2011-2012 CATALOG

LEHIGH
UNIVERSITY®

Programs and Majors

Your education at Lehigh University will help prepare you to excel by discovering and building upon your personal strengths in a campus community where active learning connects with real-world applications. Learning at Lehigh incorporates active academic research and hands-on experiences, both in and outside the classroom. As a comprehensive university, Lehigh offers students an education that integrates course work across four colleges and different fields of study in a dynamic learning experience that can be customized to individual interests.

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. These are described in Section IV, Graduate Study and Research.

Academic Programs and Majors

Accounting

Africana Studies

American Studies

Anthropology

Applied Mathematics[1]

Applied Science

Architectural History

Architecture

Art

Art History

Arts and Engineering[2]

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[1]

Counseling Psychology[1]

Design

Earth and Environmental Sciences

Economics

Educational Leadership[1]

Electrical Engineering

Elementary Counseling[1]

Elementary and Secondary Education (5-year program)[2]

Energy Systems Engineering[1]

Engineering Mechanics

Engineering Physics

English

Environmental Engineering

Environmental Policy Design[1]

Environmental Studies

French

Finance

German

Globalization and Educational Change[1]

History

Industrial Engineering

Information and Systems Engineering

International Relations

Instructional Technology[1]

International Counseling[1]

Journalism

Journalism/Science Writing

Learning Sciences and Technology[1]

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[1]

Science, Technology, and Society

Secondary Counseling[1]

Sociology and Anthropology

Sociology/Social Psychology

Spanish

Special Education[1]

Statistics

Structural Engineering[1]

Supply Chain Management

Theatre

Women's Studies

Cross-Disciplinary Programs

Africana Studies

American Studies

Arts and Engineering[2]

Asian Studies

Bioengineering

Civil Engineering /Environmental Science

Cognitive Science

Computer Science and Business (CSB)

Design Arts

Electrical Engineering/Engineering Physics

Enterprise Systems Leadership[1]

Environmental Studies

Global Citizenship

Global Studies

Integrated Business and Engineering (IBE)

Integrated Degree

in Engineering, Arts and Sciences (IDEAS)

Music and Engineering/Science[3]

Pre-Dental Science

Pre-Medical Science

Pre-Optometry Science

Science, Technology, and Society

South Mountain College

[1] Graduate level only

[2] Dual-degree (5-year) program

[3] 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

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

Admissions information:

www.lehigh.edu/admissions

Parents & family:

www.lehigh.edu/parents

Other hot links

Catalog:

www.lehigh.edu/catalog

Academic programs:

www.lehigh.edu/programs

Lehigh at a glance:

www.lehigh.edu/lufacts

Campus visits, interviews and open houses:

www.lehigh.edu/visitinglehigh

Maps and Directions

www.lehigh.edu/maps

Fall 2011

August 29	(Monday) - Registration Day; Classes begin
September 2	(Friday) - Last day web registration; Last day to add courses without instructor's signature
September 4	(Sunday) - Degree awarding date
September 5	(Monday) - Labor Day - classes held
September 9	(Friday) - Last day of registration; Last day drop/add without a "W"
September 16	(Friday) - Last day to select or cancel pass/fail grading
September 26	(Monday) - Four o'clock exams Day 1
September 27	(Tuesday) - Four o'clock exams Day 2
September 29	(Thursday) - Rosh Hashanna
October 4	(Tuesday) - Four o'clock exams Day 3
October 5	(Wednesday) – Four o'clock exams Day 4

October 6	(Thursday) – Four o'clock exams Day 5
October 8	(Saturday) – Yom Kippur
October 10-11	(Monday-Tuesday) - Pacing Break - no classes
October 19	(Wednesday) - Mid-term grades due
November 1	(Tuesday) - Applications for January degree due
November 2	(Wednesday) - Four o'clock exams Day 1
November 3	(Thursday) – Four o'clock exams Day 2
November 7-18	(Monday-Friday) - Registration for Spring
November 8	(Tuesday) – Four o'clock exams Day 3
November 9	(Wednesday) – Four o'clock exams Day 4
November 10	(Thursday) – Four o'clock exams Day 5
November 15	(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 23-25	(Wednesday-Sunday) – Thanksgiving Vacation
December 2	(Friday) - Last day for hourly exams
December 9	(Friday) - Last day of classes; Last day to drop a course with a 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 10	(Saturday) - Review-consultation-study period for Tuesday classes
December 12	(Monday) - Review-consultation-study period for Monday classes
December 13	(Tuesday) - Final exams begin
December 21	(Wednesday) - Final exams end

Spring 2012

January 15	(Sunday) – Degree awarding date
January 16	(Monday) - First day of class; Registration
January 20	(Friday) - Last day web registration; Last day to add courses without instructor's permission
January 27	(Friday) - Last day for spring registration; Last day to drop a course without a "W"
February 3	(Friday) - Last day to select or cancel pass/fail
February 15	(Wednesday) - Four o'clock exams Day 1
February 16	(Thursday) - Four o'clock exams Day 2
February 21	(Tuesday) - Four o'clock exams Day 3
February 22	(Wednesday) - Four o'clock exams Day 4
February 23	(Thursday) – Four o'clock exams Day 5
March 1	(Thursday) - Last day for filing applications for May graduation
March 5-9	(Monday - Friday) - Spring break
March 12	(Monday) - Classes resume; mid-term grades due
March 28	(Wednesday) – Four o'clock exams Day 1
March 29	(Thursday) – Four o'clock exams Day 2
April 3	(Tuesday) – Four o'clock exams Day 3
April 4	(Wednesday) – Four o'clock exams Day 4
April 5	(Thursday) – Four o'clock exams Day 5
April 6	(Friday) - Last day to withdraw from a course with a "W"; Last day for May doctoral candidates to deliver advisor approved dissertation drafts to dean
April 6	(Friday) - Good Friday - classes held
April 7	(Saturday) – Passover, classes held on weekdays
April 9-20	(Monday-Friday) Registration for Fall and Summer
April 20	(Friday) - Last day for hourly exams
April 27	(Friday) – Last Class Day; 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 28	(Saturday) - Review-consultation-study period for Tuesday classes
April 30	(Monday) - Review-consultation-

	study period for Monday classes
May 1	(Tuesday) - Final exams begin
May 9	(Wednesday) - Final exams end
May 21	(Monday) - University Commencement Day
July 2	(Monday) - Deadline to apply for September degree
July 27	(Friday) - Last day for September doctoral candidates to deliver advisor approved dissertation drafts to dean
August 17	(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

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.

I. Information of General Interest

This section includes information related to accreditation, admission, advanced placement, transfer students, tuition and fees, financial aid, campus life and academic regulations. Similar information for graduate students may be found in Section IV. The university's history, biographies of its presidents and descriptions of its buildings are found in Section VI.

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 American Assembly of Collegiate Schools of Business. The engineering programs that are accredited by ABET, Inc, 111 Market Place, Suite 1050, Baltimore, MD 21202-4012 – telephone (410) 347-7700, are listed under Section III Undergraduate Studies, 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 ABET. The computer science and business program is accredited by both ABET 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, Section IV.

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 course work being required for enrollment in certain programs within the university. Evidence of academic growth, ability to learn, and motivation are special qualities that may not be reflected in the accumulation of units. Such qualities are also considered by the admissions committee.

Minimum subject matter requirements (16 units)

English	4 units
foreign languages*	2 units
social science	2 units
laboratory science	2 units
college preparatory mathematics	3 units
elective subjects	3 units

*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 can be difficult to assess since each individual comes from a different background. However, the Committee on Admissions will look for 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 paid to courses recognized as being 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. Unnecessary delays in the decision-making process can result if the committee does not have the scores.

The Committee on Admissions recommends that students take the exam in the junior year and again as early in the senior year as possible. In the evaluation process, the highest score in each category 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. Also, 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.

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 Admissions Office 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

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. Such recommendations should address the candidate's other qualifications such as character, intellectual motivation, participation in school activities, and established habits of industry and dependability.

Campus Visits

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 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 several 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

Students may use the Common Application available from school guidance counselors, or they may apply by using the Common Application on-line at *www.commonapp.org* or via the Lehigh Web site at *www.lehigh.edu/apply*. Students are required to submit a supplemental form to the Common Application that can be obtained through the Common Application Web site or the Lehigh Web site. For information on how to apply for need-based financial aid, visit 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

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 indicated on the appropriate forms from the school guidance office. Students for whom the application fee is a hardship should consult the guidance offices at their schools.

Early Decision

Our program is a binding early decision plan, meaning that the student is expected to withdraw all applications to other schools if accepted to Lehigh. The student, his or her parents/guardians, and guidance counselor must sign an Early Decision Request form to confirm their understanding of this provision. Students applying Early 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 December 15. 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 been early and active in their college search, and is sure that he or she wants to attend Lehigh. When reviewing an early decision application, the committee 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.

Early decision candidates who have filed the CSS/Financial Aid Profile application, available at *www.collegeboard.com,* and prior year tax forms, will be notified of their financial aid packages as soon as possible after the decisions on admission are made by the Office of Admissions. In addition to the CSS/Financial Aid Profile, the Free Application for Federal Student Aid (FAFSA) is also required. This form may be accessed online at www.fafsa.ed.gov. Lehigh's code for FAFSA is 003289. The deadline to file FAFSA is February 1.

Admission and Deposit

Admissions decisions are mailed to each student and are also posted online via the Campus Portal. Admission is granted only through written notice by the Office of Admissions. 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

Each January and August, a limited number of 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, but entrance examinations are optional if a student has completed 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. Students wishing to enter in the spring should apply no later than October 1 and applicants for the fall semester should have their application in by March 1. Applications may be obtained by visiting Lehigh's Web site at *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 the student's admission application have arrived at the university. Decisions are made as soon as possible after the application is complete. 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: Transfer students are guaranteed housing for at least their first semester provided an enrollment deposit is received by the date established within the text of the offer of admission letter. 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.

Students who achieve advanced placement are afforded three major advantages. First, they commence study at Lehigh at a level where they will be academically comfortable. Second, students who qualify for college credits may be graduated at an earlier time—with resulting savings in time and tuition outlay. Third, qualified students may, in the Lehigh senior year, enroll for a limited amount of work for graduate credit.

Entering first-year students that ask the College Board to send their advanced placement grades 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 fye@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 and Architecture. Six credit hours for Art 1 and Art 2 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 three credit hours for Art 3.

Biology. Four credit hours for EES 31 and 22, 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 4 credits for CSE 015

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 will receive three hours of credit in freshman English; these students must complete the six-hour requirement by taking an English course ENGL 11. 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 22.

Government and Politics. Four credits for POLS 1 are awarded to those students that score a 4 or 5 on the American Government test, and four credits for POLS 3 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 Latin 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 21, 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 21 and Math 22, Calculus I and II. Credit for Math 21 and 22 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 French or Spanish literature examinations will receive 4 credits for French 152 or Spanish 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 Physics 11, Physics 12, 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 Physics 11, four hours of credit will be given for Physics 21, Physics 22, 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 1 are granted to students who earn a grade 4 or 5.

Statistics. Students scoring a 4 or 5 will receive 4 credits; for MATH 12 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 $450 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 one of the Category I Meal Plans. Upper-class students living in a residence hall are required to participate in 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.

