms. Typical projects: systems analysis and design, systems configuration and implementation, database design, user interface design, and internal control assessment. Students complete written reports and make formal presentations to client firms. Prerequisites as noted below or consent of instructor.

**Prerequisites:** (ACCT 311 or CSB 311)

**CSB 389 Honors Project 1-12 Credit**

**Global Citizenship**

**Global Citizenship Program**

David J. Fine, Interim Assistant Director  
 Christmas-Saucon Hall, B038, 14 East Packer Avenue, Bethlehem, PA 18015  
 Phone (610) 758-6650; email: djf207@lehigh.edu www.lehigh.edu/~ingc/

As the world becomes more interdependent in commerce, technology, and popular culture, people of different cultures must reconcile diametrically opposed views of fairness, equity, and conduct. Religious extremism, trade policies, human rights, and gender equity are but a few examples of controversies born out of belief systems colliding on the global stage. How will individuals from different national, religious, and cultural traditions understand their personal responsibilities in a world increasingly strained by resurging nationalism and the pressures of globalization?

Students planning any major can apply to join the Global Citizenship Program during the matriculation process prior to the beginning of the first year. The first-year experience in Global Citizenship includes a writing-intensive fall and spring course sequence, which replace English composition 1 and 2. During sophomore year, students receive a scholarship to travel abroad for 10-12 days as a group. In addition to the curricular elements of the program, students are required to take advantage of co-curricular opportunities like speaker programs, alternative spring break activities, and Lehigh's status as a United Nations non-governmental organization. The Certificate program in Global Citizenship is selective and will admit about 20-25 students in each entering class.

**Certificate in Global Citizenship**

**First Year**

Fall	CR Spring	CR
GCP 010	3 GCP 007 or ENGL 007	3
	<b>3</b>	<b>3</b>

**Second Year**

Fall	CR
GCP 085	1
Global Citizenship Intercession Trip (Winter Break)	0
	<b>1</b>

**Third Year**

Fall	CR
GCP 295 (Temporary number for Junior Practicum [Fall or Spring])	2
	<b>2</b>

**Fourth Year**

Fall	CR Spring	CR
GCP 385 (Fall and Spring)	2 GCP 385 (Fall and Spring)	2
	<b>2</b>	<b>2</b>

**Floating Requirements**

	CR
3 GC-designated electives	9-12
Second study abroad experience (min. 5 weeks long)	
<b>9-12</b>	

Total Credits: 22-25

**Study abroad in year 2 or 3**

The student may transfer credits back to Lehigh from the Study Abroad experience but credits are not required for the GC program. Acceptable Study Abroad experiences must be at least 5 weeks in length, take place in a non-English-speaking country, and include language instruction. Home-stay is encouraged. Students are encouraged to spend at least a semester abroad, but summer programs are acceptable.

**Courses**

**GCP 001 Introduction to Global Studies 4 Credits**

MTV/International. Islam. Yao. The UN. Global warming. Terrorism. McDonald's. Almost every aspect of human existence has been touched in some way by the dynamic of globalization. The historical and continuing integration of peoples, cultures, markets and nations, globalization may become the defining characteristic of the 21st Century. It has been a Janus-like force of two faces, with advantages and disadvantages, surfeit and suffering. In this emphatically interdisciplinary course, the foundation class for the Global Studies major and intended for freshmen and sophomores, students will be introduced to a variety of historical, critical and analytical perspectives, methods and vocabularies for continued study of globalization and social change.

**Attribute/Distribution:** SS

**GCP 002 Introduction to Environmental Science 3 Credits**

Focuses on natural and human-induced drivers and consequences of environmental change. Exploring options for mitigating and adapting to environmental change in ecosystems, physical and social systems, we will examine such topics as biogeochemical cycles, population pressure, ecosystem diversity, productivity and food security, energy, water resources, climate change, pollution, ozone, urban issues and sustainability. Stresses interactions and interrelationships, using a series of case studies.

**Attribute/Distribution:** NS

**GCP 003 Global Religion, Global Ethics 4 Credits**

Introduction to philosophical and religious modes of moral thinking, with attention given to ethical issues as they arise cross-culturally in and through religious traditions. The course will reference the United Nations Millennium Goals to consider family life and the role of women, social justice, the environment, and ethical ideals. Particular focus varies but may include one or more of the following: abortion and reproductive health, the death penalty, religiously motivated violence, and problems of personal disorder (heavy drinking, anorexia, vengeance). A Global Citizenship course.

**Attribute/Distribution:** HU

**GCP 006 Globalization and Cultures 4 Credits**

This course is a reflection on the processes of globalization and their consequences, both good and bad, on the world's societies and on our concepts of culture and identity. It provides a multidisciplinary examination of what cultures gain and lose from their interaction with the rest of the world and what it means to be a citizen of a globalized yet diverse world.

**Attribute/Distribution:** HU

**GCP 007 Global Literature 3 Credits**

This multidisciplinary seminar asks students to explore the notion of "global citizenship" by using the lens of literature, i.e., by applying rhetorical and persuasive techniques to address various issues. Literature from the country or region targeted by the intersession trip will be the object of the students' explorations. English 002 equivalent.

**Attribute/Distribution:** HU

**GCP 008 Ethics In Global Perspectives 4 Credits**

Examination of the moral perspectives of a variety of different ethical outlooks, including Euro-American, Hindu, Buddhist, Confucian, African, and Islamic traditions, and of serious moral problems arising from globalization, including the increasing gap between the rich so-called First World nations and the poor so-called Third World nations, global environmental degradation, war and terrorism.

**Attribute/Distribution:** HU

**GCP 010 Introduction to Global Citizenship 3 Credits**

A reflection on the multi-faceted notion of "global citizenship." What does it mean to be a "citizen"? Is there an irreconcilable divide between patriotism/nationalism and cosmopolitanism? Is it possible to cultivate contrasting allegiances (e.g., to one's community, one's country, the world)? How can we reconcile the sometimes conflicting calls of local action and global impact? English 001 equivalent.

**Attribute/Distribution:** SS

**GCP 012 Survey of Europe Since 1648 4 Credits**

The rise of modern nation states; the scientific and industrial revolutions; social movements and the French and Russian revolutions; impact of Enlightenment philosophy, nationalism, liberalism, imperialism and fascism; the development of modern class structure and transformations in gender relations, art, popular culture and society.

**Attribute/Distribution:** HU

**GCP 026 Energy – Origins, Impacts, and Options 3 Credits**

Critical assessment of current and predicted energy resources used by humans, including their origins, distribution, environmental impacts, and feasibility. Lectures, discussion, field trips. May be combined with EES 022 or EES 004 for 4 credits.

**Attribute/Distribution:** NS

**GCP 027 Natural Hazards: Impacts and Consequences 3 Credits**

Earthquakes, volcanoes, tsunamis, floods, and hurricanes are a natural part of the Earth and our environment. These events have violent consequences for our lives and significant economic implications. This course examines the causes, predictability, and risk mitigation for these events. We will also consider how natural disasters are represented by popular media and whether this helps or hurts public understanding of our dynamic planet and our relationship to it. May be combined with EES 022 or EES 004 for 4 credits.

**Attribute/Distribution:** NS

**GCP 060 Dramatic Action 4 Credits**

How plays are put together; how they work and what they accomplish. Examination of how plot, character, aural and visual elements of production combine to form a unified work across genre, styles and periods. Recommended as a foundation for further studies in design, literature, or performance.

**Attribute/Distribution:** HU

**GCP 073 Film, Fiction, and Gender in Modern China 4 Credits**

Study of the struggle for an individual "modern" identity out of traditionally defined roles for men and women as depicted by Chinese writers and filmmakers. Class, texts, and films in English. Students interested in setting up a corollary Chinese language component for credit as CHIN 251 may discuss this possibility with the professor.

**GCP 085 Practicum 1 Credit**

Preparation for sophomore Global Citizenship inter-session trip. Focus on the country of travel will include culture, politics, economics, art, religion, trade and technology. Taught by the faculty leader of the inter-session trip.

**GCP 089 Geographic Analysis of our Changing World 3 Credits**

This course will introduce students to maps, spatial data, and electronic tools for geographic analysis. Fundamental geographic and database concepts will include map types, spatial referencing systems, map projection systems, map scale, and database characteristics. Tools including ArcGIS Desktop software and Global Positioning System receivers will be used to acquire and analyze spatially referenced data sets drawn from diverse sources and disciplines relating to the environment. Students will use their new skills in geographic analysis to develop an electronic portfolio, including a question-based map project. This course will prepare students for more advanced geographic analysis within the arts, humanities, social sciences, natural sciences, or engineering. Lecture/demonstrations. May be combined with EES 022 or EES 004 for 4 credits.

**Attribute/Distribution:** NS

**GCP 100 Earth Systems Science 4 Credits**

Examination of the Earth as an integrated system. Study of interactions and feedbacks between key components such as the atmosphere, biosphere, geosphere, and hydrosphere to permit better understanding of the behavior of the system as a whole. Response of the Earth system to human perturbations such as land use and emissions are explored in the context of predictions of future environmental conditions and their projected impacts back on human systems. Lectures, class discussions, and lab. Prerequisites as noted below.

**Prerequisites:** (EES 022)

**Attribute/Distribution:** NS

**GCP 104 Themes in History 1-4 Credit**

Seminar on a particular theme or topic not covered by a currently listed offering.

**GCP 105 Social Origins of Terrorism 4 Credits**

Examines the social, religious, and political foundations of terrorism by studying the roots of terrorism historically and cross-nationally. We will look at the differing kinds of terrorism, including political terrorism in the Middle East, antiabortion terrorism in the United States, ecoterrorism, and religious and state terrorism throughout the world. Students will have a chance to better understand the beliefs of terrorists, conditions that produce and sustain terrorism, and the origins of political violence more generally.

**Attribute/Distribution:** SS

**GCP 111 Comparative Cultures 4 Credits**

Anthropology is a comparative discipline; through comparisons we learn what is unique to a particular culture, what is shared among a number of cultures, and how trait, idea, practice or belief are related to each other. Students will learn how anthropologists do comparisons and do their own comparative research utilizing both qualitative and quantitative techniques.

**GCP 120 Anthropology of Globalization 4 Credits**

Examines the relationship between local patterns of culture and the presumably homogenizing forces of globalization. Topics include migration, diaspora, and the politics of identity, the scope and effects of global capitalism and consumerism, tourism, popular culture, the global art market, and cultural authenticity.

**Prerequisites:** IR 010

**Attribute/Distribution:** SS

**GCP 121 Women in Art 4 Credits**

A history of women artists from Renaissance to present day, with an emphasis on artists of the 20th and 21st century from a global perspective. We explore attitudes toward women artists and their work as well as the changing role of women in art world. There may be required visits to museums and/or artists' studios.

**Attribute/Distribution:** HU

**GCP 126 The Political Economy of Globalization 4 Credits**

This course studies the relationship among economic, political and cultural forces in an era of globalization. Focus is on how global capitalism, the world market and local economics shape and are shaped by social, cultural and historical forces. Topics include political and cultural determinants of trade and investment; culture and the global economy; global capitalism, especially studied through the lens of culture; globalization and patterns of economic growth; cross-cultural study of consumerism; poverty and inequality; the interplay of foreign and domestic economic policy; international economic organizations, such as the World Trade Organization, the International Monetary Fund, and the World Bank, and globalization and national development.

**GCP 145 Islam and the Modern World 4 Credits**

Examines how numerous Muslim thinkers-religious scholars, modernists, and Islamists- have responded to the changes and challenges of the colonial and post-colonial eras. Special emphasis is placed on the public debates over Islamic authority and authenticity in contemporary South Asia.

**Attribute/Distribution:** HU

**GCP 148 Islam Across Cultures 4 Credits**

Explores the Muslim world's diversity and dynamism in multiple cultural contexts- from the Middle East and North Africa, to Asia and America- through literature, ethnography, and films. Topics include: travel and trade networks; education; women and gender; Islam and cultural pluralism; colonialism; and identity politics.

**Attribute/Distribution:** HU

**GCP 176 The Islamic Heritage of Turkey 6 Credits**

This month-long summer study travel program in Turkey explores the religion, politics and culture of Turkey, both past and present. A major frame for the course is Sufism (Islamic mysticism)- both its historical roots and contemporary expressions. Students will travel to a range of important historical sites, mosques, Sufi shrines and university campuses and engage local experts through a series of guest lectures.

**Attribute/Distribution:** HU

**GCP 231 New German Cinema 4 Credits**

Viewing, discussion, and written analysis of selected German films.

**Attribute/Distribution:** HU

**GCP 242 Geotechnical Engineering 3 Credits**

The principles related to analysis and evaluation of earthen infrastructure. Site characterization and in-situ testing of soils. Advanced stress-strain behavior, failure theories and stress path application. 2D fluid flow in porous media, flow nets, uplift forces, and liquefaction. Stability of earthen structures; slopes, dams and levees. Stability of retaining structures; lateral earth pressures. Introduction to shallow foundations; bearing capacity and settlement. Team project.

**GCP 244 Globalization and Religion 4 Credits**

This course examines the complexity of globalization and its multi-layered impact on religious identity and piety. Though comparative in methodology and historical framework, the class will give special attention to Islam and Hinduism in South Asia. Topics include: European colonialism; Orientalism and its legacy; religious nationalism; Islamophobia; and the Internet and mass media.

**Attribute/Distribution:** HU

**GCP 252 Computers, the Internet, and Society 3 Credits**

An interactive exploration of the current and future role of computers, the Internet, and related technologies in changing the standard of living, work environments, society and its ethical values. Privacy, security, depersonalization, responsibility, and professional ethics; the role of computer and Internet technologies in changing education, business modalities, collaboration mechanisms, and everyday life.

**GCP 303 Grimm's Fairy Tales: Folklore, Feminism, Film 1-4 Credit**

This intercultural history of the Grimms' fairy tales investigates how folktale types and gender stereotypes developed and became models for children and adults. The course covers the literary fairy tale in Germany as well as Europe and America. Versions of "Little Red Riding Hood", "Cinderella", or "Sleeping Beauty" exist not only in the Grimms' collection but in films and many forms of world literature. Modern authors have rewritten fairy tales in feminist ways, promoting social change. Taught in English. German language students may receive a German component.

**GCP 320 Global Capitalism 3-4 Credits**

Anthropological approach to the forms and effects of global capitalism. Topics include the structure of contemporary global capitalism, including the growth of multinational corporations, flexible corporate strategies, overseas manufacturing, and global branding and marketing; the impact of global capitalism on the environment and on the lives of people in "Third World" countries; consumer culture and the diversity of non-Western consumption practices; alternative capitalist systems, especially Asian capitalisms.

**Attribute/Distribution:** SS

**GCP 322 Global Health Issues 4 Credits**

Sociological dimensions of health, illness, and healing as they appear in different parts of the world. Focus on patterns of disease and mortality around the world, with special emphasis on major epidemics such as HIV/AIDS, and malaria; the relative importance of "traditional" and "modern" beliefs and practices with regard to disease and treatment in different societies; the organization of national health care systems in different countries; and the role of international organizations and social movements in promoting health.

**Attribute/Distribution:** SS

**GCP 325 Special Topics 4 Credits****GCP 334 Organizational Planning and Control 3 Credits**

Design of organization and procedures for managing functions of industrial engineering. Analysis and design of resources planning and control, including introduction of change in man-machine systems; manpower management and wage administration. Must have junior standing.

**GCP 385 Global Citizenship Capstone Course 2-4 Credits**

Students are required to complete a senior project and a paper that reflects on their personal concept of global citizenship as it relates to a specific topic in their individual disciplines. Students meet weekly in a seminar format to discuss their projects and peer review each other's work. Global Citizenship projects can be wrapped into other senior projects that are required for students' majors or programs. Seminar is taught by the Director of Global Citizenship, who will work closely with students and their faculty advisors.

**Repeat Status:** Course may be repeated.

**GCP 386 Chinese Culture in a Multinational Workplace 3 Credits**

Students explore the interaction between Chinese and non-Chinese cultures at a variety of work sites in the city of Shanghai, a port city that has involved people of many nationalities since its birth in the 1840s. This project-based course involves a faculty mentored practicum at one or more specific sites related to the student's own field or major, assigned readings, weekly electronic Course Site discussions, and a written summary of the experience. (H/S).

**IDEAS: Integrated Degree in Engineering, Arts and Sciences****IDEAS: Integrated Degree in Engineering, Arts and Sciences**

**Co-Directors:** Bruce Thomas, Associate Professor, College of Arts and Sciences; William Best, Professor of Practice, P.C. Rossin College of Engineering and Applied Science

IDEAS is a four-year honors program resulting in an integrated Bachelor of Science (BS) Degree—jointly administered by the College of Arts and Sciences and the P.C. Rossin College of Engineering and Applied Science.

Interdisciplinary education in the arts and sciences and engineering is of significant value to students who will pursue a wide variety of careers.

The complex challenges and problems confronting us in the 21st century dramatically underscore the importance of liberally educated and technologically sophisticated individuals whose habits of thought are thoroughly and comfortably interdisciplinary. Moreover, Lehigh is one of a small number of universities with the resources necessary to provide such an education. The students in this program will benefit from the integrated strategic leveraging of strengths across college boundaries.

This program cultivates a new breed of cross-disciplinary innovators. It provides an education that produces students well versed in dual focus areas; one in engineering and one in the arts, humanities, social sciences, mathematics or natural sciences. This educational environment also cultivates a multitude of thinking styles. It is renaissance thinking for the technological era.

#### Entry Requirements

1. Admitted students who have expressed an interest when applying will be considered for the IDEAS program. Only a limited number of students will be accepted. Students are invited to join this honors program by invitation.
2. To remain in the IDEAS program students must maintain a 3.25 GPA. At the end of the first year, a student with a GPA below 3.25 is given two semesters to achieve a GPA of 3.25; otherwise the student will be asked to transfer to a regular degree program.
3. Students may transfer into the IDEAS program at the end of their first semester or year if space becomes available. A formal application to the program must be filed and approval, from the co-directors, must be obtained.
4. Students who are interested in the IDEAS program should indicate that interest when applying and contact one of the co-directors.

The IDEAS program is designed so that students who transfer out of the program at the completion of the first year will still be able to complete an arts and sciences or engineering degree in four years. The four-year IDEAS program does not lead to an ABET accredited engineering degree. It is possible for students to complete a BS degree in IDEAS and an ABET accredited BS engineering degree (dual degrees) in one or two additional semesters.

#### Program Components

The IDEAS degree requires a minimum of 136 credits in the program components shown below:

##### IDEAS core <sup>1</sup>

IDEA 011	IDEAS Seminar I	2
IDEA 012	IDEAS Seminar II	2
IDEA 111	IDEAS Seminar III	2
IDEA 112	IDEAS Seminar IV	2
IDEA 150	IDEAS Seminar V	1
IDEA 151	IDEAS Seminar VI	1
IDEA 250	IDEAS Seminar VII	1
IDEA 251	IDEAS Seminar VIII	1

##### Math/Science core <sup>2</sup>

MATH 021	Calculus I	4
MATH 022	Calculus II	4
MATH 023	Calculus III	4
MATH 205	Linear Methods	3
CHM 030	Introduction to Chemical Principles	4
PHY 011 & PHY 012	Introductory Physics I and Introductory Physics Laboratory I	5
Select three of the following:		12
BIOS 041 & BIOS 042	Biology Core I: Cellular and Molecular and Biology Core I: Cellular and Molecular Lab	
CHM 110 & CHM 111	Organic Chemistry I and Organic Chemistry Laboratory I	4
EES gateway courses		

PHY 021  
& PHY 022

Introductory Physics II  
and Introductory Physics Laboratory  
II

MATH 231

Probability and Statistics

##### Engineering concentration <sup>3</sup>

Specified by the college 36

##### Arts & Science concentration <sup>4</sup>

Specified by the college 36

##### A&S distribution requirements <sup>5</sup>

As defined by the college 16

Total Credits 140

1. The writing intensive IDEAS core courses consist of a first year course in which students develop their interests, two stepping-stone courses in the middle years where their interests are integrated with others and a senior thesis course in the fourth year.
2. The math/science core consists of 24 credits of required courses (see table above) plus 12 elective credits drawn from: BIOS 041, BIOS 042; CHM 110, CHM 111; EES gateway courses; PHY 021, PHY 022; MATH 231. All students in the IDEAS program will automatically fulfill the CAS math and natural science distribution requirements.
3. The engineering concentration consists of a selection of engineering courses drawn either from one of the traditional engineering disciplines or from an approved interdisciplinary engineering program. Some engineering programs are designed to coordinate with specific arts and sciences themes.
4. The arts and sciences concentration is either a curriculum specific one or an interdisciplinary one such as Science, Technology and Society (STS).
5. The elective block may be used for a minor, another program, or to fulfill CAS distribution requirements.

#### Curriculum Details

Additional details on the main curricular components of the program include:

1. IDEAS Core Courses: One each semester.
  - a. These courses replace ENGR 005, ENGL 001 & ENGL 002, the CAS college seminar, and the CAS junior year writing intensive requirement. All IDEAS core courses are writing intensive.
  - b. IDEA 011 and IDEA 012: the first year IDEAS core courses will emphasize intensive faculty mentoring within a small seminar environment where students develop, write, and present their individual interest areas and select their concentrations.
  - c. IDEA 111 and IDEA 112: a continuation of IDEA 011 & IDEA 112 where interest areas are integrated into themes as individual concentrations are pursued.
  - d. IDEA 150 and IDEA 151: the junior year courses have students working on team-based projects and preparing for the senior year thesis work.
  - e. IDEA 250 and IDEA 251: the senior year honors thesis courses.
2. Math/Science Core: All students are required to fulfill the 36 credit math/science requirement, regardless of their choice of concentrations.
3. Engineering Majors: Engineering majors are divided into two different categories:
  - a. Interdisciplinary Theme: an approved interdisciplinary theme in engineering that can be coordinated with a liberal arts concentration.
  - b. Engineering Discipline: a defined engineering discipline, e.g., mechanical engineering. Students will follow a concentration in the curriculum defined by the chosen area.
4. Arts and Sciences Majors: A&S majors are divided into two different categories:
  - a. Interdisciplinary Theme: an approved interdisciplinary theme (e.g. STS) in arts and sciences that can be coordinated with an engineering concentration.
  - b. Liberal Arts Discipline: a defined liberal arts discipline, e.g., English. Students will follow the curriculum defined by the chosen concentration.



A minimum of 36 credits is required in the liberal arts concentration. If students choose a concentration that requires fewer than 36 credits, in addition to those taken as part of the math/science core, the additional credits must be selected in the CAS.

Students may select mathematics or science as the liberal arts discipline. However, the humanities and social science distribution requirement (8 credits of humanities and 8 credits of social science) must be satisfied using the 16 credit elective core which is also be accepted for distribution in the RCEAS.

5. Interdisciplinary Theme: an approved interdisciplinary theme (e.g. STS) in arts and sciences that can be coordinated with an engineering concentration.
6. Liberal Arts Discipline: a defined liberal arts discipline, e.g., English. Students will follow the curriculum defined by the chosen concentration.
  - a. A minimum of 36 credits is required in the liberal arts concentration. If students choose a concentration that requires fewer than 36 credits, in addition to those taken as part of the math/science core, the additional credits must be selected in the CAS.
  - b. Students may select mathematics or science as the liberal arts discipline. However, the humanities and social science distribution requirement (8 credits of humanities and 8 credits of social science) must be satisfied using the 16 credit elective core which is also be accepted for distribution in the RCEAS.
7. Combining the Engineering and Liberal Arts Concentrations: You may combine your particular interests in engineering and in arts and sciences and customize your academic experience at Lehigh in one of the following ways:
  - a. by combining an Engineering Discipline with an Arts and Sciences Discipline (e.g., Electrical Engineering and International Relations)
  - b. by combining an Engineering Discipline with an Arts and Sciences Theme (e.g., Chemical Engineering and STS)
  - c. by combining an Engineering Theme with an Arts and Sciences Discipline (e.g., Product Liability and Chemistry)
  - d. or custom design your own combination between Engineering and Arts and Sciences with your advisors

#### Academic Advising

1. The program is jointly administered by co-directors from the College of Arts and Sciences and the P.C. Rossin College of Engineering and Applied Science. They, after the first year, become the secondary academic advisors for all IDEAS students.
2. Primary faculty advisors from appropriate disciplines provide quality curriculum advising in each of the student's chosen concentrations. Careful advising is required because of the greater flexibility of IDEAS.
3. Students who wish to earn an accredited engineering degree in one additional year should inform their advisors.

For general information visit the IDEAS web site at: [www.lehigh.edu/IDEAS](http://www.lehigh.edu/IDEAS)

#### Courses

##### IDEA 011 IDEAS Seminar I 2 Credits

The first year IDEAS core courses will emphasize intensive faculty mentoring within a small seminar environment where students develop, write, and present their individual interest areas and select their concentrations.

##### IDEA 012 IDEAS Seminar II 2 Credits

The first year IDEAS core courses will emphasize intensive faculty mentoring within a small seminar environment where students develop, write, and present their individual interest areas and select their concentrations.

##### IDEA 111 IDEAS Seminar III 2 Credits

A continuation of IDEAS 11 & 12 where interest areas are integrated into themes as individual concentrations are pursued.

##### IDEA 112 IDEAS Seminar IV 2 Credits

A continuation of IDEAS 11 & 12 where interest areas are integrated into themes as individual concentrations are pursued.

##### IDEA 150 IDEAS Seminar V 1 Credit

The junior year courses have students working on team-based projects and preparing for the senior year thesis work.

##### IDEA 151 IDEAS Seminar VI 1 Credit

The junior year courses have students working on team-based projects and preparing for the senior year thesis work.

##### IDEA 250 IDEAS Seminar VII 1 Credit

The senior year honors thesis courses.

##### IDEA 251 IDEAS Seminar VIII 1 Credit

The senior year honors thesis courses.

### Integrated Business and Engineering Honors Program

#### Integrated Business and Engineering Honors Program

The Integrated Business and Engineering Program (IBE) is offered jointly by the College of Business and Economics and the P. C. Rossin College of Engineering and Applied Science. The mission of the Integrated Business and Engineering Honors program is to produce graduates with a unique set of skills and competencies: In addition to the mastery of the concepts and procedures taught in individual courses in each college, the IBE Honors Program develops competencies that require an integrated knowledge from both engineering and business. This program recognizes the need for today's leaders in business and industry to have a sound foundation in both commerce and technology.

After four years and a minimum of 137 credits, students will receive a single Bachelor of Science Degree in Business and Engineering. The program meets the accreditation standards of AACSB International. Students are required to maintain a minimum GPA of 3.25 in order to remain in the program.

Students in the IBE Honors Program can major in any area of business or engineering that Lehigh offers. After freshman year, each student will elect a major in either the College of Business and Economics or the P. C. Rossin College of Engineering and Applied Science. Students wanting to major in an area of business can select from: accounting, business information systems, economics, finance, marketing, management or supply chain management.

Admission to the Integrated Business and Engineering Honors Program is highly selective, with annual admission limited to approximately 50 students. The University's Office of Admissions (610-758-3100) can explain the procedure for applying to the program.

It is possible that a small number of exceptional students may be admitted to the program following the completion of their freshman year. Admission at this point would be highly competitive and based upon freshman year GPA, faculty recommendations, and space availability.

The co-directors of the IBE Honors Program are Stephen G. Buell, Professor of Finance ([steve@lehigh.edu](mailto:steve@lehigh.edu)) and Robert H. Storer, Professor of Industrial and Manufacturing Systems Engineering ([rhs2@lehigh.edu](mailto:rhs2@lehigh.edu)). For additional information, visit the IBE web site at [www.lehigh.edu/ibe](http://www.lehigh.edu/ibe).

#### Courses

##### IBE 010 Integrated Business and Engineering Freshman Seminar 1 Credit

Introduction to the various business and engineering professions through a series of presentations and demonstrations offered by faculty and business and industry leaders. Emphasis is on the diversity of business and engineering career opportunities and the associated curricular choices. Other topics include leadership, team building and career planning. Students are required to create their web page and post their four-year curriculum plan and an updated resume. Open only to first-year students in the Integrated Business and Engineering Honors Program.

**IBE 050 Integrated Business and Engineering Freshman Workshop  
3 Credits**

Introduction to how business and engineering activities create value with a focus on innovation, design and the business value chain. Introduction to analytical tools, modeling and simulation techniques used in business and engineering applications. By taking apart products and the companies that make them, students develop skills in such areas as competitive strategy, marketing mix, financial modeling, organization of the supply chain, virtual (computer) modeling, engineering drawing, development of technical specifications, testing and measurement. Open only to students in the Integrated Business and Engineering Honors Program.

**IBE 150 Integrated Business and Engineering Sophomore  
Laboratory 1 Credit**

A series of cases that integrate elements of business and engineering. Example topics include, but are not limited to, introduction to cost benefit analysis, introduction to modeling and optimization, team dynamics, and international negotiation and joint ventures. Oral presentations and written reports. Open only to students in the Integrated Business and Engineering Honors Program.

**IBE 171 Integrated Business and Engineering Independent Study 1  
Credit**

Students address a technical issue in a business context from an entrepreneurial focus. Students pursue their own business start-up idea, either a product or a service, and develop a business plan that includes prototypes and testing (engineering) as well as a marketing plan and a base case financial model (business). The goal of the course is for students to enter a business plan or entrepreneurial competition in a local, regional or national level. Open only to students in the Integrated Business and Engineering Honors Program. Prerequisites as noted below.

**Prerequisites:** IBE 050

**IBE 250 Integrated Business and Engineering Junior Laboratory 1  
Credit**

A semester-long simulation game in which interdisciplinary teams of IBE students compete against each other. Topics include market analysis, working capital management, capital budgeting, raising long-term capital, plant location, and inventory control. Oral presentations and written reports. Open only to students in the Integrated Business and Engineering Honors Program.

**IBE 271 Independent Study 1 Credit****IBE 380 Integrated Business and Engineering Capstone Project I 3  
Credits**

IBE students work in cross-disciplinary teams of 5 to 6 business and engineering majors with a faculty mentor on the marketing, financial and economic planning, and technical and economic feasibility of actual new product concepts initiated by the course's corporate sponsors. These sponsors are incubator start-up firms to ensure that the projects have both business and engineering elements. Written reports and oral presentations to sponsors and invited venture capitalists are required. Open only to students in the Integrated Business and Engineering Honors Program.

**IBE 385 Integrated Business and Engineering Capstone Project II 3  
Credits**

IBE students continue to work with the detailed design including the fabrication and testing of working prototypes of their new products designed in IBE Capstone Project I course. In addition to the technical design of the products, detailed financial and marketing plans are required. Written reports and oral presentations to sponsors and invited venture capitalists are required. Open only to students in the Integrated Business and Engineering Honors Program.

**Military Science**

The Department of Military Science, established in 1919, conducts the Army Reserve Officers Training Corps (ROTC) program at Lehigh University. This is one of the oldest ROTC programs in the nation. The Army ROTC program provides a means for students to qualify for a commission as an officer in the Active Army, Army Reserve, or Army National Guard.

MIL 101 Adaptive Team Leadership I The objectives of the military science program are to develop leadership and management ability in each student; to provide a basic understanding of the Army's history, philosophy, organization, responsibilities, and role in American society; and to develop fundamental professional knowledge and skills associated with officership. These objectives are achieved through classroom instruction, leadership laboratories, realistic training scenarios, exposure to Army doctrine, professional development, leadership simulations, and individual assessment and counseling. Army ROTC offers a four-year program and a two-year program. The four-year program consists of a two-year basic course and a two-year advanced course. The two-year program consists of the two-year advanced course offered to students with previous military experience, and those who have successfully completed the four-week ROTC Leaders Training Course. Basic course students incur no obligation for service in the Army as a result of taking these courses.

**Basic Course**

The basic course, normally taken in the freshman and sophomore years, provides training and instruction in leadership, public speaking, and basic military subjects, such as the Army's role and organizational structure, history and philosophy of the Army, basic tactics, land navigation, first aid, group dynamics, and leadership traits and characteristics. Basic course students incur no military obligation.

**Advanced Course**

The advanced course is normally taken in the junior and senior years. The instruction includes management, military skills, advanced leadership and tactics, logistics, administration, military law, ethics, and professionalism, and includes attendance at the ROTC Leadership Development and Assessment Course (LDAC). Students receive \$450 per month subsistence pay during the junior year and \$500 per month in their senior year.

To enroll in the advanced course, an applicant must complete either the basic course or the four-week Leaders Training Course; or has received basic course credit for previous military experience.

Note: The Advanced course (300 and 400 level) is a requirement for Scholarship and contracted cadets only and is not offered to participating students.

**Uniforms and Equipment**

Uniforms are provided to contracted and scholarship cadets only. In the event of lost equipment or uniforms, students will be charged for those items not returned upon leaving the program.

**Transfers**

Qualified students transferring from another institution may enter the ROTC program at the appropriate level and year, provided they have received the necessary credits, the recommendation of their former professor of military science (if applicable), and the approval of the university. Please contact the ROTC office for details.

**Obligation after Graduation**

Upon graduation, a student will receive a commission as a Second Lieutenant in either the Active Army, Army Reserves, or National Guard. If offered active duty, scholarship students serve four years of active duty and four years of inactive ready reserve. If offered reserve duty, students normally serve eight years in a Reserve or National Guard unit.

**Graduate Studies**

ROTC graduates may request to delay their active service to pursue a full-time course of instruction leading to an advanced degree. The only four major areas of concentration are medical school, law school, veterinary school and seminary. Delay does not lengthen the active service obligation unless the degree is obtained at government expense.

**Course Credit**

Students in the College of Arts and Sciences and the College of Business and Economics may substitute military science advanced credits for six hours of electives. In the College of Engineering and Applied Science, six credits of advanced ROTC work are permissible within the normal program of each student, irrespective of curriculum. For curricula that include more than six hours of personal electives in the junior and senior years, inclusion of the more than six hours of ROTC credit with normal programs can be effected only with the approval of

academic advisers. All military science credits, including those in the basic course, apply toward the student's overall cumulative grade point average.

#### Career Opportunities

Individuals are commissioned as officers in the United States Army after completion of the ROTC program including LDAC, and the completion of their bachelors degree requirements. They then qualify in one of sixteen branches (specialties) such as the Corps of Engineers, Infantry, Armor, Aviation, Field Artillery, Air Defense Artillery, Signal Corps, Military Intelligence, Chemical Corps, Ordnance Corps, Finance, Transportation, Military Police, Adjutant General, Quartermaster, Medical Service Corps, or Nursing. Officers work as leaders/managers, specialists, or combinations of the two depending on the assignment.

#### Programs and Opportunities

##### ROTC Scholarship Program

This program is designed to offer financial assistance to outstanding young men and women entering the ROTC program who are interested in an Army career. Scholarships provide full annual tuition, a textbook and supplies allowance, and laboratory fees; in addition to pay up to \$500 per month for the period the scholarship is in effect. Three-year and two-year scholarships may be available to outstanding cadets who are currently enrolled in the ROTC program and are completing their freshman or sophomore year of college. This program is also open to all qualified students who are not currently enrolled in Army ROTC.

Four-year scholarships are open to all students entering ROTC as freshmen. Applications for scholarship must be made to Headquarters, U.S. Army Cadet Command, Fort Monroe, VA by July 15th prior to the high school senior year for early selection, but no later than November 15th for normal application. You may apply on line at [www.goarmy.com](http://www.goarmy.com) (<http://www.goarmy.com>) and follow the appropriate links. Application booklets are also available from most high school guidance offices, or may be obtained from the military science department.

##### Two-Year Program

Students who want to enroll in ROTC after their sophomore year may apply. Applicants must successfully complete a four-week Leaders Training Course (LTC) and have two years of undergraduate or graduate studies remaining. The student is paid for the four-week encampment and receives transportation costs to and from the camp. Additional scholarships may be available at this camp.

##### Physical Facilities

Army ROTC uses areas on and adjacent to the university campus to conduct field training. These locations are excellent for most outdoor activities such as orienteering, patrolling, and survival training. Fort Indiantown Gap Military Reservation, located east of Harrisburg, Pa., and Fort Dix, NJ, located east of Philadelphia, Pa., are used for various weekend field exercises which allow cadets to apply the classroom leadership and Army doctrine in a training environment.

##### Off-campus U.S. Army Training Schools

Cadets may be selected to attend the following U.S. Army Schools: Airborne School (Fort Benning, Georgia), Air Assault School (Fort Campbell, Kentucky), Mountain Warfare School (Ethan Allen Training Center, Vermont), and Northern Warfare School (Fort Greely, Alaska) Combat Diver Qualification Course (Key West, Florida), Sapper Leader Course (Ft. Leonardwood, MO). This off-campus program is fully funded by the U.S. Army. Many other installations throughout the world may be visited through the Cadet Troop Leader Training program. Nursing students may choose to attend the Nurse Summer Training Program at Army hospitals located throughout the United States.

##### Minor in Military Science

A minor in military science is available in the College of Arts and Sciences. A minor in military science consists of a minimum of 28 credit hours beyond the basic Military Science course and is designed to provide the student with an academic foundation necessary to support continued intellectual growth and stimulate future inquiry in the realm of civil military affairs and military science. Credit hours required are distributed as follows:

#### Military Science

MIL 101	Adaptive Team Leadership I	3
MIL 102	Adaptive Team Leadership II	3
MIL 113	Developing Adaptive Leaders	3
MIL 114	Leadership in a Complex World	3
HIST 110	American Military History	4

#### International Relations

Select one course		3-4
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#### Written Communications

Select one course from one of the following categories:		3
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Creative Writing

Scientific Writing

Writing for Mass Communications

English Composition

#### Human Behavior

Select one course from one of the following categories:		3
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General Psychology

Sociology

Anthropology

Ethics

#### Computer Literacy

Select one course		3
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Total Credits		28-29
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#### Commissioning Requirements

Individuals must complete either the two- or four-year programs, attend LDAC, receive a college degree, have a cumulative GPA of 2.0, and complete all professional military education requirements to become commissioned officers in the United States Army.

#### Course Descriptions

Leadership Laboratory is conducted for all students once a week for 60 to 90 minutes. The Leadership Laboratory provides a forum for cadets to exercise their leadership skills amongst their peers.

Instruction at several levels on a variety of subjects with military application provides the context within which students are furnished opportunities to both teach and lead in a group setting. Responsibility is expanded as the student progresses through the program. In the senior year, the students assume the responsibility for the planning, preparation and conduct of the laboratory. Leadership Laboratory is mandatory for all students enrolled in military science courses.

#### Leadership Development and Assessment Course (LDAC)

This is a four-week training program normally conducted at Fort Lewis, WA. Prerequisites are:

1. The completion of the basic 100 and 200 level military science courses or the equivalent which is the completion of the Leadership Training Camp.
2. Scholarship/contracted cadets must have completed all level courses up to and including the 300 level military science courses.

#### Courses

##### MIL 015 Foundations Of Officership 1 Credit

The American Army as an institution, its roots, history, customs and traditions and philosophy of leadership. Emphasis on development and role of a professional officer corps. Includes leadership laboratory.

##### MIL 016 Basic Leadership 1 Credit

Role of individual and leader within the group, leadership skills and characteristics. Emphasis on problem solving and application. Includes laboratory and FTX.

##### MIL 023 Individual Leadership Studies 2 Credits

Maps as tools in basic terrain analysis and as navigational aids and introduction to small unit tactics. Emphasis on application and field exercises at individual and small group levels. Includes leadership laboratory and FTX.

**MIL 024 Leadership and Teamwork 2 Credits**

Contemporary theories, traits and principles and small unit tactics development. Leadership philosophies, communications, leader-follower relationships, and leadership problem-solving. Leadership simulations. Includes leadership laboratory and FTX.

**MIL 101 Adaptive Team Leadership I 3 Credits**

Essential junior officer skills: advanced land navigation, principles of war, small unit tactical planning, tactics and techniques of the soldier, team leading techniques, oral communications and trainer skills. Emphasizes application and field experience. Includes leadership laboratory and FTX. Consent of department chair required.

**MIL 102 Adaptive Team Leadership II 3 Credits**

Critical examination of leadership qualities, traits and principles with emphasis on military environment. Self, peer, and instructor leadership evaluation. Advanced military skills reinforced. Includes leadership laboratory and FTX. Consent of department chair required.