Tuition and Fees

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, 2011-2012	**$40,660**
Technology Fee	$300
University Housing Category I (Dravo, Drinker, Richards, McClinticMarshall, Centennial I & II)	$6,220
Category II (ROTC, UMOJA, All Greek Houses, Warren Square, Hillside)	$6,660
Category III (Taylor, Trembley Park Suite Singles, Brodhead House)	$6,930
Category IV (Sayre Park Village, Campus Square, Trembley Park Apartments)	$7,240

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

Board

The number of meals specified is per week.

Category IA Carte Balance	$ 5,080
Category I 19 meals including $100 Dining Dollars	$ 4,620
14 meals including $200 Dining Dollars	4,620
225 Block Plan any 225 meals per semester including $100 Dining Dollars	4,620
Category II 10 meals including $200 Dining Dollars	4,070
150 Block Plan any 150 meals per semester including $300 Dining Dollars	4,070
Category III 75 meals per semester including $500 Dining Dollars	2,480
Category IV 50 meals per semester including $500 Dining Dollars	1,940
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 $51,800 to $52,240 for the 2011-12 academic year.

Other Fees
(applied to prevailing circumstances)

Tuition charge per credit for part-time status or audit	$1,695
Engineering and Science Fee per year (for specified students)	450
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	100
Late application for degree	40
Examination makeup (after first scheduled makeup)	25
Late payment (after announced date)	200
Returned check fine	35
Key/lock change (lost or non-return), room door, residence halls/sorority	25
Identification card (replacement)	15

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 2011-12 academic year will be announced no later than March 2011.

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

An itemized statement of charges is mailed from the Bursar's Office approximately six weeks prior to the start of each semester. Bills are addressed to the student and mailed to the home address as recorded in the BANNER Student System. 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 5 days prior to the start of classes. If registration occurs after bills are issued, payment is still due prior to the start of classes. Students can access their account on-line 24/7 through the BANNER Student System. 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 1st for Fall Semester and December 1st for Spring Semester.

The university also offers a plan under which enrolled undergraduate students can pre-pay more than one year of tuition. 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^{th} day of class.

All refund checks will be payable to the student unless (a) the student has authorized in writing a parent or guardian listed in the Banner Student System to receive the refund, or (b) 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.

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

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, www.collegeboard.com, www.collegenet.com and 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

Application Procedures for 2011-2012

All students are required to file both the Free Application for Federal Student Aid (FAFSA – online www.fafsa.ed.gov) and College Scholarship Service CSS PROFILE (online www.collegeboard.com). Additional forms, such as tax returns (2010 for the 2011-12 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. The financial aid website: www.lehigh.edu/financialaid details the timeline for all applicants (early decision, transfer and continuing) and provides 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 any type 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

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 can range from $3,000 up 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 and men's and women's basketball and a limited number of full or half tuition awards 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.

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)

Alternative Educational Loan Programs
There are a number of private educational alternative loans available. We suggest reviewing options available at www.elmselect.com. It is the family's responsibility to evaluate and select a lender. Federal loan options are our first recommendation.

Army ROTC Scholarships
The U.S. Army awards tuition scholarships supplemented with $480 toward course-related books and a $250 per month stipend. Recipients incur an obligation to serve on active duty as commissioned officers. Contact the Department of Military Science for details.

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
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 or visit our website www.lehigh.edu/financialaid.

Campus Life

Religious Activities

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

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 recognizes over 150 student clubs ranging from academic organizations and cultural groups to competitive club sports 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 following UR www.lehigh.edu/~instuact or by visiting the Lehigh University homepage and selecting the link to clubs and organizations.

Lehigh University Theatre

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: *Antigone, Five Flights, The Last Days of Judas Iscariot,* and a student-written piece, *gEner8tion txt.*

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: *American Buffalo, Two Rooms* and *Three Degrees of Reality in Three One-Act Plays*. 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

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.

The Lehigh University Philharmonic Orchestra, directed by Eugene Albulescu, 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 will bring the great works of orchestra repertoire to life in four concerts a year in Baker Hall, Zoellner Arts Center. Membership is by audition.

The Jazz Ensemble, Bill Warfield, director, performs contemporary literature as well as the music of the more traditional bands such as Basie, Ellington, Goodman and Herman. In addition to performances on campus each semester, other concerts take place in New York City and the surrounding areas. Membership is by audition.

The Jazz Band, directed by Bill Warfield, consists of student, faculty, and community musicians performing contemporary and traditional big band literature. Concerts are performed in the fall and spring at Lehigh as well as in the surrounding communities. Membership is by audition or invitation.

The Jazz Combo is an advanced combo (chamber group) for the most experienced improvisers under the direction of Dave Riekenberg. The group performs several times each semester on and off campus. Membership is by invitation only. Other combos are formed to accommodate student interests.

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.

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.

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.

The Lehigh University Choir, directed by Steven Sametz, 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.

The Lehigh University Choral Union, composed of students, faculty, staff, and Lehigh Valley community members under the direction of Steven Sametz, 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.

The 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 – Lehigh University's Women's Ensemble begins a new tradition of women's music on campus. Under the direction of Debra Field, 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.

ArtsLehigh

ArtsLehigh is an all-university program serving students, faculty, staff, administration and the local community. ArtsLehigh's mission is to facilitate and deepen engagement in the arts among students, faculty, staff and the community. Programs for students include: *ArtsAlive* which is an orientation to the arts offered for Freshmen and transfer students; *grants* which provide funding for student initiated projects and activities in the creative and performing arts. Programs for faculty and staff include collaborative grants, workshops, faculty colloquia and facilitation services to encourage out of classroom experiences as well as interdisciplinary approaches to the arts. ArtsLehigh also promotes an *Artist in Residence* program which allows students, faculty, staff, and the community to work creatively with leading artistic practitioners.

Volunteer and Community Services

Lehigh's Community Service Office, located in the Ulrich Student Center, is a place where students, faculty, staff, and student organizations interested in volunteering in the community can get information. The Office is staffed by students who serve as Community Service Assistants, a Graduate Assistant, 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 and Livin' La Vida

Lehigh. The Office also provides students with week-long service initiatives over break giving students the opportunity to travel around the country to serve in homeless shelters, on environmental projects, Habitat for Humanity and with youth programs.

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.*

Guest Speakers

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; U.S. Supreme Court Justice Antonin Scalia; Lee Iacocca; General Colin Powell; South Africa's Bishop Desmond Tutu; 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, Alcoa. 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

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 <u>educational</u>, <u>participatory</u>, <u>competitive</u>, and/or <u>instructional</u> programs for the campus community.

Club Sports

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 Cheerleading, 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

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

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

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

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

Campus Athletics strongly encourages all participants to consider his/her personal health and physical condition prior to participation 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

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

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

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.

II. University Resources

Library and Technology Services

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.

Libraries

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 19th 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 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

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.

Lehigh also provides secure wireless connectivity in many campus settings – see 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

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 microcomputers (PCs and Apple personal computers) are distributed across campus for convenient use by students at more than 27 computing sites. For example, there are more than one hundred computers in the libraries and computing center, and another hundred in Rauch Business Center. A twenty-four hour site at Grace Hall has 30+ machines. There are e-readers 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 space from the campus sites or their residence facility. 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 a variety of high performance computing options suitable for research and computer-intensive applications. Among them are: blade servers, a multiprocessor central compute server, Beowulf clusters, and a Condor grid to utilize cycles on workstations and other resources. For more information, see 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

Instructional Media Services operates two facilities in Fairchild Library to provide students with access to and instruction in a wide range of media resources: the Media Center and the Digital Media Studio. The Media Center offers media resources, scanners, and color printers. Resources include audio, video, and electronic media and the equipment and viewing spaces needed for their use. Videos and DVDs are available for viewing or for short-term loan to faculty and graduate students, and the Center coordinates their acquisition for classroom use. The Media Center is also the location of Lehigh's Technology Resource Learning Center which offers faculty the services of instructional designers and the use of a high technology demonstration classroom with Internet2 teleconferencing capability.

The Digital Media Studio offers students and faculty consulting assistance, a graphics training 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, photographs, 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.

A third media facility, the International Multimedia Resource Center (IMRC), is located in nearby Maginnes Hall. The IMRC trains students to produce web-based, graphic, video projects and consults with faculty wishing to explore new approaches to educational technology. It conducts workshops in web-authoring and multimedia production, and includes flexible seating, a web-capture whiteboard, scanners, a slide scanner, computer and viewing stations, as well as the technology to support it as the campus broadcasting hub.

Student Services

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. 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. 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

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)

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 Upper Gallery and Lower Gallery permanent exhibitions are in the Zoellner Arts Center. Maginnes Hall houses the DuBois Gallery, the Gallery at Rauch Business Center, the Girdler Student Gallery is in the University Center, and the Siegel Gallery is in Iacocca Hall on the mountaintop campus. The Muriel and Philip Berman Sculpture Gardens are located on Memorial Walkway and on the 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

Lehigh's Faculty Development Program aims to foster excellence in teaching and learning by providing faculty with tools, development opportunities, workshops, and consultation services.

As part of the Lehigh Lab—Lehigh's award winning campus wide initiative to advance the adoption of innovative technologies and techniques that enhance teaching, learning, and research—Faculty Development works closely with the other divisions of Library and Technology Services to provide a coordinated array of support for faculty. Faculty looking for assistance with instructional technology are encouraged to arrange a visit to the the Technology Resource Learning Center (TRLC), located in the Fairchild-Martindale Library Media Center, or the Digital Media Studio. 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 Lehigh Lab also houses the TRAC (Technology, Research and Communications) Writing Fellows Program, which trains students to serve as peer tutors in discipline-based courses and consult with faculty on developing effective writing assignments.

The Director of 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, Director of Faculty Development, may be contacted at 610-758-6840 or grr3@lehigh.edu. Dr. Gregory Skutches, Writing Across the Curriculum Coordinator, may be contacted at 610-758-4932 or grs206@lehigh.edu. The Faculty Development web site is accessible at www.lehigh.edu/~infdli. Writing Across the Curriculum website is at www.lehigh.edu/~inwcx.

Lehigh University Press

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: Jeff Schramm, *Out of Steam: Dieselization and American Railroads 1920*-1960; Susan Carlile (ed.), *Masters of the Marketplace: British Women Novelists of the* 1750s; Jeffrey Kahan, *Bettymania and the Birth of Celebrity* Culture; James P. Myers, Jr., *The Ordeal of Thomas Barton: Anglican-American Missionary in the Pennsylvania Backcountry, 1755-1780*; Heikki Lempa and Paul Peucker (eds.), *Self, Community, World: Moravian*

Education in a Transatlantic World; Jessie G. Lutz (ed.), *Pioneer Chinese Christian Women: Gender, Christianity, and Social Mobility*; Priscilla H. Roberts and Richard S. Roberts, *Thomas Barclay (1728-1793): Consul in France, Diplomat in Barbary*; Douglas Charles Kane, *Arda Reconstructed: The Creation of the Published Silmarillion*; Jean R. Soderlund and Catherine S. Parsynski, (eds.) *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*; Steven Craig Harper, *Promised Land: Penn's Holy Experiment, The Walking Purchase, and the Dispossession of Delawares, 1600-1763*.