**MIL 113 Developing Adaptive Leaders 3 Credits**

Role, authority and responsibility of military commanders and staff in personnel, logistics and training management. Staff procedures, problem solving, training methods and oral and written communications skills used in military organizations. Includes leadership laboratory and FTX. Consent of department chair required.

**MIL 114 Leadership in a Complex World 3 Credits**

Development of the Profession of Arms, its fundamental values and institutions. Ethical responsibilities of military professionals in contemporary American society. Just war theory, international law of war, and American military law. Also covered are current topics to assist cadets in making the transition to the officer corps and service on active duty or in the reserve forces. Includes leadership laboratory and FTX. Consent of department chair required.

**MIL 118 Special Topics for Army Officer 1 Credit****MIL 300 Apprentice Teaching 3 Credits****Interdisciplinary Graduate Study and Research**

In addition to offering graduate degrees within academic departments, Lehigh University offers interdisciplinary graduate degrees in the fields of American studies, analytical finance, business administration and educational leadership, business administration and engineering, energy systems engineering, environment policy design, manufacturing systems engineering, photonics, polymer science and engineering, and technical entrepreneurship.

Lehigh University also offers graduate certificate programs in certain specialized fields of study. Graduate certificates consist of a minimum of twelve credits, at least six of which must be at the 400-level. Such certificates are specific to Lehigh and do not constitute official certification, as might be required to be employed professionally. Students are admitted to certificate programs in the same way as to degree programs. More specific information on admission criteria and completion requirements are available from certificate program administrators.

In addition, Lehigh's interdisciplinary research centers and institutes address the research needs of government, industry, and society. Organized to recognize research efforts in interdisciplinary problem areas, they supplement the university's academic departments. Graduate students pursuing M.S. and Ph.D. degrees in academic departments, as well as students enrolled in interdisciplinary degree programs, may pursue research opportunities in the various centers.

A complete listing of research centers, institutes, and other research organizations appears following the section on interdisciplinary graduate programs.

**Financial Assistance**

Teaching assistantships and fellowships are provided by individual academic departments, while research assistantships are available through both academic departments and research centers. Students interested in research are encouraged to seek appointments with members of the faculty working in their areas of special interest, with department chairpersons, or with center or institute directors.

**American Studies****American Studies**

A interdisciplinary Master of Arts degree in American Studies is offered by a variety of departments in the humanities and social sciences across the College of Arts and Sciences. Candidates for the master's degree must complete at least 30 credit hours. In addition to an introductory Theory and Methods course that all incoming students take in their first fall semester, students take two humanities and two social science courses, along with three additional courses of their choosing. Students also take six thesis credits to fulfill the MA thesis requirement. The final thesis can take the form of a long work of scholarship, two shorter papers, or a documentary film.

For more information visit **American Studies**.

**Analytical Finance****Analytical Finance**

This program provides students with a strong education in advanced finance and quantitative financial analysis tools to develop graduates who can create innovative solutions for real financial problems, using state of the art analytical techniques and computing technology. Students with undergraduate degrees in computer science, economics, engineering, finance, mathematics and the hard sciences should have the quantitative background needed for success in this field.

This program equips students with the necessary skill set to prepare for the Financial Risk Manager® exam offered by GARP, the Global Association of Risk Professionals. (<http://www.garp.org>)

**Prerequisites**

Applicants must show basic competency in the following areas: finance, corporate finance, investments, financial accounting, economics, money and banking, statistics, linear algebra, and calculus. These courses will not count toward the master degree.

**Entrance Prerequisites**

(Examples given from Lehigh courses)

Must show basic competency in the following areas: (Does not count towards the 30 credit minimum degree requirement)

**Corporate Finance**

FIN 328	Corporate Financial Policy (OR)	3
GBUS 419	Financial Management	3
Equivalent course		

**Investments**

FIN 323	Investments (OR)	3
GBUS 420	Investments	3
Equivalent course		

**Financial Accounting**

ACCT 151	Introduction to Financial Accounting (OR)	3
ACCT 108	Fundamentals of Accounting (OR)	3
GBUS 401	Financial Reporting for Managers and Investors	3
Equivalent accounting course		

**Statistics and Probability**

MATH 231	Probability and Statistics (OR)	3
IE 328	Engineering Statistics	3
Equivalent introductory calculus based statistics and probability course		

**Calculus Series**

MATH 021	Calculus I (AND)	4
MATH 022	Calculus II (AND)	4
MATH 023	Calculus III	4
Equivalent calculus series		

**Linear Algebra**

MATH 205	Linear Methods (OR)	3
MATH 242	Linear Algebra	3-4
Equivalent course		

Note: Entrance prerequisites at Lehigh typically have several prerequisites that must be fulfilled.

Note: Prerequisites do not have to be taken at Lehigh University.

Note: ECO 045 or an equivalent introductory course including regression analysis is not rigorous enough preparation for Math 467 and therefore is not adequate for the Statistics and Probability prerequisite.

#### Required Courses

The 30 credit hour program is a joint venture of the College of Business and Economics, the P.C. Rossin College of Engineering and Applied Science and the College of Arts & Sciences. Required courses are as follows:

#### Analytical Core

MATH 467	Financial Calculus I (fall)	3
MATH 468	Financial Calculus II (spring)	3
Select one of the following Statistics courses:		3

STAT 410	Random Processes and Applications (fall)	
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STAT 412	Statistical Computing and Applications	
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Select one of the following computation modeling courses:		3
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ECO 415	Econometrics I (fall)	
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STAT 438	Linear Models In Statistics with Applications (spring)	
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Select one of the following Industrial Engineering courses:		3
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IE 426	Optimization Models and Applications (fall)	
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IE 429	Stochastic Models and Applications	
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#### Finance Core

GBUS 421	Advanced Investments (Fixed Income - spring)	3
GBUS 422	Derivatives and Risk Management (fall)	3
GBUS 424	Advanced Topics in Financial Management (Risk Management - spring)	3

#### Computing Core

IE 447	Financial Optimization	3
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#### Capstone Practicum

IE 441	Financial Engineering Projects (fall/spring)	3
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Total Credits		30
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Note: Students with equivalent courses from an undergraduate degree program will be given credit for fulfilling the field requirement and will be permitted to replace the credits from the list of approved electives. The program director(s) must approve courses for each student's choice of electives. Typically, a finance elective will be used to substitute for a finance course waiver; a computational elective to substitute for a statistics/econometric course, and programming elective for a computing course.

#### Admissions

Students may apply through the Graduate Programs Office in the College of Business & Economics or through the Graduate Office of the P. C. Rossin College of Engineering and Applied Science in the Department of Industrial and Systems Engineering. Students must take either the GRE or GMAT. International students must have 16 years of schooling with four years at the University level to be considered for admission. Applicants whose native language is not English are required to take the Test of English as a Foreign Language (TOEFL). Deadline for international students to apply is February 1. U.S. Citizens may apply until July 15.

Further information about the M.S. in Analytical Finance Program may be obtained by visiting <http://www4.lehigh.edu/business/academics/graduate/finance/default.aspx>, contacting the Graduate Programs Office

of the College of Business and Economics or one of the following Co-Directors:

Dr. Richard Kish, Perella Department of Finance, College of Business and Economics, Lehigh University, 621 Taylor Street, Bethlehem, PA 18015, phone (610) 758-4205, email: [rjk7@lehigh.edu](mailto:rjk7@lehigh.edu)

Dr. Vladimir Dobric, Department of Mathematics, Lehigh University, 14 E. Packer Avenue, Bethlehem, PA 18015, phone (610) 758-3734, email: [vd00@lehigh.edu](mailto:vd00@lehigh.edu)

Dr. Aurelie Thiele, Department of Industrial and Systems Engineering, Lehigh University, 200 W. Packer Avenue, Bethlehem, PA 18015, phone (610) 758-2903, email: [aut204@lehigh.edu](mailto:aut204@lehigh.edu)

## Environmental Policy Design

### Environmental Policy Design

The M.A. in Environmental Policy Design trains scholars and practitioners alike for the demanding task of designing environmental policy that can protect or restore an increasingly degraded natural environment while sustaining the benefits of economic growth and providing for the needs of an ever-more-vulnerable (and growing) human population. Achieving this goal will require policy professionals to understand and analyze environmental problems amidst multiple systems and levels of law and in the context of rapidly globalizing governance structures, institutions, and regimes that cut across geographical and political boundaries.

For more information visit [Environmental Initiative](#)

## Graduate Certificates in Arts and Sciences

### Certificate in Cognitive Science

(For details see "Cognitive Science (p. 108)")

### Certificate in Documentary Film

(For details see "American Studies (p. 63)")

### Certificate in Environmental Law and Policy

(For details see "Environmental Initiative (p. 131)")

### Certificate in Stereotypes, Prejudice, Discrimination, and Intergroup Relation

(For details see "Psychology (p. 208)")

### Certificate in Regulatory Affairs in a Technical Environment

(for details see distance education ([http://www.distance.lehigh.edu/credit/cert\\_regulatory\\_affairs.htm](http://www.distance.lehigh.edu/credit/cert_regulatory_affairs.htm)))

### Certificate in Analytical Principles of Pharmaceutical Science

(for details see distance education ([http://www.distance.lehigh.edu/credit/cert\\_analytical\\_principles.htm](http://www.distance.lehigh.edu/credit/cert_analytical_principles.htm)))

### Certificate in Bioorganic Principles of Pharmaceutical Science

(for details see distance education ([http://www.distance.lehigh.edu/credit/cert\\_bioOrganic.htm](http://www.distance.lehigh.edu/credit/cert_bioOrganic.htm)))

### Certificate in Women, Gender and Sexuality Studies

(For details see "Women, Gender and Sexuality Studies (p. 239)")

### Certificate in Nanotechnology

(for details see materials science and engineering (<http://www.lehigh.edu/~inmatsci/graduate/certificate.htm>)):

## Graduate Certificates in Engineering

### Certificate in Nanotechnology

(For details see materials science and engineering (<http://www.lehigh.edu/~inmatsci/graduate/certificate.htm>))

### Certificate in Manufacturing Systems Engineering

(For details see manufacturing systems engineering (<http://www.lehigh.edu/~inmse/nondegree.shtml>))

### Certificate in Polymer Science & Engineering

(For details see materials science and engineering (<http://www.lehigh.edu/~inmatsci/graduate/certificate.htm>))

**Certificate in Quality Engineering**

(For details see industrial and systems engineering ([http://www.lehigh.edu/~inime/programcourses\\_m.html#msqe](http://www.lehigh.edu/~inime/programcourses_m.html#msqe)))

**Manufacturing Systems Engineering**

**Program director.** Keith M. Gardiner, Ph.D. (Manchester, England), professor of industrial and systems engineering.

The manufacturing systems engineering program develops engineers who can design, install, operate, and modify systems involving materials, processes, equipment, facilities, logistics and people using leading edge technologies. It integrates systems perspectives with interdisciplinary course offerings from Lehigh's colleges of engineering and applied science, and business and economics.

Complete requirements are listed under Interdisciplinary Graduate Study and Research.

**Courses****MSE 356 Micromanufacturing Systems & Technologies 3 Credits**

Manufacturing engineering in microelectronics, microelectromechanical, nano-, opto- and micro-scale manufacturing. Examination of systems design, equipment, process and operational issues and linkages to business strategies. Crystal growth, thin film deposition processes and patterning, removal processes, vacuum engineering, contamination control, clean room practices etc. Individual research assignments. Note: 300 level course may not be repeated at the 400 level for credit.

**MSE 362 Logistics and Supply Chain Management 3 Credits**

Modeling and analysis of supply chain design, operations, and management. Analytical framework for logistics and supply chains, demand and supply planning, inventory control and warehouse management, transportation, logistics network design, supply chain coordination, and financial factors. Industry case studies and a comprehensive final project.

**MSE 401 Integrated Product Development 3 Credits**

An integrated and interdisciplinary approach to engineering design, concurrent engineering, design for manufacturing, industrial design and business of product development. Design methods, philosophy and practice, the role of modeling and simulation, decision making, risk, cost, materials and manufacturing process selection, platform and modular design, mass customization, quality, planning and scheduling, business issues, teamwork, group dynamics, creativity and innovation. Case studies and team projects with geographically dispersed team members.

**MSE 431 Marketing & the Invention to Innovation Process 3 Credits**

Organizational issues and decision-making for capital investments in new technologies. The commercialization process is traced from research and development and marketing activities through the implementation phase involving the manufacturing function. Term project is a commercialization plan for a new manufacturing technology.

**MSE 438 Agile Organizations & Manufacturing Systems 3 Credits**

Analysis of the factors contributing to the success of manufacturing enterprises in an environment characterized by continuous and unpredictable change. Fundamentals of lean production: aspects of systems design, value stream analysis, flow, set-up and cycle time reduction, kaizen, elimination of waste. Fundamentals of agility: global enterprises, virtual organizations, adapting to change, mass customization, manufacturing flexibility, activity-based management.

**MSE 443 Automation and Production Systems 3 Credits**

Principles and analysis of manual and automated production systems for discrete parts and products. Cellular manufacturing, flexible manufacturing systems, transfer lines, manual and automated assembly systems, and quality control systems.

**MSE 446 International Supply Chain Management 3 Credits**

Financial and managerial issues. Evaluation, selection, development and management of suppliers; business models, financial reporting strategies, earnings, quality, risk assessment and internal control, team based new product development. Selected readings, case studies, discussions, lectures, group projects, and presentations.

**MSE 451 Manufacturing Systems Engineering Project 1-3 Credit****MSE 456 Micromanufacturing Systems & Technologies 3 Credits**

Manufacturing engineering in microelectronics, microelectromechanical, nano-, opto- and micro-scale manufacturing. Examination of systems design, equipment, process and operational issues and linkages to business strategies. Crystal growth, thin film deposition processes and patterning, removal processes, vacuum engineering, contamination control, clean room practices etc. Individual research assignments. Note: 300 level course may not be repeated at the 400 level for credit.

**MSE 472 Special Topics 3 Credits****MSE 481 Technology, Operations & Competitive Strategy 3 Credits**

Interrelationships among advanced manufacturing management, technology and competitive strategy of the firm. Industry analysis and competitiveness; competitive strategy formulation and implementation; value chain analysis; manufacturing and technology strategy; manufacturing's contribution to competitive advantage in quality, cost, variety and new product availability; segmentation and substitution; vertical integration.

**MSE 482 Aspects of Sustainable Systems Design 3 Credits**

Design of sustainable systems for manufacturing that fulfill human needs and generate wealth. Demographic, ecological, economic, environmental, ergonomic, health and global or local socio-political impacts on design and operation of future systems. Conservation of resources in the design, manufacture and use of products, processes, and implementation systems; life cycle engineering, reclamation, recycling, remanufacture. Research-based term paper.

**MSE 490 Manufacturing Systems Engineering Thesis 1-6 Credit****MSE 499 Dissertation 15 Credits****Master of Business Administration and Educational Leadership**

The MBA & Educational Leadership joint degree program offers students the opportunity to acquire a solid foundation in both business and education. Designed to develop the administrative skills required in today's educational systems, the MBA/Ed. Leadership provides a framework where excellent education and sound business practices can flourish. The MBA/Ed. Leadership will provide an additional option for business students in educational leadership. The program will enhance the students' marketability in private and public sector education while providing students with an understanding of the cultures of both business and education. Core courses from both colleges will ensure that recipients of the joint degree will bring to their future positions an extraordinary medley of skills to manage human and financial resources efficiently while employing expertise in instructional supervision and training in both education and corporate settings. This program of study will enhance training and skills for those currently in the area of business and financial management in the field of education. The Lehigh MBA/Ed. Leadership is a 45-credit joint degree program.

**Admission Requirements**

Applications need to be approved through both the MBA Program and the Educational Leadership program. Students are required to take the GMAT. Students must have at least 2 years of professional post graduate work experience to apply for this joint degree program.

Further information about the program may be obtained by contacting Dr. Floyd D. Beachum, Professor, College of Education, 610-758-5955 or [fdb209@lehigh.edu](mailto:fdb209@lehigh.edu).

**Manufacturing Systems Engineering**

Lehigh's award-winning graduate program leading to the cross-disciplinary master of science degree in manufacturing systems engineering (MSE) is administered by the Center for Manufacturing Systems Engineering within the P.C. Rossin College of Engineering and Applied Science. In addition, the College of Business and Economics participates in teaching accounting, business, finance, management, and marketing aspects affecting manufacturing systems.

This graduate curriculum aims to develop engineers who can design, develop, install, operate and modify manufacturing systems involving materials, processes, equipment, facilities, logistics, and people using

leading edge technologies. A systems perspective is integrated by means of interdisciplinary course offerings.

#### Distance Education

It is possible for distance students to earn the MS in MSE degree remotely.

#### Major Requirements

The degree requires completion of 30 credits of graduate level work, including:

#### Admission requirements

- A bachelor's degree in engineering or an appropriate science is required.
- All candidates must have at least six months work experience in industry.
- All candidates must follow admission procedures and standards established by Lehigh University.

For further information contact: Carolyn Jones, MSE Program Coordinator, 200 West Packer Avenue, Bethlehem, PA 18015 (610) 758-5157, FAX (610) 758-6527, Email ccj1@Lehigh.edu or visit the MSE web site at [www.lehigh.edu/~inmse/gradprogram/](http://www.lehigh.edu/~inmse/gradprogram/)

#### Photonics

The Master of Science Degree in Photonics is an interdisciplinary program designed to provide students with a broad training in the various aspects of photonics, including topics in electrical engineering, materials science, and physics. Admission to the program requires a B.S. or M.S. in either the engineering or physical sciences.

Applications should be directed to one of the three sponsoring departments (Electrical and Computer Engineering, Materials Science and Engineering, or Physics). Procedures and admission criteria are the same as those followed by the home department. International students must satisfy minimum university language requirements. The admissions process is under the supervision of the individual department to which you apply.

#### Polymer Science and Engineering

Lehigh has a diverse group of faculty members with strong, primary interest in polymer science and engineering. In order to provide better opportunities for courses and research in this interdisciplinary field, activities are coordinated through the Center for Polymer Science and Engineering (CPSE), and its academic Polymer Education Committee. Polymer faculty from traditional departments of chemical engineering, chemistry, materials science and engineering, physics, and mechanical engineering and mechanics, are participants of the CPSE.

There are two ways in which qualified graduate students, with degrees in the above or related fields, may participate. Students may pursue graduate studies within an appropriate department. Departmental procedures must be followed for the degree sought. The student's adviser must be in that department and the student receives a normal departmental degree, with emphasis in polymer courses and research.

Such students are encouraged to pursue a graduate certificate in polymer science and engineering.

Alternatively, students may elect to pursue studies toward an interdisciplinary M.S., M.E., or Ph.D. degree in polymer science and engineering. The procedures for this latter case are summarized as follows.

Students are admitted through one of the participating departments and must meet that department's admissions criteria. When the student is ready (must have taken/be taking at least one polymer course and be in good standing in the department), the student petitions to transfer to the Polymer Science and Engineering graduate program. After the petition is approved, his/her degree program becomes Polymer Science and Engineering, but the student remains in the home department.

#### Master of Science Degree in Polymer Science and Engineering

Master of Science Degree in Polymer Science and Engineering requires a total of 24 credits in course work and six credits in research. The masters thesis is directed and signed by a faculty member of the Center

for Polymer Science and Engineering and co-signed by the chairman of the Polymer Education Committee or the director of the CPSE.

#### Master of Engineering Degree in Polymer Science and Engineering

Master of Engineering Degree in Polymer Science and Engineering requires a total of 30 credits of course work. This option is intended for those students who do not work in a laboratory setting, or for whom thesis research is not practical, but who wish to obtain an advanced education in polymer science and engineering.

#### Ph.D. in Polymer Science and Engineering

For the Ph.D., the student must satisfactorily complete a qualifying examination administered by the Polymer Education Committee; satisfactorily complete graduate course work determined in consultation with the doctoral committee; pass a general examination administered by the Polymer Education Committee; and defend to the satisfaction of the doctoral committee, a dissertation in the field of polymer science and engineering. Students deficient in polymer science or related topics may be required by their committee to take remedial course work.

The doctoral committee consists of the research adviser, at least two other members of the center for polymer science and engineering, and at least one outside person. The committee's composition is subject to approval by the Polymer Education Committee and the Graduate and Research Committee of the university.