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: www.lehigh.edu/~inpress/

Resources for Students

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://www.lehigh.edu/~instuaff/

Dean of Students http://www.lehigh.edu/~indost/

Counseling and Psychological Services
http://www.lehigh.edu/~incso/index.shtml

Health and Wellness Center http://www.lehigh.edu/health/

Lehigh University Police Department
http://www.lehigh.edu/~inlpd/index.shtml

Alcohol, Drugs, and Other Lifestyle Choices Programs

Alcohol, drugs, and other lifestyle choices programs, education, and services are integrated into many aspects of student life. Much of this work is coordinated and provided by the Office of Counseling and Psychological Services (610-758-3880). Web based (see Counseling Services Site) and direct services are provided for a wide range of issues ranging from wellness and health to matters of substance use and misuse. Because members of the Lehigh community recognize that substance abuse and chemical dependency can significantly affect student lives, educational programs are designed to encourage peak performance and avoid high-risk behavior. Confidential individual and group counseling and consultation services are available to students who find themselves having problems because of their own substance use, or related to friends and/or family members having similar problems. Appointments for alcohol, drug, and other addiction services are easily made by calling the office of Counseling and Psychological Services at 610-758-3880 or by visiting 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.

Theme weeks and sponsored outreach programs such as Alcohol and Drug Awareness Week and National Alcohol Screening Day provide educational programs on a variety of addiction and peak performance topics. Consultation for peer education is also available to students creating programs and planning interventions. Intervention services include training programs for Residence Life staff, peer educator groups, athletes, students referred by the Dean of Students office, and other members of the Lehigh community. Individual and group counseling is provided by the office of Counseling and Psychological Services. Students who struggle with defining their own values regarding substance use and other addictions (i.e., gambling, internet) are encouraged to clarify and process their beliefs in a safe and confidential environment. On-campus counseling may allow students to successfully enter into recovery (i.e., from alcoholism or chemical dependency) without having to disrupt their university careers. If a student cannot accomplish this on campus, referrals to in-patient or outpatient treatment programs can be made. Aftercare services can be provided once the student returns to campus, utilizing on-campus counseling or by referral to 12-step group meetings (such as A.A. and N.A). These meetings are held on campus and in the surrounding community. Referral to other treatment programs, community service programs, and programs associated with the court system can also be facilitated by various offices within Student Affairs.

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.

The Health Center staff treats 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 general hospital.

Incoming students must comply with immunization requirements. There is no charge for most of the care provided to students. Some exceptions include: referrals to physicians, hospitals, or other medical facilities outside the student Health Center, and medications not carried by the Health Center which require prescriptions. 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.

The Director of Health Promotions arranges for educational programming, trains student peer educators, and coordinates with other university departments to promote a healthy campus environment.

For more information, please consult our web page at 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).

I. 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.

II. 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

UCPS staff members provide group and individual counseling and psychotherapy services to both undergraduate and graduate students. A short-term treatment model is used for individual work while much of the group work is of longer duration. Referrals for psychiatric consultation are made when requested and appropriate. All counseling and therapy services within the UCPS are confidential.

- 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. Some of this programming may include partnership with UCPS sponsored student peer education groups.

- 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 for students and for the Lehigh community. Tutoring and consultations are provided by graduate students and faculty; 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 Service 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 a free Career Planning Guide that describes how to use the on-campus interviewing system, prepare for interviews and plant/office visits, write resumes and 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, living groups, 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. 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.

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.

Similar information is contained in the OFA's booklet *National Fellowships and Scholarships*. Copies of the booklet and further information about awards can be obtained from the OFA's director, James Gunton (jdg4@lehigh.edu).

Office of International Affairs

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®

111 Research Drive; 758-6723

Richard Brandt, Director, Iacocca Institute and Director, Global Village; Elizabeth Simmons, Curriculum Director, Global Village; Mary Frances Schurtz-Leon, Candidate Manager, Global Village; Carol Ham, Director, Professional Education; Trisha Alexy, 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 1266 interns representing 119 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 and Peru 2011. Future programs are scheduled for Italy 2012 and China 2013.

The Iacocca Institute fulfills its mission for leadership development in two other program areas, Iacocca Institute Professional Education and the Pennsylvania School for Global Entrepreneurship. The Institute established and maintains a professional training arm that serves managers and leaders in business and government. Appropriate seminar-style courses are selected to serve the markets in the tri-state area with workshops, customized training and leadership programs that enhance strategic skills and networking opportunities. Professional Education programs are designed for maximum impact through dynamic, short-term learning experiences focused on the needs of busy professionals. To date, Professional Education programs have trained more than 1805 participants from over 350 companies with 70 training programs.

The Iacocca Institute has the privilege of hosting the Pennsylvania School for Global Entrepreneurship (PSGE). PSGE is designed as a unique learning program to educate top high school students from Pennsylvania and around the world on global entrepreneurship. The five-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 631 students from 47 countries.

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.

Office of International Affairs

Lehigh University's Fulbright Program Office

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 the Fulbright students, as well as Fulbright Scholars coming to Lehigh, 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 To learn more about Lehigh's commitment to the Fulbright Program please visit the following web site: http://www.lehigh.edu/fulbright/

Global Citizenship

Global Citizenship Program

Gisella Gisolo, Ph.D., director
Coxe Hall, 32 Sayre Drive, Bethlehem, PA 18015
Phone (610) 758-6646; Fax (610) 758-5156; email: gig207@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--often constructed through theological and cultural traditions. Religious extremism, trade policies, human rights, and g 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

Year 1:	GCP 010 Introduction to Global Citizenship (3) (Fall) GCP/ENGL 007 Global Literature (3) (Spring)
Year 2:	GCP 085 Practicum (1) (Fall) Global Citizenship Intersession Trip (0) (Winter Break)
Year 3:	GCP 285 Junior Practicum (2) (Fall or Spring)
Years 4:	GCP 385 Global Citizenship Capstone (4) (Fall and Spring)
Floating Requirements:	3 GC-designated electives (9 to 12 credits) Second study abroad experience (min. 5 weeks long)

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 in Global Citizenship

GCP 010. Introduction to Global Citizenship (3)
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 1 equivalent.

GCP 007 (ENGL 007). Global Literature (3)
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 2 equivalent.

GCP 085. Practicum (1)
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 385. Global Citizenship Capstone Course (4)
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.

Global Union

Bill Hunter, Director, Global Union, 215 Coxe Hall, 32 Sayre Drive, Bethlehem, PA 18015-3123, (610) 758-4505; E-mail: wdh3@lehigh.edu

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. There are more than 1,000 members of the Global Union from over 30 countries, including two-thirds 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 has a TV/VCR, stereo, comfortable couches, board games, and can be used for meetings, quiet study or film presentations.

For more information regarding the Global Union, check our website at http://www.lehigh.edu/~inglobal/

Lehigh University/United Nations Partnership

Bill Hunter, Lehigh Representative to the United Nations, 100A Coxe Hall, 32 Sayre Dr., Bethlehem, PA 18015-3123, (610) 758-4505; Email: wdh3@lehigh.edu. http://www.lehigh.edu/~inunited

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 private 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, check out our website at: http://www.lehigh.edu/~inunited

Study Abroad Office

Neil McGurty, Director; Katie Welsh Radande, Associate Director; Morgan Volkart, 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; 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 daily. 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 do not count in the student's G.P.A. 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: Religion in India; Religion in Turkey; Business and History in Belgium; Business in Prague; Microfinance Abroad in various locations; Art and Architecture in Vicenza; History and Architecture in Paris; Internships and Language in Shanghai; Sustainable Development in Costa Rica; French and Africana Studies in Martinique; MLL in Spain; Economics and Humanities in Ireland; Engineering in Germany. Several programs include internship opportunities for credit in addition to coursework. Lehigh credit and grades are applied to a student's transcript, and are counted in 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 counted in the student's GPA.

Other International Experiences: Short-term international experiences such as SummerSERVE Antigua, Choir, Engineers without Borders (EWB), Philharmonic, Interfaith Dialogue: Lehigh in Israel.

To view all program options and begin planning for a Study Abroad Experience, visit www.lehigh.edu/studyabroad.

Office of International Services

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, English 3 and 5 are designed to supplement English department required courses, English 1 and 2. Undergraduates can also take English 97 for credit (see description below). Graduate students should contact their departments regarding acceptance of credit towards residency requirements. ESLP courses may be repeated for credit with a maximum of three repetitions. 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.

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, TOEFL, GRE and GMAT.

The ESL Language Center is located in the ESL Department Office in Coxe Hall, Room 204. Contact the ESL office for more information: (610) 758-6099 or email inesl@lehigh.edu. Also, please visit our website for online English assistance and information www.lehigh.edu/~inesl

English Testing for Teaching Assistants. New Teaching Assistants must take the SPEAK test 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 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 English 3 and English 5 (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 English 310 (Introduction to Theories and Methods of ESL Instruction) and English 314 (ESL Teaching Practicum). See the Department course listings for descriptions. (These teaching courses can also be taken for graduate credit.) For more information about English as a Second Language at Lehigh, refer to our web site at www.lehigh.edu/~inesl.

Courses:

ESLP 1 ESL Academic Writing and Grammar (1)
Instruction in understanding and using advanced English sentence structures in writing. Advanced academic vocabulary and grammar development to improve writing sophistication and accuracy. Required for graduate students who do not achieve a sufficient score on the Lehigh ESL Writing Sample and/or for students needing additional writing proficiency. 4 hours per week.

ESLP 2 ESL Academic Writing and Reading (1)
The writing process and composing skills, editing skills, vocabulary development and reading fluency for ESL students. Required for graduate students who do not achieve a sufficient score on the Lehigh ESL Writing Sample and/or for students needing additional writing proficiency. 4 hours per week.

ESLP 3 ESL Clear Speech and Conversation (1)
Conversational English, colloquial language and idioms, pronunciation and accent reduction and practice in basic listening skills for an academic setting. 4 hours per week.

ESLP 4 ESL Academic Speaking (1)
Correct use of grammatical structures in oral English and practice in accurate pronunciation. ESL students will explore the functions of American English in an academic setting. 4 hours per week.

ESLP 11 ESL Technical Writing and Composition (1)
Formal composition and technical writing including general technical vocabulary, technical sentence structure, and research skills for the advanced ESL student. Prerequisite: successful completion of ESLP 1 or 2 (ESL Academic Writing and Reading) or ENGL 5, or with permission of ESL Director. 4 hours per week.

ESLP 12 ESL Advanced Speech and Presentation Skills (1)
Development of advanced speaking skills and presentation techniques through a study of formal spoken rhetoric, accent improvement, and presentation skills. For the undergraduate or graduate student seeking formal speech skills and/or for teaching assistants. Prerequisite: successful completion of ESLP 3 or 4 , or SPEAK score 200+, or permission of ESL Director. 4 hours per week.

ENGL 3. Composition and Literature I for International Writers (3) fall
Idiomatic English both oral and written, with a strong emphasis on producing well-organized, coherent essays. Enrollment limited to non-native speakers; placement is determined by placement testing or ESL director's recommendation.

ENGL 5. Composition and Literature II for International Writers (3) spring
Continuation of English 3.

ENGL 97. Speech Communication for Intl. Speakers (1) fall
Spoken English improvement through practice of American English in "real contexts." This course is for first or second year undergrads who have advanced English skills.

ENGL 310. Introduction to Methods of English as a Second Language Instruction (4)
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.

ENGL 314. Teaching English as a Second Language: A Practicum (3)
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. Prerequisite: English 310.

Office of International Students and Scholars

Gisela Nansteel, 32 Sayre Drive, Coxe Hall, Bethlehem, PA, 18015-3123; (610) 758-4859. Fax (610) 758-5156. E-mail: intnl@lehigh.edu. *http://www.lehigh.edu/~intnl/*

The Office of International Students and Scholars (OISS) 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 OISS, 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 OISS.