For more information, write to Dr. Raymond A. Pearson, Director, Center for Polymer Science and Engineering, Whitaker Laboratory, 5 E. Packer Avenue, Lehigh University, Bethlehem, PA 18015, or Dr. James E. Roberts, Seeley G. Mudd Building #6, Chairman, Polymer Education Committee, Lehigh University, 6 E. Packer Avenue, Bethlehem, PA 18015 or Ms. Lisa Arechiga, Graduate Coordinator Whitaker Laboratory, 5 E. Packer Avenue, Lehigh University, Bethlehem, PA 18015. Please address applications to one of the participating departments.

#### Courses

##### MBA 401 Introduction to the Organization and its Environment 2 Credits

An MBA core course designed to provide a thorough understanding of business organizations by examining strategies middle and senior managers use to create and sustain organizational competitive advantage. The course examines the organization from an overall perspective within the context of the firm's internal and external environment. The second aspect of this course deals with the ability to communicate effectively in today's business and professional environment. Students will examine and practice the written and verbal communications strategies and skills that are essential to their success in business.

##### MBA 402 Managing Financial and Physical Resources 4 Credits

An MBA core course designed to integrate financial and managerial concepts into operations decisions. Disciplines of accounting, finance and economics are combined to provide substantive foundations for discussing and analyzing data. Implications of analysis are applied to facilitate decision-making in other areas such as marketing, operations (manufacturing, logistics and engineering), human resources, information technology and general management. The major learning objectives will be applied through a series of "living" cases that are centered on analyzing historical financial performance, preparing a business plan, and valuing a business.

**Prerequisites:** (MBA 401 and GBUS 401 or BUAC 1)

**Can be taken Concurrently:** MBA 401

**MBA 403 Managing Information 4 Credits**

An MBA core course dealing with concepts and methods involved in the collection, organization and dissemination of information that helps managers make operational and strategic decisions. The course also deals with attributes of information and examines enterprise-wide impacts of local decisions. Revenue, cost, time and quality-based information are accorded equal emphasis, while students are exposed to alternative evaluation methods for decisions related to different parts of the value chain. Topics include: activity-based costing; activity-based management; transaction analysis; operational and strategic decisions such as outsourcing, design partnerships, etc; investment analysis for short lifecycle investments; evaluation of uncertainty, risk and ambiguity; metrics development; compensation policies; segment evaluation methods; target costing and functional analysis; quality function deployment; total cost of ownership; and transfer pricing. In addition, the course deals with: information technology enablers which allow firms to improve value delivered to customers; and evaluation and management of emerging forms of Cooperation, such as joint ventures and project based strategic alliances.

**Prerequisites:** (ECO 401 or BUEC 1) and (GBUS 401 or BUAC 1 and MBA 401)

**Can be taken Concurrently:** MBA 401

**MBA 404 Managing Products and Services 4 Credits**

An MBA core course focusing on the management of products and services within a firm's value chain. The course addresses exceeding customer expectations, establishing total quality as the core foundation, developing a strong customer focus, creating value through supply chain management, developing new products for competitive advantage, matching aggregate supply with customer demand, and designing market channels and influencing customers. Prerequisites as noted below.

**Prerequisites:** MBA 401

**Can be taken Concurrently:** MBA 401

**MBA 405 Managing People 4 Credits**

An MBA core course that examines how effective organizations are created, maintained, and improved. The course will focus on how good people are attracted to an organization and how to make them productive. Topics include: organizational design, job design, staffing, training and development, performance, teams, influence, diversity, change, ethical decision-making and current people issues facing today's organizations. Prerequisites as noted below.

**Prerequisites:** MBA 401

**Can be taken Concurrently:** MBA 401

**MBA 406 Integrative Experience 3 Credits**

An MBA course where students apply the body of knowledge acquired in MBA 401 through 405 through a simulation, case presentations and the cross core project. This course places an emphasis on strategic management and takes the point of view of the general manager to view the organization from an overall perspective in the context of the firm's internal and external environment. In doing so, students examine historical perspectives, contemporary theories, and practical applications all in the spirit of helping them develop a broad understanding of strategic management issues and solutions. By combining high-level class discussions, case analyses, a computer simulation competition and the crosscore project this course exposes students to rigorous theoretical analysis while providing hands-on, simulated real world business experiences. Prerequisites as noted below.

**Prerequisites:** (MBA 401 and MBA 402 and MBA 403 and MBA 404 and MBA 405)

**Can be taken Concurrently:** MBA 403

**Master of Business Administration and Engineering**

In today's business environment expertise is required over a broad spectrum of skills in order to maximize performance. To meet this challenge, Lehigh has developed an interdisciplinary graduate program that provides a solid foundation in both business and engineering. The joint Master of Business Administration and Engineering (MBA&E) degree has been developed through the co-operative efforts of the P.C. Rossin College of Engineering & Applied Science and the College of Business & Economics. This program is part of Lehigh's commitment to developing the industrial leaders needed to enhance our

competitiveness in the new global marketplace, and is aimed at students with an engineering or science background.

The basic 45 credit hour course sequence consists of:

MBA core courses	18
Engineering core courses	12
Business electives	5
Engineering electives	6
Free electives	3
Integrated project	1
<b>Total Credits</b>	<b>45</b>

Students can choose an appropriate engineering curriculum from any of the following programs – chemical engineering, civil engineering, computer engineering, computer science, electrical engineering, environmental engineering, industrial and systems engineering, manufacturing systems engineering, materials science and engineering, mechanical engineering, or polymer science and engineering.

**MBA Core Courses**

MBA 401	Introduction to the Organization and its Environment	2
MBA 402	Managing Financial and Physical Resources	4
MBA 403	Managing Information	4
MBA 404	Managing Products and Services	4
MBA 405	Managing People	4

**Engineering Core Courses**

Each engineering program has its own set of core courses. Course choices are intended to be as flexible as possible, and are tailored to meet the needs of individual students. Further information can be obtained from the appropriate departmental graduate coordinator, or from the Office of Graduate Studies (610-758-6310) in the P.C. Rossin College of Engineering and Applied Science.

**Electives**

Engineering electives are chosen from courses in the appropriate RCEAS engineering program and the business electives are selected from course offerings in CBE. Electives can also be chosen from joint courses that are being developed by RCEAS & CBE.

**Project**

A short interdisciplinary project is required of all students. Project topics, based on the specific interests of each student, will be developed by CBE and RCEAS faculty.

**Admissions**

Applications must be accepted by the MBA program and by the relevant department in the P.C. Rossin College of Engineering and Applied Science. When required by the engineering program, students must take the GRE. If this is not required, then the GMAT examination must be taken. Students will not be required to take both tests.

Further information can be obtained from:

Office of Graduate Studies  
P.C. Rossin College of Engineering & Applied Science  
610-758-6310  
[www.lehigh.edu/engineering](http://www.lehigh.edu/engineering)

or

The Graduate Programs Office  
College of Business & Economics  
610-758-3418  
[www.lehigh.edu/mba](http://www.lehigh.edu/mba)



**Courses****MBA 401 Introduction to the Organization and its Environment 2 Credits**

An MBA core course designed to provide a thorough understanding of business organizations by examining strategies middle and senior managers use to create and sustain organizational competitive advantage. The course examines the organization from an overall perspective within the context of the firm's internal and external environment. The second aspect of this course deals with the ability to communicate effectively in today's business and professional environment. Students will examine and practice the written and verbal communications strategies and skills that are essential to their success in business.

**MBA 402 Managing Financial and Physical Resources 4 Credits**

An MBA core course designed to integrate financial and managerial concepts into operations decisions. Disciplines of accounting, finance and economics are combined to provide substantive foundations for discussing and analyzing data. Implications of analysis are applied to facilitate decision-making in other areas such as marketing, operations (manufacturing, logistics and engineering), human resources, information technology and general management. The major learning objectives will be applied through a series of "living" cases that are centered on analyzing historical financial performance, preparing a business plan, and valuing a business.

**Prerequisites:** (MBA 401 and GBUS 401 or BUAC 1)

**Can be taken Concurrently:** MBA 401

**MBA 403 Managing Information 4 Credits**

An MBA core course dealing with concepts and methods involved in the collection, organization and dissemination of information that helps managers make operational and strategic decisions. The course also deals with attributes of information and examines enterprise-wide impacts of local decisions. Revenue, cost, time and quality-based information are accorded equal emphasis, while students are exposed to alternative evaluation methods for decisions related to different parts of the value chain. Topics include: activity-based costing; activity-based management; transaction analysis; operational and strategic decisions such as outsourcing, design partnerships, etc; investment analysis for short lifecycle investments; evaluation of uncertainty, risk and ambiguity; metrics development; compensation policies; segment evaluation methods; target costing and functional analysis; quality function deployment; total cost of ownership; and transfer pricing. In addition, the course deals with: information technology enablers which allow firms to improve value delivered to customers; and evaluation and management of emerging forms of Cooperation, such as joint ventures and project based strategic alliances.

**Prerequisites:** (ECO 401 or BUEC 1) and (GBUS 401 or BUAC 1 and MBA 401)

**Can be taken Concurrently:** MBA 401

**MBA 404 Managing Products and Services 4 Credits**

An MBA core course focusing on the management of products and services within a firm's value chain. The course addresses exceeding customer expectations, establishing total quality as the core foundation, developing a strong customer focus, creating value through supply chain management, developing new products for competitive advantage, matching aggregate supply with customer demand, and designing market channels and influencing customers. Prerequisites as noted below.

**Prerequisites:** MBA 401

**Can be taken Concurrently:** MBA 401

**MBA 405 Managing People 4 Credits**

An MBA core course that examines how effective organizations are created, maintained, and improved. The course will focus on how good people are attracted to an organization and how to make them productive. Topics include: organizational design, job design, staffing, training and development, performance, teams, influence, diversity, change, ethical decision-making and current people issues facing today's organizations. Prerequisites as noted below.

**Prerequisites:** MBA 401

**Can be taken Concurrently:** MBA 401

**MBA 406 Integrative Experience 3 Credits**

An MBA course where students apply the body of knowledge acquired in MBA 401 through 405 through a simulation, case presentations and the cross core project. This course places an emphasis on strategic management and takes the point of view of the general manager to view the organization from an overall perspective in the context of the firm's internal and external environment. In doing so, students examine historical perspectives, contemporary theories, and practical applications all in the spirit of helping them develop a broad understanding of strategic management issues and solutions. By combining high-level class discussions, case analyses, a computer simulation competition and the crosscore project this course exposes students to rigorous theoretical analysis while providing hands-on, simulated real world business experiences. Prerequisites as noted below.

**Prerequisites:** (MBA 401 and MBA 402 and MBA 403 and MBA 404 and MBA 405)

**Can be taken Concurrently:** MBA 403

**Energy Systems Engineering****Master of Engineering in Energy Systems Engineering**

For students with B.S. degrees in engineering, physics, computer science or mathematics, Lehigh's 10-month, 30-credit professional Master's program in energy systems engineering helps students develop into organizational and technical leaders in the energy and power industries. Learning takes place in an environment where potential employers actively guide curricular development and student research endeavors. Graduates of this program emerge with the skills and confidence to tackle the grand challenges facing the global energy infrastructure and its associated effect on the environment.

The hallmark of the program is student immersion in hands-on, industry-driven projects. Each student will apply advanced technical knowledge and skills and work collaboratively with a team of faculty, fellow students, and representatives from sponsor firms to complete a project of impact and significance in the field — a real project as conceptualized by the project's sponsoring researcher or industry concern. The development of targeted research projects serves as an entry point into the field for talented young innovators, and a source for firms to explore new skill sets and solutions required for success with emerging technologies and approaches.

The basic 30 credit hour course sequence consists of:

ESE Core Courses	12
ESE Technical Electives	12-15
ESE Industry Project	3-6
Total credits	30

Students typically begin this 10 month program in Summer Session II and will graduate spring of the following year with a Master of Engineering degree in energy systems engineering.

Further information can be obtained from:  
[www.lehigh.edu/esei](http://www.lehigh.edu/esei)

Prof. Martha Dodge  
Energy Systems Engineering Institute  
P.C. Rossin College of Engineering & Applied Science  
(610) 758-3529

Mrs. Eileen Kaplan  
Coordinator, Energy Systems Engineering Institute  
P.C. Rossin College of Engineering and Applied Science  
(610) 758-3650

**Recommended sequence of courses in the ESE M.Eng. program**

Summer Session II (July/August)

Summer		Credits
ESE 403	Energy and the Environment	3

ESE 405	Energy Systems Project Management	3
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Total Credits: 6

Fall Semester

<b>Fall</b>		<b>Credits</b>
ESE 401	Energy Generation	3
ESE 460	Energy Systems Engineering Project	3
	<b>Technical</b>	<b>6</b>

**Electives (2)**

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Total Credits: 12

Spring Semester

<b>Spring</b>		<b>Credits</b>
ESE 402	Transmission and Distribution	3
ESE 460	Energy Systems Engineering Project *	3
	<b>Technical</b>	<b>6</b>

**Electives (2)\***

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Total Credits: 12

\*Student may choose to take a third technical elective instead of ESE 460 in the Spring semester with the approval of the program Director.

Students acquire a level of specialized knowledge and experience through the completion of four to five technical electives courses. The electives should reflect the student's career interest. Below is the list of technical electives available to the ESE students. Other electives may be considered with the approval of the program Director.

- Two (2) electives must be 400 level courses and
- Three (3) electives must be in the P.C. Rossin College of Engineering and Applied Science.

The list of technical electives for each department listed below are available online at

<http://www.lehigh.edu/~inesei/program/electives.html>

#### Courses

##### ESE 401 Energy Generation 3 Credits

This course provides an overview of the different methods of generating electricity, such as turbine driven electrochemical generators, fuel cells, photovoltaics, and thermoelectric devices. Topics include the combustion of fossil fuels (coal, natural gas, and oil), nuclear fission and fusion, and renewable resources (solar, wind, hydro, tidal, and geothermal sources). Sustainability, energy efficiency issues, as well as public interest and policy drivers are also addressed.

##### ESE 402 Transmission & Distribution: Smart Grid 3 Credits

This course provides an overview of modern power transmission and distribution systems. Topics include transformer technology, transmission grids, load management, distribution optimization, power supply reliability, and infrastructure systems. Security and deregulation issues are also addressed.

##### ESE 403 Energy And The Environment 3 Credits

This course provides an overview of the direct and indirect impact of energy generation and transmission technologies on the environment. Topics include global climate change, clean energy technologies, energy conservation, air pollution, water resources, and nuclear waste issues.

##### ESE 405 Energy Systems Project Management 3 Credits

This course introduces students to the basics of project management in the field of energy systems, which includes the broad spectrum of empirical, theoretical and policy issues of managing the electric power grid, its generation facilities and equipment. This course focuses on the key elements of case studies in engineering that focus on the effective project management of tomorrow's intelligent energy system.

##### ESE 460 Energy Systems Engineering Project 3-6 Credits

A collaborative and intensive study in an area of energysystems engineering, with an emphasis on direct industrial applications. A written report plus a poster presentation or oral presentation is required. Students typically begin this 10 month program in SummerSession II and will graduate spring of the following year with a Master of Engineering degree in energy systems engineering.

#### Master of Engineering in Technical Entrepreneurship

Lehigh's one-year, 30-credit professional Master's program (M.Eng.) in technical entrepreneurship helps young entrepreneurs to create, refine, and commercialize intellectual property through the licensing or launching of a new business. Students in the program learn by experiencing the idea-to-venture process in an educational environment that's hard-wired to support the development of novel, innovative and commercially-viable technologies. The business community -- from young start-ups to the Fortune 500 -- recognizes the need for creative and innovative young minds with the skills to lead and manage product development. In addition, many national and state agencies require grant recipients to commercialize research. Graduates of the TE MEng program will find themselves well-positioned to take on complex product development roles and assignments.

Students with undergraduate degrees from any major in engineering, business, and design arts and sciences who are interested in developing an entrepreneurial mind set through experiencing the integrated product development process, may apply to this program.

#### Course Sequence

The TE academic calendar begins during Lehigh's summer sessions. Students complete ten credits in the summer, ten credits in the fall, and ten credits in the spring.

#### First Year

Summer	CR
TE 301	3
TE 302	2
TE 303	3
TE 407	2
	<b>10</b>

#### Second Year

	Fall	CR Spring	CR
	TE 401	3 TE 402	3
	TE 403	3 TE 404	3
	TE 461	2 TE 462	2
	TE 405	2 TE 406	2
	<b>10</b>	<b>10</b>	

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Total Credits: 30

Further information can be obtained from: <http://www.lehigh.edu/~innovate/>

Prof. John Ochs  
Director

P.C. Rossin College of Engineering & Applied Science  
(610) 758-5615

Ms. Brenda Kahn  
Coordinator

P.C. Rossin College of Engineering & Applied Science  
(610) 758-3650

**Courses****TE 301 Creativity and Systematic Innovation Methods 3 Credits**

Creativity methods, anthropological research, painstorming, bisociation, the Kano model, axiomatic design, the trimming technique, parameter analysis, decomposition, nonlinear design, Taguchi's method, DeBono's Six Hats technique, biomimicry, TRIZ, lateral benchmarking, Blue Ocean Strategy, the art of tinkering and other innovation methods. Hands-on labs, individual and team projects.

**TE 302 Methods in Visual Thinking 2 Credits**

Visualization techniques, visual thinking and envisioning information as taught by Edward Tufte and others, multimedia tools and methods. Appropriate use of technology as applied to new product development, no programming required.

**TE 303 Methods in Prototyping, Modeling and Testing 3 Credits**

Generation of mock-ups and looks-like prototypes, electro-mechanical-optical bread-boards design, fabricate, build and test multiple generations of prototypes, computer modeling methods, shop methods, testing, sensors and data collection.

**TE 401 Integrated Product Development (IPD) Process -1 3 Credits**

An integrated and interdisciplinary approach to engineering design, concurrent engineering, design for manufacturing, industrial design and the business of new product development. Topics include design methods, philosophy and practice, the role of modeling and simulation, decision making, risk, cost, material and manufacturing process selection, platform and modular design, mass customization, quality, planning and scheduling, business issues, teamwork, group dynamics, creativity and innovation. Case studies and semester-long team projects.

**TE 402 Integrated Product Development (IPD) Process-2 3 Credits**

Continuation of TE 401, the parallel development of the product, the development of the marketing and manufacturing system, manufacturing and marketing launch, sales, service and customer support. Case studies and semester-long team projects. Prerequisites as noted below.

**Prerequisites:** TE 401

**TE 403 Entrepreneurial Startup Process-1 3 Credits**

Key aspects surrounding company startups, including feasibility analysis, business model development and evaluation, formation of new venture teams, financial forecasts, sources of financing. Readings, financial templates, live case studies and guest entrepreneurs.

**TE 404 Entrepreneurial Startup Process-2 3 Credits**

Continuation of TE 403, integration of key business components to form and launch your venture: industry analysis, marketing plan and sales strategy; mobilization of the new venture team; operations, including space, legal and insurance consideration; and financial management. Selected topics related to respective venture types (i.e. social entrepreneurship, family business, franchising, immigrant entrepreneurs). Lectures, workshops and guest entrepreneurs.

Prerequisites as noted below.

**Prerequisites:** TE 403

**TE 405 Entrepreneurial Startup Projects-1 2 Credits**

Applying the concepts and processes developed in TE 403. Developing your business platform including business model, start-up team, and financial plan to launch and grow your venture. Prerequisites as noted below.

**Prerequisites:** TE 403

**Can be taken Concurrently:** TE 403

**TE 406 Entrepreneurial Startup Projects-2 2 Credits**

Applying the concepts off entrepreneurial startup process, building upon the business model, entrepreneurial team and financing plan developed in TE 405. Developing a comprehensive business plan and investor's pitch, finalize the steps necessary to launch the company and start operations. Prerequisites as noted below.

**Prerequisites:** TE 403 and TE 405

**TE 407 Intellectual Property (IP) Creation and Management 2 Credits**

Intellectual property issues: confidentiality, nondisclosure, agreement not to compete, founders agreements, patents, copyrights, trademarks, trade secrets both domestic and international.

**TE 461 Integrated Product Development (IPD) Projects-1 2 Credits**

Technical and economic feasibility study of new products. Selection and content of the project is determined by the faculty project advisor in consultation with the student, progress and final reports, oral and posters presentations. Consent of the program director and faculty project advisor required. Prerequisites as noted below.

**Prerequisites:** TE 401

**Can be taken Concurrently:** TE 401

**TE 462 Integrated Product Development (IPD) Projects-2 2 Credits**

Detailed design specification, fabrication, building and testing prototype new products and plan for production, selection and content of the project is determined by the faculty project advisor in consultation with individual students or student teams. Progress and final reports, oral and poster presentations. Consent of program director and faculty project adviser required. Prerequisites as noted below.

**Prerequisites:** TE 461

## An Overview from Past and Present

Lehigh University is independent, nondenominational, and coeducational. Founded in 1865 as a predominantly technical four-year school, the university now has approximately 4,700 undergraduates within its three major units, the College of Arts and Sciences, the College of Business and Economics, and the P. C. Rossin College of Engineering and Applied Science, and approximately 2,100 students enrolled in graduate programs offered through the graduate schools in these colleges and in the College of Education. There are undergraduates from nearly every state and U.S. territory and more than 40 foreign nations.

The university is primarily situated on the Asa Packer Campus on the north slope of South Mountain overlooking Bethlehem, Pennsylvania. Sayre Park, the wooded refuge located toward the top of the mountain, is the setting for many living groups. The residences are reached via winding private roads. Many residential units on campus command a panoramic view of the Lehigh Valley. The Appalachians are visible to the west, with an especially good view from The Lookout on the Packer Campus. Both the tower and dining room in Iacocca Hall on the Mountaintop Campus afford panoramic views of the Lehigh Valley. The campus at its highest point is 971 feet above sea level.

A substantial portion of the upper level of Lehigh's campus is maintained as a nature preserve. The preserve supports deer, squirrels, chipmunks, raccoons, wild turkeys, and other birds.

Besides the Asa Packer Campus, the university has extensive athletic fields and facilities on the Murray H. Goodman Campus, two miles to the south in Saucon Valley. The university acquired the Mountaintop Campus in 1986. It linked the Asa Packer and Murray H. Goodman campuses and brought total land holdings in Bethlehem to 1,600 acres, nearly double the former total.

The board of trustees and university officers have established and enforce policies designed to preserve Lehigh's natural beauty. It is their contention that the environment in which the young adult university student pursues knowledge can make the total educational experience more meaningful, and that the ideal environment is separate and unique from the distractions of the nonacademic community.

There are approximately 480 full-time members of the faculty, teaching a total of more than 2,000 course titles (not all of which are offered every semester). Among faculty members who are tenured and to whom the university has a permanent commitment, nearly all hold the doctorate degree (typically Ph.D. or Sc.D.).

In total, there are more than 2,000 employees of the university, making it the second-largest employer in the community.

### History and Purpose

*The principal author of the brief history of Lehigh University that follows, Dr. W. Ross Yates, holds the bachelor of arts and master of arts degrees from the University of Oregon, his native state. He received the doctor of philosophy degree from Yale University and studied in France on a Fulbright Scholarship. He joined the Lehigh staff in 1955 and served as dean of the College of Arts and Science from 1963 to 1972.*

When the sound of the last cannon of the Civil War died away, statesmen, educators, and industrial pioneers marshalled the victorious forces of the North and turned their attention to education. They wanted to increase the number of trained scientists, engineers, and other skilled people so they could transform the vast natural resources of the country into a strong and independent national economy.

Asa Packer was one of the industrial pioneers. He built the Lehigh Valley Railroad and controlled a coalmining empire in the mountains of eastern Pennsylvania. He knew, as did many others, that a strong national economy depended on more than technical skills. It needed above all people broadly educated in the liberal arts and sciences — people who could combine practical skills with informed judgments and strong moral self-discipline. He kept this in mind when founding and endowing Lehigh University.

The site that Packer chose for his university was a railroad junction across the Lehigh River from Bethlehem, a community founded in 1741 by Moravian missionaries. William Bacon Stevens, Episcopal bishop of the Diocese of Pennsylvania and the first president of the university's board of trustees, in 1869 described the origin of the university as follows:

"In the fall of 1864 an interview was requested of me by the Hon. Asa Packer, of Mauch Chunk (now Jim Thorpe), Pa. He came to my house in Philadelphia, and said that he had long contemplated doing something for the benefit of his State, and especially of the Lehigh Valley. From that valley he said he had derived much of the wealth which GOD had given to him, and to the best interests of that valley he wished to devote a portion of it in the founding of some educational institution, for the intellectual and moral improvement of the young men of that region.

"After conversing with him a little while, and drawing out his large and liberal views, I asked him how much money he proposed to set aside for this institution, when he quietly answered that he deigned to give \$500,000. At the time of this interview no one in this country, it is believed, had offered in a single sum such an endowment for a literary institution. It was the noblest offering which an American had ever laid on the altar of learning, and more than equaled many royal donations which have carried down the names of kings as patrons of European universities.

"Filled with profound emotions at the mention of such a gift for such an object, I asked the noble donor what specific plans he had dreamed in his own mind in reference to it. His reply was, 'I am not much acquainted with these matters, but you are, and I want you if you will to devise a plan which I can put into effective operation.' I told him that I would make the attempt. I did so. I drew up the outline sketch of such an institution as I thought would give the largest results for the means used, and submitted it in a few weeks to his inspection.

"He examined it with the practical judgment and business habits with which he deals with all great questions, and adopted the scheme as the basis of his future university.

"The first meeting of the Board of Trustees, selected by Judge Packer, met at the Sun Hotel, in Bethlehem, July 27th, 1865, and began to organize the work before them."

The trustees followed several principles in setting up the university. One was that of combining scientific and classical education. They considered both to be practical. The principle carried forward an ideal of the great 17<sup>th</sup> century Moravian educator, John Amos Comenius. A motto taken from the works of Francis Bacon was used to summarize this principle, namely, *Homo minister et interpres naturae* — man, the servant and interpreter of nature, to use a free translation. That motto lives on at Lehigh, being an element in the university seal.

The trustees chose as first president a man whose education and habits expressed this principle, Henry Coppee. They established five schools, including a school of general literature in addition to four scientific schools of, respectively, civil engineering, mechanical engineering, mining and metallurgy, and analytical chemistry.

Another principle upon which the trustees insisted was that of keeping the size of the student body proportionate to the abilities of the faculty to teach them well. The university would admit only as many freshmen each year as it could be assured of providing with the highest quality of education. In the 19th century the total enrollment never exceeded several hundred students; the size has increased significantly in recent decades, along with the number of faculty members.

The trustees also insisted that Lehigh was to be nondenominational and would have an admission policy based on merit. Competitive examinations were held for applicants for admission. From 1871 to 1891 no tuition was charged, but the national financial crisis at the turn of the century decimated the value of the Lehigh Valley Railroad stock that Packer had given to Lehigh, which was the principal source of income.

At first the student body was entirely male. The contemporary ideological climate would permit nothing else. But around 1916, women were admitted to graduate programs. In 1971, the university opened its

undergraduate program to them as well. Today men and women applicants are considered on an equal basis.

From the first, the students were serious-minded. In 1924, Catherine Drinker Bowen, daughter of president Drinker and later a famous biographer, published a brief history of Lehigh University, in which she commented:

"Ask any college professor which brand of boy he would prefer to teach, the cigarette brand or the flannel shirt variety. Right here we offer ten to one the flannel shirts...Lehigh still holds to the emblem of the flannel shirt—long may it wave! Engineers come to college to work. A writer in the *Syracuse Post* in 1895 spoke truthfully when he said, 'From the first, Lehigh's characteristic has been her earnestness. It is the boast of her graduates, the inspiration of her students. Men go there to learn to take a useful part in the economy of life.'" The university community was constantly infused with new faculty and students determined to renew and rework the original principles in the light of changing times. The students' ambition and zeal bore fruit; as alumni they carried the university's educational goals into the work of nation-building. And, having received, they gave to perpetuate Lehigh's work of service.

Today, Lehigh University still adheres to Asa Packer's goal of a liberal and scientific education for practical service. Faculty and students work to maintain high quality in instructional programs. Generous support from individuals, foundations, industry, and government help Lehigh to retain high quality of education and faculty while keeping tuition as low as possible. (Tuition covers only a part of the cost of a Lehigh education.)

## Presidents of the University

The presidents of Lehigh University are described and their achievements cited in the following paragraphs. The years in parentheses are those served in the presidency.

**Henry Coppee** (1866-1875). Coppee served as a railroad engineer in Georgia, a captain in the Army during the Mexican War, and taught at West Point and at the University of Pennsylvania before becoming first president in 1866.

Much building was done on the new university campus. A Moravian church on Packer Avenue was remodeled into Christmas Hall; a house for the president was erected on campus; and Packer Hall, the university center, was built.

Coppee lectured in history, logic, rhetoric, political economy, and Shakespeare.

**John McDowell Leavitt** (1875-1880). Leavitt was an Episcopal clergyman who graduated from Jefferson College and taught at Kenyon College and Ohio University. During his incumbency, the university was divided into two schools, General Literature and Technology. As of 1876, a student could receive two engineering degrees by taking a longer course, and beginning in 1877 the master of arts, doctor of philosophy, and doctor of science degrees were established.

Linderman Library rotunda was completed in 1877. Asa Packer died in May 1879, and Founder's Day was held in his honor the following October.

**Robert Alexander Lamberton** (1880-1893). Lamberton, a graduate of Dickinson College, practiced law in Harrisburg, Pa., and was a university trustee when asked to become president. During his administration, students and the community witnessed the first Mustard and Cheese dramatic presentation.

A gymnasium (now Coppee Hall) was erected, and Chandler Chemistry Laboratory was built, now known as Chandler-Ullmann Hall. Lehigh was also building its reputation for academic excellence; the mechanical engineering department was established in 1881 and the Lehigh chapter of Phi Beta Kappa was founded in 1887.

**Thomas Messinger Drown** (1895-1904). Drown studied medicine at the University of Pennsylvania and went abroad to study chemistry. Thereafter he was professor of chemistry at Lafayette College. In 1895 he assumed the presidency of Lehigh and was greatly interested in furthering the university's development as a technical school.

His first years were difficult ones because the Panic of 1893 decimated the university's stock holdings in the Lehigh Valley Railroad. Nevertheless, Lehigh managed to grow in enrollment, academics, and in physical plant. Williams Hall was completed. The curriculum leading to a degree in arts and engineering was established, as was the department of zoology and biology. New curricula were adopted in metallurgical engineering, geology, and physics.

Drown died in office in 1904. Professor William H. Chandler became acting president.

**Henry Sturgis Drinker** (1905-1920). Drinker, an 1871 Lehigh graduate, was the only university alumnus ever to become president. In 1907, the alumni endowment fund began, the *Lehigh Alumni Bulletin* was first published in 1913, and the Alumni Association was incorporated in 1917.

Drinker, besides being a lawyer, was a mechanical engineer and had been largely instrumental in solving the problems of constructing the two-mile-long Musconetcong Tunnel, an engineering feat that made possible a railroad line between Easton, Pa., and New York City. He started a tradition of businesslike management of university affairs.

During Drinker's years, more buildings were completed: the original section of Fritz Engineering Laboratory, Drown Hall, Coxe Mining Laboratory, Taylor Hall, Taylor Gymnasium and Field House, Taylor Stadium, and Lamberton Hall. Drinker's interest in horticulture led to the planting of many rare trees and plants.

A teacher's course and business administration course were begun in 1909 and in 1918 the university was divided into three colleges: liberal arts, business administration, and engineering — the roots of the colleges of today. Army ROTC was established in 1919.

Drinker's daughter, Catherine Drinker Bowen, went on to become a historical writer of note. Her experiences as the daughter of a Lehigh president and occupant of the President's House are recorded in *Family Portrait* (Atlantic Little-Brown).

Drinker resigned in 1920 and Natt M. Emery, vice president, served as chief executive officer until 1922.

**Charles Russ Richards** (1922-1935). Richards took office in 1922. During his presidency, the first graduate degrees were awarded to women. Lehigh faced a shortage of students from 1929 to 1936 as a result of the Depression, but the newly established office of admission, as well as university scholarships, fellowships, and deferred tuition payments, helped to ease the shortage.

Changing concepts of education were evident in several newly organized academic offerings: philosophy, music, psychology, journalism, history, and fine arts. The majors system was instituted as were the senior comprehensive examinations in the Arts College. The placement bureau, a public relations office, and a student health service were organized.

The Alumni Memorial Building, a memorial to the Lehigh alumni who served in World War I, was opened in 1925 and Packard Laboratory was completed in 1929. In the same decade, a major addition to Linderman Library also was completed.

**Clement C. Williams** (1935-1944). Williams, a civil engineer, was president during an era of unprecedented alumni support. Undergraduate enrollment rose to an all-time high, passing 2,000 in 1938. Richards and Drinker residential houses, and the Ullmann wing adjoining the Chandler Chemistry Laboratory, were built. Grace Hall, the first arena-type facility of any size on campus, was completed in 1940, the gift of Eugene G. Grace, an 1899 graduate, who headed the board of trustees. A Graduate School implemented the programs in the three colleges. Williams retired in 1944, and the university was without a president for approximately two years.

**Martin Dewey Whitaker** (1946-1960). Dr. Whitaker, who had been director of the Atomic Energy Commission Laboratory at Oak Ridge, Tenn., and had worked in developing the atomic bomb, faced the responsibility of helping the university community readjust to peacetime conditions after World War II.

During his time as president, Lehigh's assets nearly tripled; the endowment more than doubled to \$18 million. Many buildings were renovated, and the Dravo House and McClintic-Marshall House

residence halls were built. The faculty increased in number by 75 percent and the first endowed distinguished professorships were established.

The Centennial development program was begun in 1959. It raised more than \$22 million for faculty salaries and construction that later included Whitaker Laboratory.

An extensive renovation and enlargement project associated with Packer Hall was undertaken in 1957, and, upon completion in 1958, the building became a university center.

Whitaker died in office.

**Harvey A. Neville** (1961-1964). Dr. Neville was the only faculty member ever elected president. His association with the university began in 1927 as an assistant professor of chemistry. During his three-year term as president, the first phase of the Saucon Valley athletic complex was completed, and Sayre Field was opened atop South Mountain. The Center for Information and Computing Science was established.

Neville, a strong supporter of research who fostered its growth on the campus, died in 1983.

**Deming Lewis** (1964-1982). Willard Deming Lewis became Lehigh's 10th president after a distinguished career as a space engineer and research administrator.

Dr. Lewis earned three degrees at Harvard and two from England's Oxford University, where he was a Rhodes Scholar in advanced mathematics. In 1941, he joined Bell Telephone Laboratories, and in 1962 he became general manager of systems development with Bellcomm Inc., which engineered systems for the Apollo project that placed the first man on the moon.

Lewis, who died in 1989, received 33 U.S. patents on such devices as microwave antennas and filter and digital error detection systems. He helped write the equations describing a stylus sliding through a warped groove.

During Lewis' tenure as Lehigh president, women were admitted as undergraduate students in 1971. New majors were begun in natural science, biology, social relations, geological sciences, environmental science and resource management, religion studies, computer engineering, computing and information science, applied mathematics, management science, American studies, and other fields. Six research centers and seven institutes were established.

Capital campaigns brought in more than \$130 million, and construction was completed on Maginnes Hall, Whitaker Lab, Mart Science and Engineering Library, Sinclair Lab, the Seeley G. Mudd Building, Neville Hall, Rathbone Hall dining room, 13 fraternity houses, the Centennial I and Centennial II residential complexes, the Brodhead House residence hall, the Trembley Park student apartments, the Saucon Village Apartments, the Philip Rauch Field House, and the Stabler Athletic and Convocation Center. The restoration of Packer Memorial Church was completed, and Packard Lab was renovated.

The original Physics Laboratory is now named in Lewis' honor, as is the indoor tennis center.

**Peter Likins** (1982-1997). Dr. Likins, who earned a B.S. and Ph.D. from Stanford, and an M.S. from the Massachusetts Institute of Technology, became Lehigh's 11th president in 1982. He sought balanced excellence in undergraduate programs while pursuing focused objectives in graduate study and research.

Under Likins, Lehigh nearly doubled in size with the purchase in 1986 of 742 acres of land and a research complex from Bethlehem Steel Corp. The new Mountaintop Campus links the Asa Packer and Goodman campuses.

Lehigh also added many new buildings and facilities. Perhaps most notable was the \$33 million Zoellner Arts Center, which provided a new home to Lehigh's departments of music and theatre and to the University Art Galleries, and made Lehigh a center for the fine arts. The arts center and the new Rauch Business Center, home of the College of Business and Economics, were built on the site of Taylor Stadium, which was replaced by Goodman Stadium on Lehigh's athletic campus.

Also during Likins' term, Lehigh built a \$20 million, state-of-the-art telecommunications system, the E.W. Fairchild-Martindale Library and Computing Center, one of the most automated libraries anywhere, and the Harold S. Mohler Lab, which honors the former chairman of the board of trustees.

Also dedicated was the Sherman Fairchild Center for the Physical Sciences, which includes the renovated Physics Building (renamed Lewis Lab), and the adjoining Sherman Fairchild Lab.

Lehigh became home to the Northeast Tier Ben Franklin Advanced Technology Center, which has helped hundreds of new high-technology businesses get started. And the university led the way in establishing the Colonial League, now the Patriot League, in football. The league is committed to the Lehigh tradition of scholar-athletes.

Financial support grew from \$10 million a year to over \$24 million. With over half of alumni making gifts, Lehigh ranked among the top Ph.D.-granting schools in percentage of alumni donors.

Likins' term also saw the establishment of the Lehigh Valley Center for Jewish Studies at Lehigh, the Center for Advanced Technology for Large Structural Systems, largest of its kind in North America, and centers in integrated circuits, management studies, chemical process modeling and control, and international studies.

Likins, an expert in spacecraft dynamics and control who has written textbooks in engineering mechanics, was one of 13 science advisers to President George H.W. Bush. He came to Lehigh after serving as dean of engineering and provost at Columbia, and left to become president of the University of Arizona.

**William C. Hittinger** (1997-1998). A former chairman of the university's board of trustees, Hittinger became interim president after the departure of Peter Likins. A member of the National Academy of Engineering, Hittinger served for 22 years on the board of trustees. He graduated from Lehigh in 1944 with a B.S. in metallurgical engineering, and received an honorary doctor of engineering degree from Lehigh in 1973.

Over a 40-year career in the electronics industry, Hittinger worked for Western Electric Co., National Union Radio Corp., Bell Telephone Laboratories, Bellcomm Inc., General Instrument Corp., and RCA Corp. At Bellcomm, he oversaw systems engineering for NASA's manned spaceflight program, and at RCA, where he became executive vice president, he was responsible for corporate technology, patents, licensing, international business and marketing development, and corporate technology planning.

Hittinger was a member of President Reagan's National Security Telecommunications Advisory Committee from 1982-86. He was also a member of the U.S.-Brazil Presidential Committee on Science and Technology and a member of the board of directors for eight companies.

Hittinger served as national president of the Lehigh Alumni Association in 1971-72 and received the prestigious L-in-Life Award in 1979. An ROTC student at Lehigh, he served in the U.S. Army in 1943-46 during World War II, rising to the rank of captain.

During Hittinger's term as chairman of the board of trustees, Lehigh began construction of the Zoellner Arts Center, completed the Ulrich Student Center, aggressively improved its financial aid for undergraduates, and completed the \$300 million Campaign for Preserving The Vision. As president, Hittinger realigned the Iacocca Institute into the College of Business and Economics, oversaw the construction of the new Sayre Park Village residential complex, and helped Lehigh move forward during a time of presidential transition.

**Gregory C. Farrington** (1998-2006). Dr. Farrington was appointed Lehigh's 12th president in May 1998 and served the university for eight years before stepping down in June 2006. Proclaiming on many occasions that "the only thing good enough for Lehigh is the best," Farrington promoted academic excellence, improved facilities, and fostered collaborative relationships between Lehigh and the surrounding community.

Farrington earned his B.S. from Clarkson University and his A.M. and Ph.D. from Harvard, all in chemistry and specializing in solid state electrochemistry. Before joining the University of Pennsylvania's Department of Materials Science and Engineering in 1979, he was a research chemist for General Electric Company's Corporate Research

and Development Center in New York State. At Penn, he served as dean of the School of Engineering and Applied Science. He holds or shares more than two dozen patents and has written or edited books and book chapters, as well as 100 technical papers.