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

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 19 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 8 graduate degrees in a variety of disciplines which include Biological Chemical Engineering, Chemistry, Chemical Engineering, Healthcare Systems Eng., Manufacturing Systems Engineering, MBA, Mechanical Engineering, Molecular Biology, and Polymer Science & Engineering. We also offer 6 graduate certificates available either for Credit or Professional Continuing Education. They include Analytical Principles of Pharmaceutical Science, BioOrganic Principles of Pharmaceutical Science, Regulatory Affairs, Project Management, Supply Chain Management, and Quality Engineering.

For more information on programs and course offerings, admission, registration and technical requirements, visit the distance education website at *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/summersessions*, see us on Facebook or 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.

III. Undergraduate Studies

Graduation Requirements

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 advisers 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

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

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 Engineering and Applied Science.

Some five-year, two-degree programs appear in the description of courses under Arts-Engineering and Five-Year Programs in Section V. 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 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 major 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; ARTS-Master of Business Administration; Civil Engineering and Earth and Environmental Sciences; Electrical Engineering and Engineering Physics; Engineering-Master of Business Administration; and College of Education.

Advisement

Every undergraduate is assigned a faculty adviser. Undeclared majors in the College of Business and Economics are assigned to an undergraduate adviser and a student mentor. Until the major is declared, assistance is also available through the dean's office of the college in which the student is enrolled. When the major has been chosen, a faculty member from the major department will act as the academic adviser.

This adviser 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 adviser will help to identify other resources and support systems available at the university, such as The Learning Center, the counseling service, and the Office of Career Services.

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. All students are given a Handbook at the beginning of the fall semester; Rules and Procedures is available on Lehigh'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 responsible for his or her progress toward meeting specific requirements for graduation. Academic advisers and department chairs 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.

The registrar's office will provide, at the student's request, a printout of a degree audit noting all program deficiencies. The degree audits are also available on the web for all undergraduate students. All students are requested to go through this process before registering for their senior year.

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 March 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 November 1.

Failure to file such notice by such dates mentioned debars 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.

Latest date for registration. No registration is accepted later than the tenth day of instruction in any semester, or fifth day of a summer session.

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 students 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 incompletion 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.

The notation of NR (not reported) is temporarily placed in a student record when due to circumstances, no grade was reported by the instructor by the established deadline.

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 1st semester 0 to 21 credits earned	1.70
sophomores 22 to 51	1.80
juniors and seniors 52 or more	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 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 l.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.

Withdrawal From a Course. 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 withdrawing from the university and the policy is noted below. A student who drops 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 drops 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.

Release of Final Grades. Grades for undergraduate students are available from the registrar as soon as possible following the deadline for reporting of grades on line using the secure access facility. Undergraduates students who would like a 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. If a course is repeated, the final grade received upon repetition of the course is counted in the cumulative average. The original grade and credit hours received will be dropped 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 (a) file the deletion form with the registrar's Office; and (b) repeat the identical course with a final grade at Lehigh.

Pass-Fail Systems for Undergraduates

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 noted in section V of the catalog. 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

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 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 on the other institution's transcript. 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 intersession 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.
- 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 few days 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.

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 seniors working for departmental honors in particular majors. Names of those students attaining 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; or by a proficiency exam administered by the Department of Modern Languages and Literature)
- 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.

College of Arts and Sciences

Anne S. Meltzer, *dean*; Michael Stavola, *associate dean*; Augustine Ripa, *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's studies

Mathematics and Natural Science: Astronomy, behavioral neuroscience, biology, chemistry, computer science, earth and environmental science, mathematics, molecular biology, physics

BA degrees in predental 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.

A. College Seminar/First-Year Class (one course during the first year)	1-4 credits
B. English Composition (two courses during the first year)	6 credits

Students and advisers should monitor closely the progress toward completion of requirements C through F. Courses taken to satisfy a major program may be used to satisfy distribution requirements in only one distribution area.

C. Mathematical Sciences 3 credits
Chosen from mathematics or designated courses from philosophy or computer science
D. Natural Sciences 8 credits
Chosen from those designated in: astronomy, biological anthropology, biosciences, chemistry, earth and environmental sciences, physics, and neuroscience.
At least one science course must also include the associated laboratory.
E. Social Sciences 8 credits
Chosen from those designated in: anthropology, classics, economics, political science, history, international relations, journalism, psychology, social psychology, social relations, sociology, STS, and urban studies.
F. Arts and Humanities 8 credits
Chosen from those designated in: architecture, art, classics, history, modern languages and literature, English, music, philosophy, religion studies, and theatre.

Total required for graduation: 120 credits

A student's program, including the choice of distribution requirements, is not official until approved by the adviser.

College Scholars Program (Eckardt Scholars)

The Roy Eckardt College Scholars Program is a selective and unique honors program in the College or Arts and Sciences emphasizing interdisciplinary exploration as well as student choice and flexibility in designing an independent course of study. Students in the program are exempt from the Arts & Sciences distribution requirements and work with the director to create a course of study that best suits their academic interests and ambitions. The program includes a significant component of independent research in the form of a College Scholar Thesis requirement as a capstone event.

This highly selective program is restricted to a small number of especially qualified students, some of whom are enrolled at the time of admission to the university and the rest as first-semester sophomores. Entering first-year students may join the program at the invitation of the Eckardt Scholars Advisory Council. Applications from sophomores are evaluated by the Advisory

Council on the basis of their academic records, written statements of educational goals, and recommendations from two faculty members.

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. Additionally, all Eckardt College Scholars will complete two special Eckardt Scholar seminars required of all program participants.

In addition to the academic privileges of the program, Eckardt Scholars are offered a variety of extracurricular opportunities, including invitations to meet visiting speakers, informal meetings with faculty members, dinners, lectures, plays, musical events, and other cultural activities.

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 Arts
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)
Theatre
Women's 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: CHM 30/31 (or CHM 40/41) and CHM 110/111 and 112/113
Biology: BIOS 41/42, 115/116, and 120
Physics: PHY 10/12 (or 11/12) and 13/22 (or 21/22)
Math: MATH 21/22 (or 51/52) and one Approved Math Elective
Required Non-Science Courses
First-Year Seminar
English Comp & Lit (I and II)
Humanities (three courses, 9-12 credits)
Social Sciences (three courses, 9-12 credits)
Writing Intensive
Approved Electives (12-16 credits)

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 predental 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: CHM 30/31 (or CHM 40/41) and CHM 110/111 and 112/113
Biology: BIOS 41/42, 115/116, and 120; and two Approved Electives (6 credits)
Physics: PHY 10/12 (or 11/12) and 13/22 (or 21/22)
Math: MATH 21/22 (or 51/52)

Required Non-Science Courses

First-Year Seminar
English Comp & Lit (I and II)
Humanities (three courses, 9-12 credits)
Social Sciences (three courses, 9-12 credits)

Junior Writing Intensive
Approved Electives (12-16 credits)

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: CHM 30/31 (or 40/41) and CHM 110/111 and 112/113
Biology: BIOS 41/42, 115/116, 120, 177, 276/277, 197, and 382
Physics: PHY 10/12 (or 11/12) and 13/22 (or 21/22)
Math: MATH 21/22 (or 51/52)

Required Non-Science Courses

First-Year Seminar

English Comp & Lit (I and II)
Psychology (PSYC 1)
Social Sciences (one course, 4 credits)
Humanities (two courses, 8 credits)
Writing Intensive
Approved Electives (two courses, 6-8 credits)

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 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.

For more information about the Education Minor, contact the Teaching, Learning, and Technology Program Coordinator at 610-758-3230 or TLTProgram@Lehigh.edu.

Fifteen credit hours are required for the education minor as follows:

TLT 314	Seminar in Elementary and Secondary Education (3)
TLT 394	Special Topics in Education: (subtitle) (3)

One of the following:

TLT 408	Development, Classroom Management and Assessment: Elementary (3)
TLT 409	Development, Classroom Management and Assessment: Secondary (3)

and two TLT XXX Elective College of Education courses (3+3=6)

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/ or contact TLTProgram@Lehigh.edu 610-758-3230.

The Five-Year Bachelor's Plus Master's of Education and Teacher Certification Program

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 either 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 a master's degree in either elementary (grades PreK-4) or secondary (grades 7-12) education. In addition, students also earn eligibility for an Instructional I teaching certificate from the Pennsylvania Department of Education (PDE). These certification areas are

Early Elementary Education (PreK-4)

Secondary Education (7-12) in the following content areas:

- Biology
- Chemistry
- Citizenship Education
- Earth and Space Science
- English
- General Science
- Mathematics
- Physics
- Social Sciences
- Social Studies

Environmental Education (K-12)

IMPORTANT NOTE: The Pennsylvania Department of Education (PDE) has divided elementary (K-6) certification into two separate certifications: Early Elementary (Pre-kindergarten through 4th grade) and Upper Elementary/Middle (4th grade through 8th grade). Secondary certification remains grades 7 through 12. Under these new regulations, effective January 1, 2011, there will no longer be a separate initial certification for special education; special education teachers must now also acquire one of the two elementary certifications or a secondary certification. Lehigh has decided to offer only the PreK-4th grade certification at the elementary level, although we will continue to offer secondary and special education certification. By PDE regulation, students already enrolled in our current K-6, secondary or special education initial certification-preparation programs must complete their programs of study by August 31, 2013. Students who are unable to complete their initial teacher certification eligibility programs by that date will need to complete one of our new PDE-approved teacher certification eligibility programs (PreK-4 or 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 currently begin education courses in the second semester of their sophomore year (junior year for those admitted later). PDE changes in certification requirements may dictate changes in course sequence and when a student starts coursework in the 5-year teacher education program. Please check the College of Education Website for the most up-to-date information. www.lehigh.edu/education/tlt/elemseceduc.html

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 5year Teacher Education Program, contact the Teaching, Learning, and Technology Program Coordinator at 610-758-3230 or TLTProgram@Lehigh.edu.

College of Business and Economics

Paul Brown, dean; Katrina A. Zalatan, associate dean, director of undergraduate programs; 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; K. Sivakumar, 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 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. These are described in Section IV.

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

ENGL 1	Composition and Literature I (3)
ENGL 2, 4, 6, 8, 10	Composition and Literature II (3)
MATH 21	Calculus I (4) or MATH 81 Calculus with Business Applications
ECO 1	Principles of Economics (4)
BUS 1	Introduction to Business (3)

Excel competency must be successfully completed before ACCT 151, ECO 045, and BIS 111.

ECO 045	Statistical Methods (3)
ECO 029	Money, Banking, and Financial Markets (3)
BUS 005	Values-Based Decision Making for Business (1)

Second Year

ACCT 151	Introduction to Financial Accounting (3)
ACCT 152	Introduction to Managerial Accounting (3)
BIS 111	Introduction to Information Systems (3)
ECO 146	Applied Microeconomic Analysis (3)
FIN 125	Business Finance (3)
MKT 111	Principles of Marketing (3)
SCM 186	Supply Chain Operations Management (3)

Third Year

LAW 201	Legal Environment of Business (3)
MGT 243	Managing and Leading People in Organizations (3)

Fourth Year

MGT 301	Strategic Management (3)

Major Programs (15 credits - 22 credits)

Before the end of the first semester of the junior 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 the following guidelines. Students must declare a single major prior to declaring a second major, and must complete an application including a statement of rationale for pursuing the 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

Students must also take one course that is eligible to satisfy the globalization requirement, and another course eligible to satisfy the diversity requirement. 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 1 – Principles of Economics (4) ECO 1 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

- BUS 125 – Behavioral Skills Workshop (1) fall
- BUS 126 – Information Analysis and Financial Decision Making I (3) fall
- BUS 127 – Information Analysis and Financial Decision Making II (3) spring
- Second Year
- BUS 225 – Developing, Producing, and Marketing Products and Services I (3) fall
- BUS 226 – Developing, Producing, and Marketing Products and Services II (3) spring
- BUS 326 – **Business Strategy** (1) spring

Recommended courses:

- Probability Theory and Statistics (e.g., ECO 045, MATH 12, IE 111, PSYC 110.)
- **An Integrated Learning Experience** (e.g., ME/BUS 211, MGT 311, or 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 BUS 125 and BUS 126 before taking BUS 127, BUS 127 before taking BUS 225, and BUS 225 before taking 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 Geraldo M. Vasconcellos, Allen DuBois Distinguished Professor of Finance & Economics (gmv0@lehigh.edu). Professor Vasconcellos' office is in the Rauch Business Center, Room 320.

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.

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 135 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 co-directors of the CSB program are James A. Hall, Peter E. Bennett Chair in Business and Economics (jah0@lehigh.edu) and Edwin Kay, Professor of Computer Science and Engineering (ejk0@lehigh.edu). For additional information see Section V of this catalog or visit the CSB web site at: *www.cse.lehigh.edu/csb*

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 and Business Information Systems (sgb2@lehigh.edu) and Robert H. Storer, Professor of Industrial and Manufacturing Systems Engineering (rhs2@lehigh.edu). For additional information, see the IBE Honors Program entry in Section V of this catalog or visit the IBE web site at *www.lehigh.edu/inibep/inibep.html.*

Centers and Institutes

The college also oversees research and scholarship in a number of centers and institutes, where graduate and undergraduate students work closely with faculty members. These include: Iacocca Institute, Martindale Center for the Study of Private Enterprise, Murray H. Goodman Center for Real Estate Studies, Philip Rauch Center for Business Communications, Value Chain Research Institute, Financial Services Laboratory, and Small Business Development Center.

Program Directors. James A. Hall, Ph.D. (Oklahoma State University) associate professor of accounting and information systems; Edwin Kay, Ph.D. (Lehigh University) professor of computer science and engineering.

The computer science and business (CSB) program is offered jointly by the College of Business and Economics and the Computer Science and Engineering department in the P.C. Rossin College of Engineering and Applied Science. This carefully crafted 136 credit hour program 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.

Students enrolled in the CSB program obtain the skills and training needed to understand business functions and business related problems, to analyze business-user information needs, to design computer based information systems, and to implement systems solutions within business organizations. Graduates of the program are ideal candidates for placement within public accounting firms, large consulting companies, and startup companies. This program also prepares students to become the Chief Information Officers, decision makers, and general managers of information age corporations.

The four year program constitutes 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. The CSB major is accredited in Business (AACSB International) and is accredited by the Computer Accreditation Commission of ABET, 111 Market Place, Suite 1050, Baltimore, MD 21202-4012 - telephone (410) 347-7700.

Mission for Program

The CSE department's mission for its Computer Science and Business program 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 www.cse.lehigh.edu/CSBSEQUENCE.

Total required credit hours: 136

Required Computer Science courses (39-40 credit hours):

CSE 15	Introduction to Computer Science (4)
CSE 17	Programming and Data Structures (3)
CSE 33	Introduction to Computer Engineering (4)
CSE 109	Systems Programming (4)
CSE 201	Computer Architecture (3)
CSE 216	Software Engineering (3)
CSE 241	Database Systems and Applications (3) OR
CSE 341	Database Systems, Algorithms, and Applications (3)
CSE 261	Discrete Structures and Applications (3)
CSE 262	Programming Languages (3)
CSE 303	Operating System Design (3)
CSE 340	Design and Analysis of Algorithms (3)

One 300-level course drawn from the list at www.cse.lehigh.edu/CSBCHOICE

Required Business courses (34 credit hours):

BUS 1	Introduction to Business (3)
ACCT 151	Introduction to Financial Accounting (3)
ACCT 152	Introduction to Managerial Accounting (3)
ECO 1	Principles of Economics (4)
ECO 29	Money and Banking and Financial Markets (3)
ECO 146	Applied Microeconomic Analysis (3)
FIN 125	Business Finance (3)
LAW 201	Legal Environment for Business (3)
SCM 186	Supply Chain Operations Management (3)
MGT 301	Strategic Management (3)
MKT 211	Principles of Marketing (3)

Required Math and Science courses (26 credit hours):

MATH 21	Calculus I (4)
MATH 22	Calculus II (4)
MATH 205	Linear Methods (3)
MATH 231	Probability & Statistics (3) **OR**
ECO 45	Statistical Methods (3)

Twelve credits 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. Suggested sequences can be found at www.cse.lehigh.edu/SCISEQ

Required CSB courses (9 credit hours):

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 (9 credit hours):

Courses approved by the student's advisor. See "CSB TRACKS" below

Humanities and Social Science requirements (18 credit hours):

ENGL 1	Composition and Literature (3)
ENGL 2	Composition and Literature II (3)
CSE 252	Computers, Internet and Society (3)

An additional 6 credit hours in the humanities (HU).

An additional 3 credit hours in the social sciences (SS).

CSB Tracks

Students can 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 student's advisor may also approve courses from other departments. Some examples of CSB tracks are presented at www.cse.lehigh.edu/CSBSEQUENCE

Course Descriptions

CSB 311. Computer Applications in Business (3) fall

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 systems development techniques. Application of CASE technology to a hypothetical business project. Prerequisites: ACCT 152 or ACCT 108, and CSE 17 or CSE 18 or equivalent. Not available to students who have credit for ACCT 311.

CSB 312. Design of Integrated Business Applications I (3) spring
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. Prerequisite: CSB 311.

CSB 313. Design of Integrated Business Applications II (3) fall
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. Prerequisite: CSB 312

CSB 314. International Practicum (1-3)
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: ACCT 311, or CSB 311, or permission of the instructor.

College of Education

The university's College of Education offers opportunities for advanced study in the field of education. For information, see Graduate Study in Education, Section IV, or College of Education, Section V.

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 18 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*

Chemical Engineering*

Chemistry

Civil Engineering*

Computer Engineering*

Computer Science**

Computer Science And Business***

Electrical Engineering*

Engineering Mechanics

Engineering Physics

Environmental Engineering*

Industrial Engineering*

Information And Systems Engineering*

Integrated Business And Engineering

Integrated Degree In Engineering, Arts And Sciences

Materials Science And Engineering*

Mechanical Engineering*

**Accredited by the Engineering Accreditation Commission of ABET, Inc., 111 Market Place, Suite 1050, Baltimore, MD 21202-4012 – telephone (410) 347-7700*

*** Accredited by the Computing Accreditation Commission of ABET, Inc., 111 Market Place, Suite 1050, Baltimore, MD 21202-4012 – telephone (410) 347-7700.*

****Accredited by both the by the Computing Accreditation Commission of ABET, Inc., 111 Market Place, Suite 1050, Baltimore, MD 21202-4012 – telephone (410) 347-7700 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.

Information about each of these programs may be found under alphabetical listings in Section V.

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.

First year, first semester (14 - 15 credits)

- ENGL 1 Composition and Literature (3)
- MATH 21 Calculus I (4)
- Science: Required natural science course*
- ENGR 1 Engineering Computations (3), or
- ENGR 5 Introduction to Engineering Practice (3)

First year, second semester (14 - 15 credits)

- ENGL 2 Composition and Literature: Fiction, Drama, Poetry (3)
- MATH 22 Calculus II (4)
- Science: Required natural science course*
- ENGR 1 Engineering Computations (3), or
- ENGR 5 Introduction to Engineering Practice (3)

**The required science courses, one taken fall semester and the other taken in spring, are:*

- CHM 30 Introductory Chemical Principles and Laboratory (4)
- PHY 11, 12 Introductory Physics I and Laboratory (5)

Bioengineering students take Chm 30 and ENGR1 in the fall, and Bioscience 41/42 (instead of ENGR5) in the spring along with PHY 11/12.

Humanities/Social Sciences (HSS) Requirement for all Accredited Engineering Majors

Basic Requirement: English and Economics. Three courses totaling a minimum of ten credit hours: Students must complete English 1 (or 3), English 2 (or 5, or 11) and Economics 1. Students with advanced placements in English 1 usually take English 11 to complete the English requirements.

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.

Currently, the following technical minors are offered:

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

A minor in Engineering Leadership provides students with knowledge, experiences and interaction with successful business managers in order to become more effective leaders.

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. Minors in Real Estate and Entrepreneurship are also offered. 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 and free electives.

Engineering Minor

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 taking the Minor in Engineering 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 is required to fulfill the engineering minor.

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 or minor.

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 3 free elective credits per successful work assignment for a total of 6 free elective credits.

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.

Integrated Real Estate @t Lehigh (ire@l) 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.

Required Courses comprising the minor include:

- 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 Summer IPRE Internship (0 – 1)
- Bus 347 Practicum in Real Estate I (2)
- Bus 348 Practicum in Real Estate II (2)

Recommended Courses:

- IPRE 101 Real Estate Practicum Clerkship I (1)
- IPRE 102 Real Estate Practicum Clerkship II (1)

The director of the Goodman Center for Real Estate Studies and the ***ire@l*** *Program is Associate Professor Stephen Thode (ire@lehigh.edu).*

Entrepreneurship

Program Management: CBE and RCEAS faculty committee.
Minor Program Director: Graham Mitchell

Minor in Entrepreneurship

The purpose of the entrepreneurship minor is to enable students to supplement their major with knowledge and skills that increase their ability to realize their entrepreneurial goal and/or make them more marketable upon graduation. It will also work to create an environment and campus center of gravity that fosters an entrepreneurial spirit and mindset among students and also serve as a locus for community building among entrepreneurial students, faculty, and alumni. This minor is available for students at Lehigh University.

Required pre-requisite course:

- ECO 1 Principles of Economics (4) ECO 1 must be completed prior to entering the entrepreneurship minor program.

Required Courses:

- ENTP 101: Entrepreneurship I (3)
- ENTP 201: Entrepreneurship and Enterprise (3)
- One of the following Integrated Learning Experience (ILE) options
- ENTP 311: Entrepreneurship Practicum (3)
- IBE 395: Capstone Projects 1 (3)
- MGT 311: LUMAC Management Assistance Counseling (3)
- Or other independent experiential project approved by the minor program director.
- ENTP 312: Launching Entrepreneurial Ventures (3)

Recommended Additional Courses:

- ACCT 108 or 151/152
- Law 201 and 202
- MGT 306
- MKT 211 and 319
- SCM 309
- Excel Competency Program

Students must complete the minor sequence with an average GPA of at least 2.0 in the required minor courses in order to qualify for the minor. Courses in the Entrepreneurship minor cannot be used towards either the Engineering Minor or the Business minor.

Integrated Business and 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 27 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 elect 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 45 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) and Stephen G. Buell, Professor of Finance (sgb2@lehigh.edu). For additional information, see the IBE Honors Program entry in Section V of this catalog or visit the IBE web site at 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.

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.