While at Lehigh, Farrington established the university's bold and creative Lehigh 2020 Initiative. Launched in October 2000, the \$75-million academic venture capital fund focused investment on attracting and retaining the best faculty and students, creating distinctive academic programs, funding critical research fields, and stimulating cross-curricular collaboration. New programs created through the 2020 program include those in bioscience, bioengineering, applied life science, computer science and engineering, information systems and engineering, and bioeconomics.

Along with the reinvigoration of academics and the promotion of interdisciplinary learning, Farrington also literally changed the face of Lehigh's historic campus. More than 20 major campus enhancement projects were completed during his term, among them the construction of Campus Square, a new Alumni Building Arrival Court and parking garage, and a pedestrian walkway through the heart of the campus green, transforming it into a central gathering place. In addition, Coppee Hall, Lambertson Hall, Maginnes Hall, Wilbur Powerhouse, Grace Hall, the A. Haigh Cundey Varsity House, and Linderman Library were renovated.

Under Farrington's leadership, Shine Forever: The Campaign for Lehigh generated more than half of its \$500 million goal to endow faculty chairs, scholarships, academic programs, and facilities.

He also advocated collaborations with the city of Bethlehem, the state and federal governments, industry, and other partners to strengthen the university and spur regional economic development. His commitment to the Lehigh Valley was evident in his participation on various boards as well. He actively participated on the board of trustees of St. Luke's Hospital & Health Network, the National Museum of Industrial History, and Lehigh Valley Partnership.

**Alice P. Gast**, a world-renowned scholar, researcher, and academic leader, became the 13th president of Lehigh University on August 1, 2006.

Before coming to Lehigh, Dr. Gast served as the vice president for research and associate provost at the Massachusetts Institute of Technology, where she was also the Robert T. Haslam chair in chemical engineering. Prior to joining MIT in 2001, she spent 16 years as a professor of chemical engineering at Stanford University and at the Stanford Synchrotron Radiation Laboratory.

The focus of Dr. Gast's distinguished research career was the study of surface and interfacial phenomena, in particular the behavior of complex fluids. Her areas of research include colloidal aggregation and ordering, protein lipid interactions, and enzyme reactions at surfaces. She is the co-author of *Physical Chemistry of Surfaces*, a classic textbook on colloid and surface phenomena, and has presented named lectures at several of the nation's leading research institutions.

Dr. Gast received her B.S. in chemical engineering from the University of Southern California. After earning her Ph.D. in chemical engineering from Princeton University, she spent a postdoctoral year on a NATO fellowship at the Ecole Supérieure de Physique et de Chimie Industrielles in Paris.

Dr. Gast has served on numerous advisory committees and boards, including the Board of the American Association for the Advancement of Science and the National Research Council Committee for Science, Technology, and the Law. In 2010, Dr. Gast was named to the prestigious post of science envoy by U.S. Secretary of State Hillary Rodham Clinton and the U.S. State Department. In 2012, she was appointed to the board of directors of Chevron Corporation.

## University Campuses

Lehigh University's three campuses are located in Bethlehem, Pa., and comprise 1,600 acres.

**Asa Packer Campus.** Lehigh's main academic campus, encompassing approximately 360 acres on the north slope of South Mountain

overlooking Bethlehem, is a wooded area where most students attend class and live. This contains the original campus of the university.

**Murray H. Goodman Campus.** During the 1960s, the university acquired extensive acreage in the Saucon Valley just south of South Mountain. Development of one of the nation's finest collegiate athletic complexes has continued since that time. The 500-acre campus now includes the Murray H. Goodman Stadium and other athletic fields, as well as the 6,000-seat Stabler Athletic and Convocation Center, the Philip Rauch Field House, the Cundey Varsity House, the Lewis Indoor Tennis Facility, and the Ulrich Sports Complex. The campus is named for a major benefactor, Lehigh alumnus Murray H. Goodman, of West Palm Beach, Fla.

**Mountaintop Campus.** Lehigh bought this campus from Bethlehem Steel Corp. in 1986. It contains 670 acres of woods and a 72-acre research site with 8 buildings, including a landmark tower building visible for miles around. Acquisition of the facilities connected the two older campuses. The Mountaintop Campus houses the College of Education; the departments of Biological Sciences and Chemical Engineering; programs in biochemistry, biotechnology, bioengineering, ATLSS (Advanced Technology for Large Structural Systems) center, Energy Research Center, the Military Science and Leadership program (Army ROTC) and Ben Franklin TechVentures headquarters and incubator companies.

## University Buildings

Lehigh has a major collection of 19<sup>th</sup> century buildings designed by such prominent architects as Addison Hutton (1834-1916), Edward T. Potter (1831-1904), and the firm of Furness and Evans (Frank Furness, 1839-1912).

Designed by Dagit Saylor Architects just east of the Rauch Business Center is the Zoellner Arts Center, which houses a 1,000-seat music auditorium, a 300-seat theatre, a permanent art gallery and museum store, and the departments of music and theatre. A 350-car parking garage is on the same site.

Opened in 2002, and designed by the AIA award-winning architectural firm of Bohlin Cywinski Jackson, is the Campus Square residential and retail complex with upperclass student apartments, bookstore, and various eateries.

The university's newer structures include the Ulrich Sports Complex (2002) and additions to the Cundey Varsity House (2002), Iacocca Hall for biological sciences (2003), Stabler Arena (2004), Sinclair Lab for optical technologies (2005), the Mulvihill Golf Learning Center (2007), and the STEPS building for science, technology, environment, policy and society (2010), Lehigh's first LEED-certified building (Leadership in Energy and Environmental Design), achieving Gold status in 2011.

Recently completed are campus enhancements that eliminated vehicular traffic and created landscaped walkways in the historic core of the Asa Packer Campus. Recently opened is a 350-car parking garage pavilion and visitors arrival court at the west entrance to the Alumni Memorial Building.

Altogether, the three campuses contain more than 160 buildings with more than 4 million square feet of floor space.

## Campus Landmarks

In the following list, the date after the name of each building indicates the year of construction.

**Alumni Memorial Building (1925).** This edifice of Gothic design, housing the Visitor Center, Admissions and other administrative offices, and those of the Alumni Association, represents a memorial to the 1,921 Lehigh alumni who served in World War I and the 46 who died. The building was designed by Theodore G. Visscher, Class of 1899, and James Lindsey Burley, Class of 1894.

**E. W. Fairchild-Martindale Library and Computing Center (1985).** The high-technology building houses science and engineering holdings, The Media Center, library and technology services staff, and a computer center. Construction was made possible by a major gift from Harry T. Martindale, a 1927 Lehigh graduate, and his wife, Elizabeth, daughter

of the late Edmund W. Fairchild, founder of a business publications and communications empire.

**Linderman Library** (1877). The rotunda, designed by Addison Hutton, was built as a gift to the university by founder Asa Packer as a memorial to his daughter, Lucy Packer Linderman. The rotunda is surrounded except on the south by a major addition constructed in 1929. The building houses more than 20,000 rare books and volumes related to the humanities and social science. The Bayer Galleria of Rare Books, made possible by a gift from Curtis F. Bayer '35, was dedicated in 1985. The building reopened in the spring of 2007 as the intellectual and humanities hub of the university after being closed for renovations for nearly two years. Major new features include more seminar and group study rooms, wireless Internet access throughout, central air conditioning, new furniture and finishes, and a cafe.

**Packer Memorial Church** (1887). The church was the gift of Mary Packer Cummings in memory of her father, founder Asa Packer. It was dedicated on Founder's Day, October 13, 1887. The building was designed by Addison Hutton; the building is on the National Register of Historic Places.

**President's House** (1868). This 21-room residence, designed by Edward Potter, is the home of university presidents and is often used for receptions on special university occasions.

**Packer Hall, The University Center** (1868). When construction of the building began in 1865, a railroad was built to transport stone to the site. The building, designed originally by Potter, was extensively renovated and enlarged in 1958.

The building was constructed at the expense of the founder, who vetoed a plan to erect it of brick. "It will be built of stone," Asa Packer responded.

Today the building houses student and faculty dining facilities, a food court, deans' offices, student activities offices, the Women's Networking Center, The Center for Academic Success, a bank office, and conference facilities.

## Academic and Research Facilities

In the following list, the first date after the name of each building indicates the year of construction. The second date indicates the year of a major addition.

**Chandler-Ullmann Hall** (1883, 1938, respectively). These adjoining buildings formerly were the William H. Chandler Chemistry Building (designed by Hutton) and the Harry M. Ullmann Chemistry Laboratory. Chandler served as acting university president, 1904 and 1905, and taught chemistry from 1871 to 1906. Ullmann served as chairman of the chemistry department. The building has been named a National Historic Chemical Landmark by the American Chemical Society.

The Department of Art, Architecture and Design and Department of Psychology are located in Chandler-Ullmann.

**Christmas-Saucon Hall** (1865 and 1872, respectively). Christmas Hall is the university's oldest building. When Asa Packer acquired the South Mountain site for the university in 1865, a Moravian church was being constructed. The newly formed university took over the building and completed it for use in recitations and as a dormitory and chapel. The name Christmas Hall was chosen in keeping with Moravian religious tradition. In 1872, Saucon Hall was constructed a few feet to the east of Christmas Hall. The buildings were connected with the construction of a "hyphen" in 1926. The building houses the Department of Mathematics, The University Press, and classrooms, while the ID Card and Gold PLUS offices are located in the annex.

**Coppee Hall** (1883). The building was the original university gymnasium. It is named in honor of Henry Coppee, first president. The building was renovated in 2002 and houses the Weinstock Center for Journalism and Communication.

**Coxe Hall** (1910). Originally a mining laboratory, the structure is named for Eckley B. Coxe, pioneer mining engineer and trustee of the university. The building was recently renovated for the International Students and Scholars and the English as a Second Language

programs and the Global Union. It also houses the office of the Vice President for International Affairs.

**Dialogue Center**. This Victorian structure, until recently used by the Newman Association, was converted to a center for dialogue on values and spirituality, and also houses the university chaplain's office.

**Drown Hall** (1908). The building, designed by Furness and Evans, is a memorial to Thomas M. Drown, president from 1895 to 1904. It is headquarters for the English Department and the Writing and Math Center.

**Fritz Engineering Laboratory** (1909, 1955). The laboratory is named for John Fritz, pioneer in the steel industry in the United States and a member of the university's original board of trustees. Fritz provided funds for the original section; a seven-story addition accommodates the university's testing machine, which is capable of applying a five-million-pound load to tension or compression members up to forty feet in length. The hydraulic testing machine is the largest facility of its kind currently in operation in the world. The laboratory is used primarily by the Department of Civil and Environmental Engineering.

**Iacocca Hall** (1958, 2003). Known as the tower building for its panoramic views of the Lehigh Valley, it houses the College of Education, the chemical engineering department, the biological sciences department, The Iacocca Institute, as well as a dining room and food service facilities, plus a teleconferencing classroom.

**Imbt Laboratories**. This is primarily a high-bay research lab space where the ATLSS project was constructed, and where chemical engineering and Energy Research Center have major research facilities. It is also the headquarters of the "Fleet of the Future" program.

**Johnson Hall** (1955). The building houses the university health service, the counseling service, campus police, and the parking services office. Earle F. "Coxey" Johnson '07, a director of General Motors Corp. and university trustee, provided funding for the structure.

**Jordan Hall** (1958). One of the original Bethlehem Steel buildings, this facility now houses the Military Science and Leadership program (Army ROTC) and the university investment office.

**Lamberton Hall** (1907). The structure served as the university commons and dining room until the renovation of Packer Hall in 1958. The building honors the memory of Robert A. Lamberton, third president. In January of 2006 it reopened as a late-night diner called the "Hawk's Nest" and student programming facility in the Kenner Great Room.

**Maginnes Hall** (1970). The multilevel structure is headquarters for the College of Arts and Sciences and also houses the departments of modern languages and literature, history, international relations, political science, and religion studies, as well as the Philip and Muriel Berman Center for Jewish Studies, and the office of Interdisciplinary Studies. New classrooms opened on the ground floor in January 2004. The building is named for Albert B. Maginnes '21, who was a lawyer and university trustee.

**Mart Science and Engineering Library** (1968). This structure honors the memory of Leon T. Mart '13, and his son, Thomas '51. It was incorporated into the E. W. Fairchild-Martindale Library and Computing Center in 1985.

**Seeley G. Mudd Building** (1975). This seven-story building houses the chemistry department. The late Seeley G. Mudd was a California medical doctor. The Seeley G. Mudd Foundation, of Los Angeles, made a major gift toward the building.

**Neville Hall** (1975). This building in the chemistry complex has three auditoriums used for lectures and events. The building is named for Dr. Harvey A. Neville, president from 1961 to 1964, who was a chemist.

**Packard Laboratory** (1929). The structure was the gift of James Ward Packard, Class of 1884, the electrical pioneer and inventor of the Packard automobile who served as a university trustee. The first Packard automobile (1898) is displayed in the lobby. The building is the headquarters for the P. C. Rossin College of Engineering and Applied Science. It also houses classrooms and laboratories for mechanical engineering and mechanics, for electrical and computer engineering, and computer science and engineering. An auditorium accommodates large classes and various events.



**Philosophy Building** (1879). This small building just below Packer Memorial Church was constructed as a porter's lodge. Today it houses the philosophy department.

**Price Hall.** This structure formerly was a brewery named Die Alte Brauerei. In 1912 it was remodeled to serve as a dormitory, and it was named in honor of Henry Reese Price, president of the university board of trustees. It serves as the home of the sociology and anthropology department.

**Rathbone Hall** (1971). This building's upper level is a major and recently renovated student dining facility, with window walls affording a panoramic view of the Lehigh Valley. The building bears the name of its donor, Monroe Jackson Rathbone '21, president of the university board of trustees from 1957 to 1973. Rathbone was chairman of the board, Standard Oil Co. (New Jersey), now Exxon Corp., and was a major innovator in the oil industry. The lower level houses the Residential Services Office.

**Rauch Business Center** (1990). Philip Rauch '33, L.L.D. '79, retired chairman of the board and director of the Parker-Hannifin Corp., made the principal contribution to build this facility. Lehigh's Rauch Business Center was dedicated in 1990 as the state-of-the-art home of the university's College of Business and Economics. The \$17.8-million facility has 115,000 square feet of floor space on five stories and features a diverse array of classrooms, auditoria, conference rooms, the Career Services Office, The Common Grounds Café, and is also home to the Perella Financial Services Lab.

**Sayre Building** (1869). Originally known as the Sayre Observatory, the dome that once housed the telescope can still be seen.

**Sherman Fairchild Center for the Physical Sciences** (1892, 1976, 1986). The center, completed with help from the Sherman Fairchild Foundation, houses classrooms and laboratories for undergraduate and graduate students in physics, faculty offices, and a 260-seat auditorium. The complex includes the Lewis Laboratory, the original five-story stone structure built in 1892, the Sherman Fairchild Laboratory for Solid-State Studies built in 1976, and the 1986 addition comprised of the Oberkotter Auditorium and research laboratories.

**Sinclair Laboratory** (1970). This facility houses the office of the Vice President for Research, the Center for Optical Technologies, The International Materials Institute, and other research laboratories. It is named for Francis MacDonald Sinclair, and was the gift of his widow, Jennie H. Sinclair. A 12,000-square foot research addition (The Smith Family Center for Optical Technologies) was completed in 2005.

**STEPS Building** (2010). This facility is the cornerstone of the new STEPS Initiative, which was founded to strengthen Lehigh's commitment to collaboration, innovation, and scholarship in the areas of science, technology, environment, policy, and society. The new 137,000-square-foot building is at the corner of Packer Avenue and Vine Street on Lehigh's Asa Packer campus. The building was designed to eliminate boundaries between the disciplines and features state-of-the-art teaching and research areas mingled with seminar rooms, study lounges, and faculty offices. The \$60 million facility is the university's first "green" building having been awarded LEED gold certification (Leadership in Energy and Environmental Design). It incorporates features such as heat recovery systems, a radiant-floor heating system, an abundance of natural lighting, an automated daylight harvesting system, an Energy Star roof membrane, and an 8,000-square-foot vegetated roof. It is home to the Earth and Environmental Sciences department and the Energy Systems Engineering institute (ESEI) and contains research labs for environmental engineering and teaching labs for biological sciences and chemistry.

**Whitaker Laboratory** (1965). This five-story structure with an adjoining two-level classroom-auditorium section honors the memory of Martin Dewey Whitaker, university president from 1946 to 1960. The building serves the Department of Materials Science and Engineering and Center for Advanced Materials and Nanotechnology. There are laboratories for high-pressure research and reaction kinetics, nuclear studies, analog computation, process control, optoelectronics, high-temperature thermodynamics and kinetics, and fine structures and metallography. The Offices of Government and Community Relations and Technology Transfer are also located in the building.

**Wilbur Powerhouse** (1908). During most of its life, the building served as a power plant with some early engineering laboratory use. Renovated during the 1970s, it provided performing space for student theatrical productions, until the Zoellner Arts Center was built, and it is now the new home for student shops and project studios for the IPD (Integrated Product Development) and The Baker Institute for Entrepreneurship.

**Williams Hall** (1903). This brick structure was the gift of Edward H. Williams, Jr., Class of 1875. Dr. Williams was a professor of mining and geology and the founder of the Tau Beta Pi engineering society. A small greenhouse adjoins the building. The building was extensively renovated and a fourth story added in 1956 following a fire, and is awaiting new occupants following the opening of the new STEPS building

**Zoellner Arts Center** (1997). With major gifts from Vickie and Robert Zoellner '54, Dorothy and Dexter Baker '50, and Claire and Theodore Diamond '37, Dagit-Saylor Architects created a 105,000-sq.-ft. structure designed to showcase Lehigh's rapidly growing programs in the performing and visual arts as well as the departments of music and theatre and 5,000 sq. ft. of exhibition space for the Lehigh University Art Galleries. Baker Hall has a seating capacity of more than 1,000, Diamond Theatre features a thrust stage and seating for 307; and a "black box" theater provides flexible space for experimental productions.

## Athletic and Convocational Facilities

In the following list, the first date after the name of each building indicates the year of construction. The second date indicates the year of a major addition.

**Murray H. Goodman Stadium** (1988). Joanie and Murray Goodman '48, L.L.D. '88, were the principal benefactors. On October 1, 1988, Lehigh opened the gates to Murray H. Goodman Stadium, located on the Goodman Campus. Capacity is 16,000, and the stadium features a three-tiered press box and limited chair back seating, with picturesque South Mountain in the background.

Grace Hall (1940). The building is named for its donor, Eugene G. Grace, Class of 1899, who was chairman of Bethlehem Steel Corp. and president of the university's board of trustees, 1924 to 1956. Grace Hall serves as the headquarters and offices for Lehigh intramural and club sports. The lower level houses the recently renovated Leeman-Turner Arena, and the upper level is undergoing renovation to become the new Caruso Wrestling Complex to be ready for use in the spring of 2013.

**Ulrich Sports Complex** (1999; expanded in 2009). Lehigh chairman of the board of trustees, Ronald J. Ulrich '66, provided the principal funding for the construction of a multi-field game complex used for men's and women's soccer, men's and women's lacrosse, and field hockey. The complex features a natural grass and two artificial surface fields: Frank Banko Field and Ronald J. Ulrich Field. The complex has permanent seating, press boxes, and lighting for night contests. A group of students enrolled in the University's distinctive ILE (Integrated Learning Experience) program collaborated in the design of the original complex, illustrating the strong partnership between athletics and academics at Lehigh.

**Lewis Tennis Facility** (1994). An anonymous donor made possible the construction of four indoor tennis courts for recreational use as well as team practice, and is named for former Lehigh President W. Deming Lewis. The building also includes men's and women's locker room facilities.

**Philip Rauch Field House** (1976). Philip Rauch '33, L.L.D. '79, made a gift toward the facility. The building has 62,000 square feet of uninterrupted floor space, the equivalent of two football fields, for a variety of athletic activities. It has a six-lane, one-eighth-mile flat track.

**Sayre Field** (1961). Located atop South Mountain, the field is used for intramural sports.

Stabler Athletic & Convocation Center (1979). This arena provides seating for 6,000 people for concerts, spectator sports, including Lehigh's basketball teams, and other events. University trustee Donald B. Stabler '30 made a major financial contribution toward the facility.