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. Because Lehigh's well-established graduate programs are closely integrated with the undergraduate programs, it is possible to consider programs leading to the arts/master of business administration degree and the engineering/master of science in material science, among others. 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.

Interdisciplinary Programs

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. Please refer to Section V for descriptions of interdisciplinary programs.

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

Timothy Bonner, Director
205 Coxe Hall
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 English 3 and English 5 (Composition and Literature for International Writers I and II) in substitution for required English 1 and 2 or English 97 (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 English 310 and English 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*

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

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

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

1. No undergraduate student may take one 400-level course 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 a possible exception to theses standards.
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 be permitted to take a second graduate level course if enrolled for more than 15 credits.)

Curricular Flexibility

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.

Academic offerings of the various departments are described in Section V. To provide additional flexibility and encourage student initiative and depth of investigation, the university has developed academic alternatives including the following:

Provisional Courses. 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. 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

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 that cannot be scheduled at the home institution 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 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 Session

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.

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.

The General College Division

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.

IV. Graduate Study and Research

Graduate Study

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

Anne S. Meltzer, dean

Michael Stavola, 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.

Information on the various degree programs appears under the departmental listings in Section V and the Interdisciplinary Graduate Study and Research part of this Section. 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

Paul R. Brown, 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 Master's 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 as well as preparing 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. Course descriptions can be found listed under business and economics graduate courses in Section V. More information about the various degree programs appears below. Information on the college's graduate programs may be obtained at 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

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 distinguishes 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. More information about these programs can be found in Section IV under

Graduate Degrees in Education. 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 the six core 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. 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 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. 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/

The Office of International Programs

The Office of International Programs is committed to promoting global awareness and transcultural understanding to educators worldwide. The programs provide professional development and degree opportunities for teachers and school administrators using innovative technologies, evocative teaching strategies and current research. It challenges learners to appreciate the complexities of schooling in the midst of globalization. www.lehigh.edu/lbl

Information on the various degree programs appears under the departmental listings in Section V and 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/.

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, mechanical engineering, polymer science and engineering, and structural engineering. 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 nanomaterials, manufacturing systems 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 appears under the departmental listings in Chapter V and in the Interdisciplinary Graduate Study and Research section of Chapter IV. Students can also contact 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 obtained on-line at the university's graduate website or by writing to the department to which admission is sought, or writing to the office of the dean of the prospective college.

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 gradepoint 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 a necessary but may not be sufficient condition for admission as a regular graduate student. 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.

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). This does not include MBA & Engineering students in the College of Engineering and Applied Science who may substitute the Graduate Record Exam if required by the Engineering Department. 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 the doctoral programs in special education 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.

Other 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 grade below B-. Associate graduate students receiving a grade lower than a C- will be dropped from the program. Students should note that individual departments may impose more rigorous probationary standards.

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; 4) 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 that 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 for external certification may subsequently be admitted to a degree program, but needs to do so through a petition that includes all components required for admissions consideration by that degree program.

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: (a) the course credits are not submitted as part of the requirement for an undergraduate degree; and (b) 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 grade 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 in Section III except that, at a minimum, no grade 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 grades 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 in Section III 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 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 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. 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 withdrawing from the university under the policy noted below. A student who drops a course 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 drops 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. 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 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.

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: will be placed on probation when they receive their first grade 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+" grades or one grade 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: will be placed on probation at the end of the term in which they are assigned their fourth grade 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 grade below a "B-".

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

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 approve the petition. The student will be readmitted on probation and may be dropped again with any additional grades 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 of the Campus Portal. Information about the various payment options is available at te Bursar's Office web site at *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. <u>The "first day of classes" is considered the first day of the semester, not the first day a particular class meets.</u> 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 2011-2012 per credit hour

College of Arts & Sciences	$1220
College of Business & Economics	$840
College of Education, and for fulltime elementary and secondary teachers and administrators enrolled in the other three colleges	$550
College of Engineering & Applied Science	$1220
Special Programs MBA & Engineering and Master of Science in Analytical Finance	$955
MBA/Educational Leadership	$605
MS/Analytical Finance	$955
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 one-credit 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 2011-2012 period beginning in September, the following are the monthly rents exclusive of utilities:

Efficiency apartment	$515
One-bedroom apartment	$610
Small two-bedroom apartment	$645
Two-bedroom apartment w/o AC	$660
Two-bedroom apartment w/AC	$675
Three-bedroom apartment	$685

Other Fees

Application fee	Consult with individual college (for graduate admission consideration)

Application fee	Consult with individual college (College of Business and Economics)
Non-degree application	Consult with individual college (engineering, education)
Non-degree application	Consult with individual college (College of Business and Economics)
Late pre-registration	$100 (assigned to full-time graduate students who do not select their full class load during the designated period each term)
Late registration	$100 (for completing registration after announced day)
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, 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 January15. (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 the federally funded Stafford and Perkins loans, and Federal Work-Study through the Office of Financial Aid located at 218 W. Packer Avenue. These funds are awarded on the basis of demonstrated need using the Free Application for Federal Student Aid. In addition, the University requires a university application (Graduate Student Financial Aid Application) and a copy of the student's and spouse's (where applicable) most recent (2009) federal tax return and W-2. Applications for loans cannot be processed, and funds cannot be disbursed, until the FAFSA, and attending forms, are received and reviewed. There is, however, only limited availability of Federal Perkins loans, and Work-Study.

Eligibility for student loans is based on: (1) the number of credits to be taken, (2) the amount of assistance received, and (3) the calculated financial need. 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*).

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.

Multiple Graduate Degree credit requirements

Students pursuing multiple graduate level degrees must meet minimum unique degree credit-hour requirement of 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 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 48 unique Lehigh credit-hour minimum for a doctoral degree. No graduate credit may be counted towards two graduate level degrees.

Master's Degree

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. Course grades 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.

Doctor of Philosophy

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 spent less 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) will have satisfied the tuition requirements for the doctoral degree upon completion of 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 the 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, registration is permitted for 'Maintenance of Candidacy.' The tuition charge is for one credit hour. 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 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 department 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 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 either the Graduate Management Admissions Test (GMAT) for the degree in business administration and the degree in accounting and information analysis. The Graduate Record Examination general test (GRE) or the GMAT must be submitted for degrees in 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.

The MBA program is available in two modes: on campus and distance through Classroom Time technology. Students may elect to follow one mode exclusively or mix and match modes. Select elective course work is also available on-line. Students electing to pursue the degree by distance may choose a concentration in Supply Chain Management or Project Management.

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.

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.

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 ECO 401 Basic Statistics for Business and Industry or equivalent. The Accounting prerequisite may be waived by enrolling in GBUS 401, 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.

Core Courses

MBA 401	Introduction to the Organization and Its Environment (2)

MBA 402	Managing Financial and Physical Resources (4) Prerequisite: GBUS 401, MBA 401
MBA 403	Managing Information (4) Prerequisites: GBUS 401 and ECO 401, MBA 401
MBA 404	Managing Products and Services (4) Prerequisite: MBA 401
MBA 405	Managing People (4) Prerequisite: MBA 401
MBA 406	Integrative Experience (3) Prerequisites: MBA 401-MBA 405

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 Scores. All applicants are required to take the Graduate Management Admissions Test (GMAT) administered by Pearson Vue. The computer-based exam is given during several weeks each month. To make an appointment to take the GMAT exam call 1-800-717-GMAT (4628) or by registering online at *www.mba.com*.

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*.

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

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: Start-Ups 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 Start-Ups: Seeking Outside Venture Capital (1)

Elective Courses:

GBEN 401	Business Plan I: Strategic Considerations (2)
GBEN 402	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 Forecasting (1)
GBEN 412	Developing Exit Strategies: Concepts and Approaches (1)
GBEN 413	Integrative Experience/New Venture Internship (1-4)

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 450	Strategic Supply Management (3)
GBUS 453	Transportation and Logistics Management (3)

Elective Courses

ECO 402	Managerial Economics (3)
GBUS 464	Business to Business Marketing (3)
GBUS 447	Negotiations (3)
GBUS 459	Survey of Project Management (3)
GBUS 455	E-Business Enterprise Applications (3)
MSE 438	Agile Organizations and Manufacturing Systems (3)
MSE 423/ME 401	Product Design Analysis (3)
GBUS 492	Field Project (1-4)

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 (REP) by the Project Management Institute. The certificate is cohort based and is completed within 12 months through both on-line and on-campus modules.

Directed Electives (12 credits):

PMGT 401	Course Framework & Project Leader Assessment (1)
PMGT 402	Skills and Abilities for Effective Leadership of Teams (1)
PMGT 403	Initiating the Project and Planning Scope and Schedule (2)
PMGT 404	Planning Resources, Communication, Quality and Risk Management (2)
PMGT 405	Project Leader Communications Expertise and Evaluating Team Performance (1)
PMGT 406	Implementing and Managing Projects (2)
PMGT 407	Controlling Performance and Assessing Outcomes (2)
PMGT 408	Problem Solving, Decision Making and Ethics (1)

Admissions

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. 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

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. We make every effort to offer those courses during Lehigh's Summer Session to accommodate students needing those background courses. Please contact the Program Director for information about the background courses to be offered in specific Summer Sessions.

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	Information Systems Auditing (3)
MACC 413	The Corporate Financial Reporting Environment (3)
MACC 420	Consulting Process and Practice in Professional Accounting (3)
MACC 424	Corporate Governance and Business Risk (3)
MACC 427	Analyzing Accounting Information for Management and Business Solutions (3)

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 50th 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*.

Presidential Scholars. Presidential Scholars must meet the 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. 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. For academic questions, please email Dr. Heibatollah Sami, Director, M.S. in Accounting and Information Analysis Program (hes205@lehigh.edu). email: business@lehigh.edu 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 fulltime 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. As part of the 30 hours, the following courses must be taken:

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)

The remaining 15 credit hours are taken as electives. 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) 758-3418
email: business@lehigh.edu
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 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
www4.lehigh.edu/business/academics/graduate/phdeconomic s/default.aspx

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 and Pennsylvania Teacher Certification program or they can minor in education (see section III). 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.

Other opportunities for financial assistance are available through our field-based programs: Community Choices, Lehigh Support for Community Living, and Lehigh University Transition and Assessment Services.

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, and 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 postmaster'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.

IMPORTANT NOTE: The Pennsylvania Department of Education (PDE) has divided elementary (K-6) certification into two separate certifications: Early Elementary (Pre-kindergarten through 4th grade) and Upper Elementary/Middle (4th grade through 8th grade). Secondary certification remains grades 7 through 12. Under these new regulations, effective January 1, 2011, there will no longer be a separate initial certification for special education; special education teachers must now also acquire one of the two elementary certifications or a secondary certification. Lehigh has decided to offer only the PreK-4th grade certification at the elementary level, although we will continue to offer secondary and special education certification. By PDE regulation, students already enrolled in our current K-6, secondary or special education initial certification-preparation programs must complete their programs of study by August 31, 2013. Students who are unable to complete their initial teacher certification eligibility programs by that date will need to complete one of our new PDE-approved teacher certification eligibility programs (PreK-4 or 7-12).

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

Doctor of Philosophy (Ph.D.)
The College of Education also offers the Ph.D. degree to students enrolled in the fields of counseling psychology, learning sciences and technology, school psychology, and special education. 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 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 advisors on admissions and must work with the advisor 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 12credit 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.

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.