**Taylor Gymnasium** (1904 and 1913). This structure was the gift of Charles L. Taylor, Class of 1876, who was a friend and business associate of steel magnate Andrew Carnegie. There are two indoor

swimming pools, two basketball courts, the Welch Fitness Center, men's and women's locker rooms, two racquetball and two squash courts, a steam room, a multipurpose dance/aerobics room, a climbing wall, a Sports Medicine Complex, and the Penske Hall of Fame. The athletic department offices are also housed in the Warren (Pete) Musser wing.

**Cundey Varsity House** (1963 and 2002). The building, expanded and renovated in 2002, houses a modern weight training facility, sports medicine and equipment areas, team meeting and reception areas, and locker rooms for several varsity teams. The Varsity House is located on the Murray H. Goodman Campus adjacent to the John C. Whitehead Football Practice Facility.

## Residential Facilities

In the following list, the first date after the name of each building indicates the year of construction. The second date indicates the year of a major addition.

**Brodhead House** (1979). This structure is the university's first high-rise residential facility. The six-story building includes 4-person suites on the five upper floors, with a dining facility and lobby on the entrance level. The building is named in memory of Albert Brodhead, a member of the Class of 1888 who died in 1933, leaving 51 Bethlehem properties to his alma mater.

**Campus Square** (2002). In August of 2002, Lehigh opened a 250-bed residential complex that includes the campus bookstore, the university post office, and several retail stores. Air-conditioned, two-, three-, and four-bedroom apartments are complete with full kitchen, private bathroom and fully furnished living room/dining room areas. Attached to the complex is a parking garage for 350 cars for residents' convenience.

**Dravo House** (1948). This 5-story stone edifice is the university's largest residential facility. It bears the name of two brothers, Ralph M. Dravo, Class of 1889, and Francis F. Dravo, Class of 1887, who founded the Dravo Corp., a Pittsburgh-based international construction company. Both men served as university trustees.

**Drinker House** (1940). This stone building honors the memory of Henry S. Drinker, Class of 1871, university president from 1905 to 1920.

**McClintic-Marshall House** (1957). This U-shaped stone structure was built in memory of Howard H. McClintic and Charles D. Marshall, both Class of 1888, who founded the McClintic-Marshall Construction Co. The firm was the world's largest independent steel fabricating firm before its acquisition by Bethlehem Steel Corp. in 1931. It built locks for the Panama Canal and constructed the Golden Gate Bridge in San Francisco Bay.

**Packer House** The Graduate Student Center and Office of Graduate Life moved here in the summer of 2009, offering multipurpose social programming and meeting space as well as residential space for graduate students.

**Richards House** (1938). The building honors the memory of Charles Russ Richards, president of the university from 1922 to 1935. The building is constructed of stone in modified Gothic design.

**Sayre Park Village** (1998). This residential complex is comprised of three apartment buildings and houses students in three- and four-person apartments. Included is a fourth multipurpose community building and outdoor recreation facilities.

**Taylor House** (1907, 1984). The U-shaped building is one of the earliest concrete structures ever built. It was the gift of industrialist Andrew Carnegie in honor of his friend and associate, university trustee Charles L. Taylor, Class of 1876. The interior of the building was reconstructed and the exterior refinished prior to the facility becoming Lehigh's first residential college in 1984.

**Trembley Park** (1975). This seven-building undergraduate apartment complex is named in memory of Francis J. Trembley, Lehigh professor and pioneer ecologist.

**Umoja House**. The Umoja House was established in 1989 to enhance the campus atmosphere for underrepresented students at Lehigh. The U House offers a safe and comfortable environment for any student who values multiculturalism.

**Warren Square Complex**. This cluster of four residence halls is located on Warren Square and Summit Street. They are upperclass facilities and some are used as special-interest houses.

### Centennial I Complex (1965)

**Congdon House**. Located at the east end of the Centennial I complex. Dr. Wray H. Congdon served as dean of students, dean of the graduate school, and special assistant to the president.

**Emery House**. It is named for Dr. Natt M. Emery, who was vice president and controller.

**Leavitt House**. The Rev. Dr. John McD. Leavitt was the second president, 1875 to 1879.

**McConn House**. C. Maxwell McConn was dean of the university from 1923 to 1938.

**Smiley House**. Dr. E. Kenneth Smiley served as vice president from 1945 to 1964.

**Thornburg House**. Dr. Charles G. Thornburg was professor and head of the Department of Mathematics, 1895 to 1923

### Centennial II complex (1970)

**Beardslee House**. Dr. Claude G. Beardslee was chaplain from 1931 to 1947.

**Carothers House**. Dr. Neil Carothers was dean of business.

**Palmer House**. Dr. Philip M. Palmer was dean of the arts.

**Stevens House**. The Rt. Rev. William Bacon Stevens, of Philadelphia, was Protestant Episcopal bishop of the Diocese of Pennsylvania and first president of the university board of trustees. He was the principal architect of the university's original academic plan.

**Stoughton House**. Dr. Bradley Stoughton was dean of the engineering college, 1936 to 1939.

**Williams House**. Dr. Clement C. Williams was president of the university, 1935 to 1944.

### Saucon Village Apartments (1974)

The five-building garden apartment complex includes housing for married, graduate, and undergraduate students.

**Diamond**. Dr. Herbert M. Diamond, professor emeritus of economics, retired in 1964.

**Gipson**. Dr. Lawrence Henry Gipson, research professor of history, bequeathed his estate to the university to establish the Lawrence Henry Gipson Institute for Eighteenth-Century Studies. Dr. Gipson wrote a monumental 15-volume history, *The British Empire before the American Revolution*. He won the Pulitzer Prize for volume 10, *The Triumphant Empire: Thunderclouds Gather in the West, 1763-1766*.

**Hartman**. Dr. James R. Hartman was chairman of the department of mechanical engineering and mechanics.

**More**. Dr. Robert P. More '10, dean of the College of Arts and Sciences, who also taught German for forty years, bequeathed to the university his \$746,000 estate, amassed after investing \$3,000 in IBM stock. The university child care center is located in this building.

**Severs**. Dr. J. Burke Severs, of Bethlehem, is distinguished professor emeritus of English. He is a Chaucerian scholar.

### Fraternities and Sororities

The university has a strong fraternity tradition, dating back to 1872. Since the admission of undergraduate women in 1971, several sororities have come into being. Some 500 men live in 17 fraternities.

All of the fraternities have houses located on Asa Packer campus. All are chapters of national fraternities.

An alphabetical listing follows. The date of the founding of the chapter is given in the first column. The second column lists the date the chapter occupied its present house; any additional date indicates the most recent addition or major renovation.

Fraternity	Chapter Founded	Present House Occupied	Recent Addition or Renovation
Alpha Tau Omega	1966		

Chi Phi	1872	1923	1968
Chi Psi	1893	1915	2005
Delta Phi	1884	1959	
Delta Sigma Phi	1931	1971	
Delta Upsilon	1885	1968	
Kappa Alpha	1894	1961	
Lambda Chi Alpha	1926	1973	
Phi Gamma Delta	1921	1921	1968
Phi Kappa Theta	1966		
Phi Sigma Kappa	1901	1956	1970
Pi Kappa Alpha			
Psi Upsilon	1884	1909	1966
Sigma Chi	1953	1953	
Sigma Phi	1907	1963	
Epsilon			
Theta Chi	1942	1964	
Theta Xi	1904	1967	

There are nine sororities. All are nationally affiliated and all reside in Sayre Park. Over 430 women live in sororities.

The sororities are listed with year of establishment at Lehigh in the first column and year of moving into their present house in the second column.

<b>Sorority</b>	<b>Establishment at Lehigh</b>	<b>Present House Occupied</b>
Alpha Chi Omega	1988	2007
Alpha Gamma Delta	1975	2000
Alpha Omicron Pi	1983	2004
Alpha Phi	1975	1996
Delta Gamma	1982	2003
Gamma Phi Beta	1975	1998
Kappa Alpha Theta	1984	2006
Pi Beta Phi	1997	2008
Zeta Tau Alpha	2010	2011

## Administration, Faculty and Staff

This section lists the people whose talents and abilities constitute the university's most important resource. Members of the board of trustees contribute their expertise to establish the policies of the university. Also listed are the administration, members of the faculty and staff, and the members of the visiting committees who help to keep courses of instruction current and of maximum value to the students and prospective employers.

### Board of Trustees

When only the year of the degree is listed, the degree was awarded by Lehigh University. Brad Eric Scheler, chair; Kevin L. Clayton, vice chair; Jane P. Jamieson, vice chair; Frank A. Roth, corporate secretary; Denise M. Blew, treasurer and assistant secretary; David L. Hammer, assistant treasurer

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**Victoria Zoellner**, Alpine Associates

#### Principal Officers

Educational information (degrees earned and colleges and universities attended) may be found in the alphabetical listing that follows in this section. The highest degree earned is given here. All offices, unless otherwise noted, are located at Bethlehem, PA 18015; the area code, unless otherwise noted, is (610).

#### Principal Officers

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## College Offices

### College of Arts and Sciences

Maginnes Hall

9 West Packer Avenue; 758-3300

Donald E. Hall, Ph.D., Herbert J. and Ann L. Siegel dean

Diane Hyland, Ph.D., senior associate dean for faculty and staff

Frank Davis, Ph.D., associate dean, undergraduate programs

Garth Isaak, Ph.D., associate dean, research and graduate programs

### College of Business and Economics

Rauch Business Center

621 Taylor Street; 758-3400

Tom Hyclak, Ph.D., interim dean

Katrina Zalatan, Ph.D., associate dean and director of the undergraduate programs

Andrew Ward, Ph.D., associate dean, graduate programs

### College of Education

Iacocca Hall

111 Research Drive; 758-3221

Gary M. Sasso, Ph.D., dean

Ward Cates, Ed.D., associate dean

### P.C. Rossin College of Engineering and Applied Science

Packard Laboratory

19 Memorial Drive West; 758-4025

S. David Wu, Ph.D., dean

John P. Coulter, Ph.D., associate dean, graduate studies

Gregory L. Tonkay, Ph.D., associate dean, undergraduate studies

## Offices and Resources

In this section, only the principal officers are listed. For degree information, consult the alphabetical listing that follows.

### Academic Outreach

618 Brodhead Avenue; 758-4802

Angela Scott, director of academic diversity and outreach

### Admissions

27 Memorial Drive West; 758-3100

J. Leon Washington, dean of admissions and financial aid

### Advancement

27 Memorial Drive West; 758-4711

Joseph P. Kender, vice president for advancement

### Alumni Association

27 Memorial Drive West; 758-3135

Robert W. Wolfenden, assistant vice president alumni relations

### Art Galleries/Museum Operations

420 East Packer Avenue; 758-3615

Ricardo Viera, director/curator

### Athletics

641 Taylor Street; 758-4300

Joseph D. Sterrett, Murray H. Goodman dean of athletics

### Ben Franklin Technology Center

125 Goodman Drive; 758-5200

R. Chad Paul, president & chief executive officer

### Bookstore

9 West Packer Avenue; 758-3383

Brian Alder, General Manager

### Budget Office

422 Brodhead Avenue; 758-4204

Stephen J. Guttman, director of budget

### Bursar

27 Memorial Drive West; 758-3160

Michael J. King, bursar

### Business Services

516 Brodhead Avenue; 758-3840

Mark R. Ironside, executive director

### Career Services

621 Taylor Street, 484 RBC; 758-3710

Richard Freed, acting director

**Center for Writing, Math and Study Skills**

35 Sayre Drive; 758-3098

Edward E. Lotto, director

**Chaplaincy Services**

661 Taylor Street; 758-3877

Rev. Dr. Lloyd H. Steffen, university chaplain, chairperson and professor of religion studies

**Child Care Center**

5 Duh Drive #21; 758-5437

Kathy N. Calabrese, director

**Community and Regional Affairs**

343 Whitaker Lab, 5 E. Packer; 758-5801

Dale A. Kochard, assistant vice president, community and regional affairs

**Computing Center (see Information Resources)**

**Conference Services**

63 University Drive, Rathbone Hall; 758-5306

Mary Kay Baker, director

**Controller's Office**

524 Brodhead Avenue; 758-3140

Kathleen J. Miller, controller

**Corporate and Foundation Relations**

27 Memorial Drive West; 758-6845

Kathryn Humphreys, assistant vice president corporate foundation relations & career services

**Counseling & Psychological Services**

36 University Drive; 758-3880

Ian T. Birky, director

**Dean of Students**

29 Trembley Drive, C108 University Center; 758-4156

Sharon K. Basso, associate vice provost and dean of students

**Development (see Advancement)**

**Distance Education (see Special Academic Programs)**

**Environmental Health and Safety**

616 Brodhead Avenue; 758-4251

Barbara A. Plohocki, director

**Facilities Services and Planning**

461 Webster Street; 758-3970

Van Dobson, associate vice president

**Finance and Administration**

27 Memorial Drive West; 758-3180

Denise M. Blew, associate vice president

**Financial Aid**

218 W. Packer Avenue; 758-3181

Jennifer Mertz, director

**Fraternity and Sorority Affairs**

29 Trembley Drive B004; 758-4157

Tim Wilkinson, assistant dean and director

**General Counsel**

27 Memorial Drive West, Room 307; 758-3572

Frank A. Roth, Esq., general counsel

Heather K. Hosfeld, Esq., associate general counsel

**Government Relations and Economic Development**

5 Whitaker Lab; 758-5802

William D. Michalerya, associate vice president; 758-5802

Vito G. Gallo, assistant vice president for state relations; 758-5801

**Graduate Student Life**

217 W. Packer Ave.; 758-4722

Kathleen S. Hutnik, director of graduate student life

**Health Center**

36 University Drive, Johnson Hall; 758-3870

Susan C. Kitei, M.D., director

**Human Resources**

428 Brodhead Avenue; 758-3900

**Institutional Research**

422 Brodhead Ave.; 758-5890

J. Gary Lutz, vice provost for institutional research

Yenny Anderson, associate director of institutional research

**Internal Audit**

526 Brodhead Avenue; 758-5012

Robert J. Eichenlaub, director

**International Affairs**

32 Sayre Drive, Coxe Hall; 758-2981

Mohamed S. El-Aasser, vice president for international affairs

**Library and Technology Services**

8A East Packer Avenue; 758-3025

Bruce M. Taggart, vice provost

**Mailing and Printing Services**

118 ATLSS Drive; 758-5402 (Mailing); 758-5408 (Printing)

Glenn H. Strause, director

**Manufacturers Resource Center**

125 Goodman Drive; 758-5599

Jack E. Pfunder, executive director

**Parking Services**

36 University Drive, 106 Johnson Hall; 758-3893

Christopher J. Christian, director

**Personnel (see Human Resources)**

**Police (see University Police)**

**President's Office**

27 Memorial Drive West; 758-3156

Alice P. Gast, president

**Provost's Office**

27 Memorial Drive West; 758-3605

Patrick V. Farrell, provost and vice president for academic affairs

**Purchasing**

516 Brodhead Avenue; 758-3840

Mark Ironside, executive director

**Registrar**

27 Memorial Drive West; 758-3200

Emil Gnasso, registrar

**Research**

7 Sinclair Laboratory, Rm. 305; 758-6964

Alan J. Snyder, vice president & associate provost for research & graduate studies

**Research and Sponsored Programs**

526 Brodhead Avenue; 758-3021

Thomas J. Meischeid, director

**Residential Services**

63 University Drive, Rathbone Hall; 758-3500

Ozzie Breiner, director

**Risk Management**

616 Brodhead Ave.; 758-3899

Richard Freeman, director

**Special Academic Programs (Distance Education and Summer Studies)**

436 Brodhead Avenue; 758-3966 (Summer); 758-4373 (Distance)

Margaret Portz, director

**Sports Communications**

641 Taylor Street; 758-3174

Steve Lomangino, director

**Student Affairs**

29 Trembley Drive, University Center; 758-3890

John W. Smeaton, vice provost for student affairs

**Student Auxiliary Services**

63 Rathbone Hall; 758-5339

David M. Joseph, executive director

**Summer Studies (see Special Academic Programs)****Transportation Services**

126 Goodman Drive; 758-4410  
Christopher J. Christian, director

**Treasurer (see Finance and Administration)****University Police**

36 University Drive, Johnson Hall 221; 758-4200  
Edward K. Shupp, chief

**University Communications and Public Affairs**

125 Goodman Drive; 758-4487  
Fred J. McGrail, vice president for communications and public affairs

**Women's Center**

29 Trembley Drive; 758-6484  
Rita Jones, director

**Zoellner Arts Center**

420 East Packer Avenue; 758-5323  
Andrew Cassano, administrative director

**Faculty and Emeriti**

**John H. Abel, Jr.** (1985, 2003), professor emeritus of biological sciences. College of Wooster, BAC, 1959; Brown University, MS, 1964, SCD, 1966.

**Hisham Abu-Nabaa** (2011), program director of healthcare systems engineering and professor of practice of industrial and systems engineering. The University of Jordan(Jordan), BSEE, 1994; Wilkes University, MSEE, 1996.

**John W. Adams** (1965, 1995), professor emeritus of industrial and systems engineering. University Nebraska Lincoln, BS, 1952; University of North Carolina, PhD, 1962.

**Sanaz Aghazadeh** (2012), assistant professor of accounting. Louisiana State University, BS, 2005; University of Oklahoma, PhD, 2012.

**Eugene O. Albuлесcu** (2007, 2011), Ronald J. Ulrich Chair in Orchestral and String Music and associate professor of music. Indiana University, AA, 1992, MA, 1994.

**Jack A. Alhadeff** (1982), professor emeritus of chemistry. University of Chicago, BA, 1965; Oregon Health Science University, PhD, 1972.

**Carlos Alvare** (1971, 1984), professor emeritus of art, architecture and design. Yale University, BArch, 1947; University of Pennsylvania, MCP, 1954; Yale University, MArch, 1973.

**Saladin M. Ambar** (2011), assistant professor of political science. Georgetown University, BA, 1990; The New School, MA, 1994; Rutgers University, PhD, 2008.

**Dave Curtis Amidon, Jr.** (1965, 1994), professor emeritus of political science. Juniata College, BA, 1957; The Pennsylvania State University, MA, 1959.

**David J. Anastasio** (1986, 1993), chairperson and professor of earth and environmental science. Franklin & Marshall, BS, 1980; Johns Hopkins University, MA, 1984, PhD, 1988.

**Anne-Marie Anderson** (2003, 2009), Joseph R. Perella & Amy Perella Chair and associate professor of finance. United States Military Academy, BS, 1987; University of Tulsa, MBA, 1993; University of Arizona, PhD, 2003.

**David C. Angstadt** (2009), professor of practice of mechanical engineering and mechanics. Lehigh University, BS, 1987, MS, 2000, PhD, 2004.

**Rosemarie Arbur** (1972, 1986), professor emerita of english. Nazareth College, BA, 1966; University of Illinois at Chicago, MA, 1967, PhD, 1972.

**Marie-Sophie Armstrong** (1986), associate professor of modern languages and literatures. Sorbonne University(France), BA, 1979; University of Oregon, MA, 1982, PhD, 1986.

**J. Richard Aronson** (1965, 1972), William L Clayton Distinguished Professor and center/institute director of martindale center for the study of private enterprise and professor of economics. Clark University, BEC, 1959; Stanford University, MA, 1961; Clark University, PhD, 1964.

**Catherine M. Arrington** (2005), associate professor of psychology. Furman University, BA, 1994, BS, 1994; Wake Forest University, MA, 1996; Michigan State University, PhD, 2002.

**Kelly F Austin** (2012), assistant professor of sociology and anthropology. Oregon State University, BA, 2006, BS, 2006; North Carolina State University, MS, 2008, PhD, 2012.

**Betzalel Avitzur** (1964, 1995), professor emeritus of materials science and engineering. Israel Institute of Technology(Israel), BA, 1947; University of Michigan Ann Arbor, MS, 1956, PhD, 1961.

**Dunham R. Bainbridge** (1972, 1984), professor emeritus of accounting. Rider University, BS, 1963; Lehigh University, MS, 1972, PhD, 1978.

**Henry S. Baird** (2004), professor of computer science and engineering. Harvard College, BA, 1966; Rutgers University, MS, 1976; Princeton University, PhD, 1984.