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, manufacturing systems engineering, photonics, polymer science and engineering, business administration and engineering, and business administration and educational leadership, and analytical finance.

Lehigh University also offers graduate certificate programs in certain specialized fields of study. Graduate certificates consist of a minimum of twelve credits, 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.

Graduate Certificates in Arts and Sciences

Certificate in Cognitive Science

(For details see "Cognitive Science" in Section V)

Certificate in Environmental Law and Policy

(For details see "Environmental Initiative" in Section V)

Certificate in Stereotypes, Prejudice, Discrimination, and Intergroup Relation

(For details see "Psychology" in Section V)

Certificate in Regulatory Affairs in a Technical Environment (for details):

http://online.lesn.lehigh.edu/reg_affairs_overview.htm

Certificate in Analytical Principles of Pharmaceutical Science (for details)

http://online.lesn.lehigh.edu/analytical_home.htm

Certificate in Bioorganic Principles of Pharmaceutical Science (for details)

http://online.lesn.lehigh.edu/bioOrg_home.htm

Certificate in Women's Studies

(For details see "Women's Studies" in Section V)

Interdisciplinary Graduate Programs

Several interdisciplinary programs are offered to the Lehigh graduate student.

American Studies

A Master of Arts degree in American Studies is offered jointly by English, History, and other departments in the humanities and social sciences. Candidates for the master's degree must complete at least 30 credit hours. In addition to the Theory and Method course, students must choose two courses in American history and two courses in American literature and film from those offered by the history department and the English department. Students must also take one special topics seminar. The other four courses for the master's degree will be divided between thesis or "thesis paper" credits and American Studies courses not in history or literature/film. To fulfill the thesis requirement, students will write one longer thesis or two thesis papers that are aimed at conference presentation and/or publication.

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 details see "Environmental Initiative" in Section V)

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.

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 masters 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 or GBUS 419 or an equivalent course
Investments - Fin 323 or GBUS 420 or an equivalent course
Financial Accounting - Acct 151 or Acct 108 or GBUS 401 or an equivalent accounting course
Statistics and Probability - Math 231 or IE 328 or an equivalent introductory calculus based statistics and probability course
Calculus Series - (Math 21, 22, 23) or an equivalent calculus series
Linear Algebra - (Math 205 or 242) or 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 145 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 (3) Spring
Math 468	Financial Calculus II (3) Spring

(Must take 1 of the following Statistics courses)

Stat 410	Random Processes and Applications (3) Spring
Stat 412	Statistical Computing and Applications (3)

(Must take 1 of the following computation modeling courses)

Eco 415	Econometrics I (3) Fall
Stat 438	Linear Models in Statistics with Applications (3) Spring

(Must take 1 of the following Industrial Engineering courses)

IE 426	Optimization Models and Applications (3) Fall
IE 429	Stochastic Models and Applications (3)

Finance Core

GBUS 422	Derivatives and Risk Management (3) Fall

(Must take 2 of the following 3 finance courses)

GBUS 473	International Finance (3) Fall
GBUS 421	Advanced Investments (3) Spring
GBUS 426	Financial Markets and Institutions (3)

Computing Core

IE 447	Financial Optimization (3)

Capstone Practicum

IE 441	Financial Engineering Projects (3) Fall/Spring

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. UlS. 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) 758-3418, email: business@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

Dr. Tamás Terlaky, Department of Industrial and Systems Engineering, Lehigh University, 200 W. Packer Avenue, Bethlehem, PA 18015, phone (610) 758-4050, email: terlaky@lehigh.edu

Master of Engineering in Energy Systems Engineering

For students with B.S. degrees in engineering, physics, 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 credits
ESE Technical Electives	15 credits
ESE Industry Project	3-6 credits

ESE Core 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 and energy efficiency issues are also addressed.

ESE 402: Transmission and 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 Technical electives

Students acquire a level of specialized knowledge and experience through the completion of five technical elective courses, selected from a large pool of designated courses in Chemical Engineering, Chemistry, Civil & Environmental Engineering, Computer Science & Engineering, Earth & Environmental Science, Economics, Electrical & Computer Engineering, Environmental Studies, Industrial & Systems Engineering, International Relations, Materials Science & Engineering, Mechanical Engineering & Mechanics, Physics, Political Science.

Industry Project

ESE 460: Energy Systems Engineering Project (3-6 credits)
A collaborative and intensive study in an area of energy systems engineering, with an emphasis on direct industrial applications. A written report plus a poster presentation or oral presentation is required.

Students 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

Prof. Martha Dodge
Energy Systems Engineering Institute
P.C. Rossin College of Engineering & Applied Science
(610) 758-3529

Ms. Shaku Jain-Cocks
Coordinator, Energy Systems Engineering Institute
P.C. Rossin College of Engineering and Applied Science
(610) 758-3650

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 credits
Engineering core courses	12 credits
Business electives	5 credits
Engineering electives	6 credits
Free electives	3 credits
Integrated project	1 credit

Students can choose an appropriate engineering curriculum from any of the following programs – chemical engineering, civil engineering, computer engineering, electrical engineering, industrial and systems engineering, manufacturing systems engineering, materials science and engineering, mechanical engineering and mechanics.

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

or

The Graduate Programs Office
College of Business & Economics
610-758-3418
www.lehigh.edu/mba

Master of Business Administration and Educational Leadership

The MBA & Master of Education 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/M.Ed. provides a framework where excellent education and sound business practices can flourish. The MBA/M.Ed. 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. Students earning an MBA/Ed. Leadership will be prepared for positions such as: School Superintendent, Principal, and School District Administration

Educational Leadership Core Courses

Introduction to Organizational Leadership	3
Supervision of Instruction	3
Human Resources Management	3
School Financial Management	3
School Law	3
Practicum in School Business Management	1
Research	3
Multicultural Issues	3
Electives	3

MBA Core Courses

Introduction to the Organization & Its Environment	2
Managing Financial & Physical Resources	4
Managing Information	4
Managing Products & Services	4
Practicum: Integrative Experience	1
MBA Electives	5

Electives. Educational electives are chosen from courses in the College of Education and the business electives are selected from course offerings in the College of Business and Economics.

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. George White, Professor, College of Education, 610-758-3262 or gpwl@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:

four (4) core MSE courses.

MSE 362	Logistics and Supply Chain Management (3)
MSE 443	(IE 443) Automation and Production Systems (3)
MSE 438	Agile Organizations and Manufacturing Systems (3)
MSE 481	(GBUS 481) Technology, Operations & Competitive Strategy (3)
Either	
MSE 451	Manufacturing Systems Engineering Project (3)
	Or
MSE 490	Manufacturing Systems Engineering Thesis (6)

And

Elective courses (12 or 15 credits). At least one elective must be an MSE-numbered course.

Elective courses are selected in consultation with the MSE academic adviser from technical and business areas related to manufacturing.

These areas include:

- design
- materials, manufacturing processes and quality control
- automation, control systems, and computer integration
- computer and information systems
- business, management, organization, and operations research
- 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/*

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.

Required Courses*(15 credits):

PHY 352	Modern Optics (3) [Prerequisite: Math 205, PHY 212/ECE 202]
PHY 355/455	Lasers and Nonlinear Optics (3) [Prerequisite: PHY 31**, PHY 213/ECE 203 or MAT 201]
ECE 348/448	Lightwave Technology (3) [Prerequisite: ECE 203]
ECE 372/472	Optical Networks (3) [Prerequisite: ECE 81]
MAT 496	Photonic Materials (3)

Selected pre-requisites for the required courses may be waived by the program director for students with equivalent background.

A minimum of three courses must be selected from the following list:

ECE 325/425	Semiconductor Lasers I
ECE 326/426	Semiconductor Lasers II
ECE 338/438	Quantum Electronics
ECE 371/471	Optical Information Processing
ECE 347/447	Introduction to Integrated Optics
ECE 407	Linear and Nonlinear Optics
ECE 451	Physics of Semiconductor Devices
PHY 363	Solid State Physics
PHY 369	Quantum Mechanics
PHY 421-422	Electricity and Magnetism
MAT 302	Electronic Properties of Materials
MAT 423-427	Electron Microscopy (TEM and SEM)
MAT 430	Glass Science
PHY 312/412	Advanced Laboratory in Photonics

In order to complete the MS degree requirements of the University, candidates must submit either a Master's thesis or a report based on a research course of up to 6 credit hours. Research courses should be at the 400 level.

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 may be in that department, or in another department, or research center, in which case, the student receives a normal departmental degree, with emphasis in polymer courses and research.

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 enter through the departments and must meet each entering department's 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 Center for Polymer Science and Engineering. After entering the center degree program, 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 requires a total of 24 credits in course work and six credits in research based on a pre-approved library program. The research report 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.

Required courses:

CHE (CHM/MAT) 388	Synthesis and Characterization Lab (3)
CHE (CHM/MAT) 393	Physical Polymer Science (3)
CHE (CHM) 394	Organic Polymer Science (3)
	Research (6)

Three 400-level polymer courses to be selected from the following list (list may vary slightly from year to year, check with Professor Pearson or Professor Roberts for more details):

CHE 428	Rheology (3)
PHY 472	Polymer Physics (3)
CHE (CHM) 483	Emulsion Polymers (3)
CHE (CHM/MAT) 482	Engineering Behavior of Polymers (3)
CHE (CHM/MAT) 485	Polymer Blends and Composites (3)
CHE 486	Polymer Processing (3)
CHM 489	Organic Polymer Science II (3)
CHM 491	Physical Chemistry of Organic Polymer Coatings (3)
CHE (CHM) 492	Topics in Polymer Science (3)
CHM 493	Organic Chemistry of Organic Polymer Coatings (3)
CHE 487	Polymer Interfaces (3)

Courses in the admitting department must include one of the following:

CHE (CHM) 400	Chemical Engineering Thermodynamics (3)
CHM (CHE) 445	Elements of Physical Chemistry (4)
MAT 401	Thermodynamics and Kinetics I (4)
ME 420	Advanced Thermodynamics
PHY 442	Statistical Mechanics

plus one other 300- or 400-level non-polymer related course from the admitting department.

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.

The additional six hours of coursework must include two additional 300 or 400 level polymer courses, or one polymer and one non-polymer home department course. For full-time graduate students electing the M.E. degree option, the polymer course program must include Chem. Eng. (CHM.; MAT) 388, Polymer Synthesis and Characterization, a laboratory course.

Part-time and Distance Education M.S. and M.E. degree students in Polymer Science and Engineering may substitute another polymer course for Chem. Eng. (CHM; Mat) 388.

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. Please address applications to one of the participating departments.

Certificate Programs

Cognitive Science

Stereotypes, Prejudice, Discrimination, and Intergroup Relations

Business College Certificates

Education College Certificates

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); 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); Terry Delph (Mech Eng); 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); Tianbo Liu (Chem); Charles Lyman (Mat Sci); Alastair McAulay (ECE); Anthony McHugh (Chem Eng); Steven McIntosh (Chem Eng); Wojciech Misiolek (Mat Sci); 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); Svetlana Tatic-Lucic (ECE); Jean Toulouse (Phys); Dmitri Vezenov (Chem); Richard Vinci (Mat Sci); Masashi Watanabe (Mat Sci); Edmund Webb (Chem Eng); Zhiyuan Yan (ECE); Xiaohui Zhang (Mech Eng)

Staff: Andrea Harmer, Director of Web Based Instruction; Robert Keyse, Research Scientist; Katrina Kraft, Financial Manager; Samuel Lawrence, Research Scientist; Gene Lucadamo, Industrial Liaison Officer; Alfred Miller, Research Scientist; William Mushock, Electron Microscope Technician; Joan Stanescu, Industrial Liaison Associate; Susan Stetler, Coordinator; Amy White, Communications Specialist.