**Nicholas W. Balabkins** (1957), professor emeritus of economics. Rutgers University, MA, 1953, PhD, 1956.

**Linda M. Bambara** (1988, 2002), professor of education and human services. SUNY Oneonta, BS, 1975; State University of NY, Binghamton University, MSED, 1977; Vanderbilt University, EdD, 1985.

**Soutir Bandyopadhyay** (2010), assistant professor of mathematics. St. Xavier's College, Calcutta(India), BA, 2003; Indian Statistical Institute(India), MA, 2005; Texas A&M University, PhD, 2010.

**Arindam Banerjee** (2012), assistant professor of mechanical engineering and mechanics. Jadavpur University(India), BS, 1999; Florida Institute of Technology, MS, 2002; Texas A&M University, PhD, 2006.

**Henri J. Barkey** (1987, 1999), Bernard L and Bertha Cohen Chair in International Relations and chairperson and professor of international relations. City University London(United Kingdom), BS, 1975; University College London(United Kingdom), MS, 1976; University of Pennsylvania, PhD, 1984.

**Robert F. Barnes, Jr.** (1965, 2008), professor emeritus of philosophy. Massachusetts Institute of Technology, BS, 1957; Dartmouth College, MA, 1959; University of California Berkeley, PhD, 1965.

**Susan E Barrett** (1987, 1994), associate professor of psychology. Clark University, AS, 1981; Brown University, MS, 1983, PhD, 1987.

**Donald D. Barry** (1963, 1970), professor emeritus of political science. Ohio State University, BA, 1956; Syracuse University, MA, 1959, PhD, 1963.

**Richard W Barsness** (1978, 2009), professor emeritus of management. University of Minnesota Minneapolis, BS, 1957, MA, 1958, MA, 1960, PhD, 1963.

**Filbert J. Bartoli** (2005), Chandler Weaver Chair Professor and chairperson and professor of electrical and computer engineering. Catholic University of America, BE, 1965, MENG, 1967, PhD, 1971.

**Daniel A. Bayak** (2007, 2010), professor of practice of finance. Bloomsburg University, BS, 1971; University of Scranton, MBA, 1974.

**Michael G. Baylor** (1976, 1990), professor emeritus of history. Knox College, BA, 1964; Stanford University, MA, 1966, PhD, 1971.

**Floyd D. Beachum** (2009), Peter E. Bennett '63 Chair in Urban Principalship and program director of educational leadership and associate professor of education and human services. Alabama State University, BA, 1995, MS, 1999; Bowling Green State University, PhD, 2002.

**Gordon C. F. Bearn** (1985, 1992), associate professor of philosophy. Williams College, BA, 1977; Oxford University(United Kingdom), BA, 1979; Yale University, PhD, 1985.

**Gray E. Bebout** (1991, 1997), associate professor of earth and environmental science. University Texas Arlington, BS, 1981, MA, 1984; University of California Los Angeles, PhD, 1989.

- Michael J. Behe** (1985, 1997), professor of biological sciences. Drexel University, BS, 1974; University of Pennsylvania, PhD, 1978.
- Carl R. Beidleman** (1967, 1995), professor emeritus of finance. Lafayette College, BS, 1954; Drexel University, MBA, 1961; University of Pennsylvania, PhD, 1968.
- Peter G. Beidler** (1967, 1977), professor emeritus of english. Earlham College, BA, 1962; Lehigh University, MA, 1965, PhD, 1968.
- Liuba Y. Belkin** (2007), assistant professor of management. International Institute of Economics and Law(Russia), MS, 1997; Rutgers University, MBA, 2002, PhD, 2007.
- Raymond Bell** (1966, 1982), professor emeritus of education and human services. University of Leeds(United Kingdom), BAC, 1961; Temple University, MA, 1966; Lehigh University, EdD, 1971.
- Russell E. Benner** (1962, 1994), professor emeritus of mechanical engineering and mechanics. Cornell University, BS, 1947; Lehigh University, MS, 1951, PhD, 1959.
- Yevgeny Berdichevsky** (2012), assistant professor of electrical and computer engineering. University of California Berkeley, BA, 1999; University of California San Diego, MA, 2002, PhD, 2006.
- Bryan W. Berger** (2010), assistant professor of chemical engineering. Univeristy of Illinois Urbana-Champaign, BSCH, 1999; University of Delaware, PhD, 2005.
- Taieb Berrada** (2009), assistant professor of modern languages and literatures. University of North Carolina, MA, 2001; Northwestern University, PhD, 2007.
- William Andrew Best** (2008), program director of integrated degree in engineering, arts and sciences and professor of practice of electrical and computer engineering. Tufts University, BSME, 1981; Virginia Tech, MS, 1984.
- Ivan Biaggio** (2002, 2010), professor of physics. ETH Zurich(Switzerland), MA, 1986, PhD, 1993.
- Mark H. Bickhard** (1990), center/institute director of institute for interactivist studies and professor of philosophy. University of Chicago, BS, 1966, MS, 1970, PhD, 1973.
- Jerry T. Bidlack** (1973, 1979), professor emeritus of music. Oberlin College, BA, 1953; Boston University, MA, 1957.
- Glenn D. Blank** (1984, 1990), professor emeritus of computer science and engineering. The Pennsylvania State University, BA, 1974; Michigan State University, MA, 1975; University Wisconsin at Madison, MS, 1983, PhD, 1984.
- Ricky S. Blum** (1997, 2002), Robert W. Wieseman Chair in Electrical Engineering and professor of electrical and computer engineering. The Pennsylvania State University, BSSC, 1984; University of Pennsylvania, MSCS, 1987, PhD, 1991.
- Philip A Blythe** (1968), professor emeritus of mechanical engineering and mechanics. University of Manchester(United Kingdom), BS, 1958, PhD, 1961.
- Paolo Bocchini** (2011), assistant professor of civil and environmental engineering. University of Bologna(Italy), MS, 2003, PhD, 2008.
- Alec M. Bodzin** (1999), program director of teaching, learning, and technology and associate professor of education and human services. University of Michigan Ann Arbor, BS, 1988; George Washington University, MEd, 1992; North Carolina State University, PhD, 1999.
- John W. Bonge** (1972, 1980), professor emeritus of management. Princeton University, BS, 1957; Northwestern University, MBA, 1959, PhD, 1968.
- Robert K. Booth** (2006), Class of '61 Professor and associate professor of earth and environmental science. The Pennsylvania State University, BS, 1995; Georgia Southern University, MS, 1998; University of Wyoming, PhD, 2003.
- Berrisford W Boothe** (1991, 1996), associate professor of art, architecture and design. Lafayette College, BA, 1983; Maryland Institute College of Art, MFA, 1986.
- Garold J Borse** (1966, 1977), professor emeritus of physics. University of Detroit, BS, 1962; University of Virginia, MS, 1964, PhD, 1966.
- Amanda C. Brandone** (2010), assistant professor of psychology. Boston College, BA, 2003; University of Michigan Ann Arbor, MA, 2007, PhD, 2010.
- Paul Brockman** (2009), Joseph R. Perella & Amy Perella Chair and associate dean of College of Business and Economics and professor of finance. Nova College, MBA, 1987; Louisiana State University, PhD, 1994.
- Jay D. Brodish, Sr.** (2009), professor of practice of accounting. Lehigh University, BS, 1966.
- Addison C. Cross** (1967, 2011), professor emeritus of english. Davidson College, BA, 1959; Duke University, MA, 1960; Louisiana State University at Eunice, PhD, 1967.
- Forbes T. Brown** (1970), professor emeritus of mechanical engineering and mechanics. Massachusetts Institute of Technology, BS, 1958, MS, 1958, DSC, 1962.
- Derick G. Brown** (2001), associate professor of civil and environmental engineering. Boston University, BS, 1986; University of California Irvine, MS, 1992; Princeton University, MA, 1996, PhD, 2000.
- Stephen G. Buell** (1973, 1995), program director of integrated business & engineering and professor of finance. Lehigh University, BSIE, 1970, MS, 1971, PhD, 1977.
- William Bulman** (2012), assistant professor of history. Washington University of St. Louis, BA, 2002; Princeton University, MA, 2005, PhD, 2010.
- R. Michael Burger** (2006), associate professor of biological sciences. Ithaca College, BA, 1993; University Texas Austin, PhD, 2000.
- Christopher T. Burke** (2008, 2009), assistant professor of psychology. Carnegie Mellon University, BS, 2003; New York University, PhD, 2008.
- Matthew R. Bush** (2008), Frank Hook Assistant Professor and program director of latin american studies and assistant professor of modern languages and literatures. University of Nebraska-Lincoln, BA, 2000; University of Colorado Boulder, MA, 2003, PhD, 2008.
- Sidney R. Butler** (1969, 1974), professor emeritus of materials science and engineering. University Maine, BS, 1954; The Pennsylvania State University, MS, 1956, PhD, 1960.
- Mary Beth Calhoon** (2010), program director of special education and associate professor of education and human services. University of Oklahoma, BA, 1984; Oral Roberts University, MEd, 1994; Vanderbilt University, PhD, 1999.
- Huai-Dong Cao** (2003), Everett Pitcher Professor of Mathematics and professor of mathematics. Tsinghua University(Peoples Republic of China), BA, 1981; Princeton University, MA, 1983, PhD, 1986.
- Hugo S. Caram** (1977, 1986), professor of chemical engineering. Buenos Aires University(Argentina), BSCH, 1967; University of Minnesota Minneapolis, PhD, 1977.
- G. Slade Cargill, III** (1997, 2008), professor emeritus of materials science and engineering. Georgia Institute of Technology, BS, 1966; Harvard University, MS, 1966, PhD, 1969.
- Kimberley Carrell-Smith** (2005), program director of community fellows and professor of practice of history. Wesleyan University, BA, 1979; University of Delaware, MA, 1981, PhD, 1989.
- Allen M. Carrion** (2012), assistant professor of finance. Virginia Tech, BS, 1993; University of Maryland College Park, MBA, 2003; University of Utah, PhD, 2012.
- Bobb Carson** (1971, 2003), professor emeritus of earth and environmental science. Carleton University, BA, 1965; University of Washington, MS, 1967, PhD, 1971.
- David Casagrande** (2012), associate professor of sociology and anthropology. Southern Connecticut State University, BA, 1984; Yale University, MA, 1996; University Georgia Athens, PhD, 2002.



- Grace Caskie** (2004, 2010), Class of '61 Professor and associate professor of education and human services. Millersville University, BA, 1993; University of North Carolina, MA, 1996, PhD, 1998.
- Lynne U. Cassimeris** (1992, 2004), professor of biological sciences. Springfield College, BS, 1980; University of North Carolina, PhD, 1988.
- Ward M. Cates** (1991, 1993), associate dean of College of Education and associate professor of education and human services. Duke University, BA, 1971, EdD, 1979.
- Marie-Helene Chabut** (1988, 1994), professor of modern languages and literatures. ENSEEIHT Institut National Polytechnique de Toulouse(France), BA, 1974, MA, 1979; University of California San Diego, PhD, 1984.
- Helen M. Chan** (1986, 1995), New Jersey Zinc Company Professor and chairperson and professor of materials science and engineering. Imperial College London(United Kingdom), BS, 1979, PhD, 1982.
- Manoj K. Chaudhury** (1993), Franklin J. Howes, Jr. Distinguished Professor and associate professor of chemical engineering. University of Calcutta(India), BSPH, 1976; University at Buffalo, SUNY, PhD, 1984.
- Brian Y Chen** (2010), P.C. Rossin Assistant Professor and assistant professor of computer science and engineering. Rutgers University, BA, 2000; Rice University, MA, 2003, PhD, 2007.
- John C. Chen** (1970, 2010), professor emeritus of chemical engineering. Cooper Union, BS, 1956; Carnegie Mellon University, MS, 1959; University of Michigan Ann Arbor, PhD, 1961.
- Xuanhong Cheng** (2008), assistant professor of materials science and engineering. Wuhan University(Peoples Republic of China), BS, 1998; University of Washington, MS, 2004, PhD, 2004.
- Liang Cheng** (2002, 2009), associate professor of computer science and engineering. Huazhong University of Science and Technology(Peoples Republic of China), BS, 1994; Tsinghua University(Peoples Republic of China), MS, 1997; Rutgers University, PHDC, 2002.
- Meng-Sang Chew** (1992, 1995), associate professor of mechanical engineering and mechanics. Columbia University, BS, 1977, MS, 1977, MPhil, 1979, PhD, 1980.
- Ravindra Chitturi** (2003, 2009), Alison and Norman H. Axelrod '74 Endowed Summer Research Fellow and associate professor of marketing. Illinois Institute of Technology, MS, 1984; University Texas Austin, MBA, 1996, PhD, 2003.
- Ye T. Chou** (1970, 1995), professor emeritus of materials science and engineering. Chung King National University, BS, 1945; Carnegie Mellon University, MS, 1954, PhD, 1957.
- Shin-Yi Chou** (2003, 2010), Frank L. Magee Professor and professor of economics. National Taiwan University(Taiwan), BA, 1994; Duke University, PhD, 1999.
- Mooi Choo Chuah** (2004), associate professor of computer science and engineering. University of Malaya(Malaysia), BE, 1984; University of California San Diego, MS, 1988, PhD, 1991.
- Anna Chupa** (2004), associate chair and associate professor of art, architecture and design. Rutgers University, BA, 1977; University of Delaware, MFA, 1996.
- Alvin Cohen** (1970, 1996), professor emeritus of economics. George Washington University, BA, 1953; Columbia University, MBA, 1955; University of Florida, PhD, 1962.
- Christine L. Cole** (1988, 1994), associate professor of education and human services. St. Olaf College, BSPSY, 1975; University Wisconsin at Madison, MS, 1977, PhD, 1982.
- Vincent E Coll** (2011), lecturer of mathematics. Loyola University Louisiana, BS, 1979; Texas A&M University, MS, 1983; University of Pennsylvania, PhD, 1990.
- Karen M. Collins** (1990, 1994), professor emerita of accounting. Salisbury State, BS, 1976, MBA, 1984; Virginia Polytechnic Institute and State University, PhD, 1988.
- Helen Lynn Columba-Piervallo** (1989, 1995), associate professor of education and human services. Morehead State University, BA, 1972; University of Louisville, MEd, 1977, EdD, 1989.
- Daniel Conus** (2011), assistant professor of mathematics. Swiss Federal Institute of Technology(Switzerland), MA, 2003, PhD, 2008.
- Constance A. Cook** (1989, 1996), professor of modern languages and literatures. University of Washington, BA, 1976, MA, 1980; University of California Berkeley, PhD, 1990.
- Gail A. Cooper** (1987, 1996), associate professor of history. University of California Santa Barbara, BA, 1975, MA, 1980, PhD, 1987.
- Pasquale J. Costa** (2003, 2009), professor of practice of industrial and systems engineering. The Pennsylvania State University, BA, 1969.
- John P. Coulter, Ph.D.** (1990, 1994), associate dean of P.C. Rossin College of Engineering and Applied Science and associate professor of mechanical engineering and mechanics. University of Delaware, BS, 1983, MA, 1985, PhD, 1988.
- Katherine Crassons** (2004, 2010), associate professor of english. Louisiana State University, BA, 1996; University of Colorado Boulder, MA, 1998; Duke University, PhD, 2004.
- David L. Cundall** (1975, 1992), professor of biological sciences. McGill University(Canada), BS, 1967; University of Arkansas, MS, 1970, PhD, 1974.
- Frank E. Curtis** (2009), Frank Hook Assistant Professor and assistant professor of industrial and systems engineering. College of William and Mary, BS, 2003; Northwestern University, MS, 2004, PhD, 2007.
- Stephen H. Cutcliffe** (1980, 2002), program director of science, technology, and society and professor of history. Bates College, BA, 1968; Lehigh University, MA, 1973, PhD, 1976.
- John Hartley Daniels** (1967, 1991), professor emeritus of civil and environmental engineering. University of Alberta(Canada), BS, 1955; University of Illinois Urbana, MS, 1959; Lehigh University, PhD, 1967.
- Dena S Davis** (2011), Presidential Chair in Health - Social Sciences and Humanities and professor of religion studies. Marlboro College, BA, 1972; University of Iowa, PhD, 1986; University of Virginia, JD, 1990.
- Donald M Davis** (1974, 1984), professor of mathematics. Massachusetts Institute of Technology, BS, 1967; Stanford University, PhD, 1972.
- Frank L. Davis** (1987, 1993), associate dean of College of Arts and Sciences and associate professor of political science. University of Nevada Reno, BA, 1973; North Carolina State University, PhD, 1987.
- Brian D. Davison** (2001, 2009), associate professor of computer science and engineering. Bucknell University, BS, 1991; Rutgers University, MS, 1995.
- Marc de Vinck** (2012), professor of practice of mechanical engineering and mechanics. Parsons School of Design, BFA, 1994.
- James A. Dearden** (1989, 2000), chairperson and professor of economics. Muhlenberg College, BA, 1982; The Pennsylvania State University, PhD, 1987.
- Jack A. DeBellis** (1965, 1980), professor emeritus of english. University of Florida, BA, 1957; University of California Los Angeles, MA, 1959, PhD, 1964.
- David Richard Decker** (1982), professor of electrical and computer engineering. North Carolina State University, BS, 1961; Lehigh University, MS, 1963, PhD, 1970.
- Boris Defourny** (2013), assistant professor of industrial and systems engineering. Universite de Liege(Belgium), BS, 2000, MS, 2005, PhD, 2010.
- Mary E. Deily** (1991, 1995), professor of economics. University of Maryland College Park, BA, 1979; Harvard University, MA, 1983, PhD, 1985.
- Gary G. DeLeo** (2001, 1996), associate chair and professor of physics. Suny College Fredonia, BS, 1974; University of Connecticut, MS, 1976, PhD, 1979.

- Terry J. Delph** (1978, 1989), professor emeritus of mechanical engineering and mechanics. Georgia Institute of Technology, BS, 1967; California Institute of Technology, MS, 1968; Stanford University, PhD, 1976.
- Nandini Deo** (2008), assistant professor of political science. Bryn Mawr College, BA, 2001; Yale University, MS, 2003, PhD, 2008.
- Bridget V. Dever** (2013), assistant professor of education and human services. University of Notre Dame, BA, 2002; Marywood University, MA, 2004; University of Michigan Ann Arbor, PhD, 2009.
- Volkmar R. Dierolf** (2000, 2008), chairperson and professor of physics. University of Stuttgart(Germany), MA, 1987; University of Utah, PhD, 1992.
- David B. Diggs** (1998, 1999), lecturer of music. Oklahoma City University, BMUS, 1969; Suny College Stony Brook, MMUS, 1974.
- Robin S. Dillon** (1987, 1993), William Wilson Selfridge Professor and chairperson and professor of philosophy. University of Pittsburgh, BA, 1978, MA, 1981, PhD, 1987.
- Yujie Ding** (2002, 2005), professor of electrical and computer engineering. Jilin University(Peoples Republic of China), BS, 1984; Purdue University, MS, 1987; Johns Hopkins University, PhD, 1990.
- Panayiotis Diplas** (2013), chairperson and professor of civil and environmental engineering. National Technical University of Athens(Greece), BS, 1979; University of Minnesota Duluth, MS, 1983, PhD, 1986.
- Vladimir T. Dobric** (1987, 1993), program director of ms analytical finance and associate professor of mathematics. University of Zagreb(Croatia), BS, 1974, MS, 1980, PhD, 1985.
- Martha Dodge** (2011), professor of practice of electrical and computer engineering. Simmons College, BA, 1975; Lehigh University, BA, 1982, MA, 1988.
- Bruce A. Dodson** (1978, 1986), associate professor of mathematics. University of Oregon, BS, 1972; Suny College Stony Brook, MA, 1975, PhD, 1976.
- Elizabeth A. Dolan** (2001, 2007), associate professor of english. Davidson College, BA, 1989; University of North Carolina, MA, 1992, PhD, 1999.
- Lyndon Dominique** (2011), assistant professor of english. University of Warwick(United Kingdom), BA, 1994; Princeton University, PhD, 2003.
- Beibei Dong** (2009), assistant professor of marketing. Tongji University(Peoples Republic of China), BA, 2002; University of Missouri Columbia, PhD, 2009.
- Louise E. Donohue** (2011, 2009), professor of practice of education and human services. Immaculata University, BA, 1976; Villanova University, MA, 1981; Lehigh University, PhD, 1995.
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