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. Its 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, electronics materials, interfacial kinetic engineering, polymer, ceramic, and metal nanocomposites, micro-electromechanical systems (MEMS), metals and alloys, microfabricated devices for clinical diagnostics, 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 has been a multiyear program funded by the Pennsylvania Ben Franklin Technology Development Authority. This complements a National Science Foundation Materials Research Science and Engineering Center (MRSEC) for collaborative research with Carnegie Mellon University to study the control and optimization of interface dominated material properties. This program has supported graduate student research, improvements and new equipment for CAMN user facilities, and R&D assistance for a broad range of companies. 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.

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 collaboration. The ILP connects with a range of technology based companies in need of technical expertise or laboratory resources, and provides ways for companies to collaborate with faculty and students. It also helps companies form partnerships to obtain funding, create ideas, and stay competitive. These connections can provide student exposure to industry challenges and practices, and lead to internship and employment opportunities.

The Lehigh Nanotech Network (LNN), founded at Lehigh University in 2004 and administered by CAMN, is an organization of business, education, and government that promotes the understanding and commercialization of nanotechnology. Centered on the resources of its members, the LNN aims to broaden access to nanotechnology expertise and facilities, facilitate the exchange of ideas and knowledge, encourage member collaborations, and identify employment or experience opportunities for students. LNN member benefits include networking opportunities, connection of academic research to commercial applications, faculty consultations, information on funding, graduate contacts, exposure for industry products, representation at conferences, and seminars and workshops on nanotechnology issues. The LNN currently includes over 150 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 the largest collection electron microscopes of any university in the United States and is utilized and managed 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 beam lithography system, an electron microprobe, and several scanning probe microscopes. Lehigh is the only university that operates two aberration corrected electron microscopes that can resolve images on a sub-nanometer scale. Our Scienta ESCA, one of the best instruments for surface chemistry analysis via XPS, is the only one in the United States. Since 1970 Lehigh has trained over 5,000 scientists and engineers in electron microscopy through its highly regarded 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 nanotechnology courses offered include Materials for Nanotechnology, Strategies for Nanocharacterization, 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 live via video conferencing. Through MatPAC, the CAMN also facilitates connection of students with job opportunities in Pennsylvania.

For more information, write to Martin P. Harmer, Director, CAMN, Lehigh University, 5 E. Packer Avenue, Bethlehem, PA 18015-3194.

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*

Administration: Richard Sause, Ph.D., Director, Manager, Infrastructure Monitoring Program; James M. Ricles, Ph.D., Deputy Director; Chad Kusko, Ph.D., Administrative Director; Frank E. Stokes, M.S., Manager structural testing program; Peter Y. Bryan, B.S., Manager computer systems; Doris Oravec, B.S., financial services; Leslie Ladick, research coordinator; Elizabeth MacAdam, research coordinator; Richard Sause, Ph.D., CodirectorPennsylvania Infrastructure Technology Alliance (PITA); James M. Ricles, Ph.D., Director RealTime MultiDirectional Testing Facility, (RTMD); Eric J. Kaufmann, Ph.D., Manager, material laboratories; 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

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

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, rsause@lehigh.edu; Chad Kusko, Administrative Director, chk205@lehigh.edu; or Elizabeth MacAdam, Research Coordinator, es00@lehigh.edu; ATLSS Research Center, Lehigh University, 117 ATLSS Drive, Bethlehem, PA 18015-4728; web-site address *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

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

Pasquale J. Costa; Dale F. Falcinelli; William Forster, Ph.D.; William R. Haller; Sandra F. Holsonback, Ph.D.; Thomas J. Hyclak, Ph.D.; Christopher D. McDemus, J.D.; Bruce E. Moon, Ph.D.; Holona L. Ochs, Ph.D.; John B. Ochs, Ph.D.; Neal G. Simon, 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.

III. 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).

IV. II. 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.

V. 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.

VI. 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.

VII. 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.

VIII. 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, wll0@lehigh.edu.

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

111 Research Drive; 610-758-6093
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 for further details.

Energy Research Center

117 ATLSS Drive; 610-758-4090

Edward K. Levy, Sc.D., director; Russell Glenn Bateman, Ph.D.; Harun Bilirgen, Ph.D.; Derek Brown, Ph.D.; Hugo S. Caram, Ph.D.; Terry J. Delph, Ph.D.; Vladimir Dobric, Ph.D.; John N. DuPont, Ph.D.; Sharon Friedman, M.A.; Richard G. Herman, Ph.D.; Christopher Kiely, Ph.D.; Kamil Klier, Ph.D.; Mayuresh Kothare, Ph.D.; Arnold H. Kritz, Ph.D.; Gerard P. Lennon, Ph.D.; Ursla 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.; Nenad Sarunac, Ph.D.; Eugenio Schuster, Ph.D.; Arup Sengupta, Ph.D.; Shivaji Sircar, Ph.D.; Charles R. Smith, Ph.D.; Arkady Voloshin, 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. Please visit our website at *www.lehigh.edu/energy*.

Enterprise Systems Center (ESC)

The Enterprise Systems Center (ESC), an affiliate of the Industrial and Systems Engineering Department, 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. The center seeks to advance interdisciplinary research and scholarship relating to information technology, new process development, sustainable manufacturing and improving enterprise systems to regain U.S. global competitiveness. Additional research initiatives focus on discovering new methods for collaboration among academic, industry and government partners through the use of advanced technology and leadership. Emphasis is given to innovative systems approaches to problem-solving. Housed in Mohler Laboratory, the ESC 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 500 projects with industry and government partners. Over 1000 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 operational improvements, enterprise resource optimization, sustainable manufacturing for global competitiveness 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 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.

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, computer graphics, computer integrated manufacturing, industrial engineering techniques, 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 project. Graduate studies leading to both masters and doctoral degrees are also available through the Industrial and Systems Engineering department.

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) named as one of the top curriculum innovations in 2009 by the Institute of Industrial Engineers, the 600-member National Society of Leadership and Success, Lehigh Chapter and the Innovation and Leadership Residency program.

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, 200 West Packer Avenue, Bethlehem, PA, 18015 (ewz0@lehigh.edu)

Global Islamic Studies (Center for)

9 W. Packer Avenue; 610-758-3335
Rob Rozehnal, Director

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 GIS 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

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 "Creativity," "The Public Intellectual," "Waste," "Just Globalization," "Contagion," and "New Bethlehem," 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. Also, Summer Research Grants are available for faculty and graduate students. The objective of the grant is to provide support for faculty to pursue a humanistic research project or creative activity and for graduate students to finish their dissertations. The recipients of the grant commit to share the outcome of their activities during the fall in the form of a reading, a lecture, a workshop or any other interaction that would lead to a meaningful exchange.

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, contact the Director, M. EdurnePortela at the Humanities Center, 224 West Packer Avenue, Bethlehem, PA 18015 or by email at 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 five

International Summer Institutes: 2001 at Lehigh; 2003 in Copenhagen; 2005 at Clemson University; 2007 in Paris; and 2009 in Vancouver. These have attracted philosophers, psychologists, biologists, roboticists, and linguists from more than twenty countries. ISI 2011 is planned for Greece.

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. holds a weekly student reading and discussion group,
5. participates in contributing to the journal New Ideas in Psychology, published by Elsevier, and
6. 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.
7. For more information, contact Mark Bickhard, Director, mhb0@lehigh.edu.

Institute for Metal Forming

5 E. Packer Avenue; 758-4252

Wojciech Z. Misiolek Sc.D., director, Arlan O. Benscoter, John C. Chen, Ph.D., Xuanhong Cheng, Ph.D., John P. Coulter, Ph.D., John DuPont, Ph.D., Edwin W. Force II, Christopher Kiely Ph.D., Samuel Lawrance, Alparlslan Oztekin, Ph.D., Sudhakar Neti, Ph.D., Herman F. Nied, Ph.D., Michael Rex, Jean Toulouse, Ph.D., Kemal Tuzla 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 analysis, coatings of powders, 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

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, 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 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 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 Dr. 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 or e-mail 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; Michael G. Baylor, Ph.D.; Marie- Helene Chabut, Ph.D.; Stephen H. Cutcliffe, Ph.D.; Elizabeth Dolan, 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.

Center for Optical Technologies (COT):

Sinclair Laboratory, 7 Asa Drive; 610-758-2600; FAX 610-758-2605; *www.lehigh.edu/optics*

Administration: Thomas L. Koch, Ph.D., Director; Venkat Gopalan, Ph.D.(PSU), Associate Director; Anne L. Nierer, Administrative Coordinator.

Faculty Associates: Fil Bartoli, Ph.D., Ivan Biaggio, Ph.D., Rick Blum, Ph.D., Slade Cargill, Ph.D., Helen Chan, Pd.D., Volkmar Dierolf, Ph.D.; Yujie Ding, Ph.D.; Miltiadis Hatalis, Ph.D.; James Hwang, Ph.D.; Himanshu Jain, Ph.D.; Thomas Koch, Ph.D.; Sushil Kumar, Ph.D.; Tiffany Li, Ph.D., Alastair McAulay, Ph.D., Herman Nied, Ph.D., Daniel OuYang, Ph.D.; Sibel Pamukcu, Ph.D., Raymond Pearson, Ph.D.; Slava Rotkin, Ph.D., Michael Stavola, Ph.D., Nelson Tansu, Ph.D.; Svetlana Tatic-Lucic, Ph.D., Jean Toulouse, Ph.D., Richard Vinci, Ph.D., Marvin White, Ph.D.

Launched in 2001, the Center for Optical Technologies (COT) is a multi-institutional initiative based at Lehigh University with a charter to advance research, applications, and regional economic development opportunities for optical and optoelectronic technologies. (See *www.lehigh.edu/optics*.) Lehigh partners with Pennsylvania State University in research and education, with Northampton Community College and Lehigh Carbon Community College in education and outreach programs, and with Ben Franklin Technology Partners of Northeastern Pennsylvania in business development. The COT has joint research and business development activities with a growing list of local and national companies administered through the Center's industrial liaison program, as well as major research funding from the commonwealth of Pennsylvania and federal sources administered by the Offices of Sponsored Research at both Lehigh and Penn State.

The COT mission statement is: "To generate advances in the science and application of optical technologies, and to forge partnerships that drive growth and diversity in the industry." Pennsylvania, and the Lehigh Valley in particular, has an enviable infrastructure in optical and optoelectronic technologies, advanced optical, electronic and optoelectronic materials, and a host of related advanced nanotechnologies and nano-characterization capabilities. The COT vision and goal is to provide a sustainable university hub and partnership to accelerate the innovative and economic development potential of these resources, to transform the economic trajectory of the region, and develop the next generation optics technology and applications. In addition to the initial vision of advancing optical communications technologies, COT has expanded its research and application studies into new fertile high-value areas in life sciences, sensors, and displays, with significant interest from large and small corporate partners, from all corners of the globe.

The Center was initiated in 2000 with a $1M Phase I grant from the Pennsylvania Department of Community and Economic Development (PDCED), followed in 2001 with a major $15M five-year PDCED Phase II commitment through a Ben Franklin Technology Development Authority Contract, with matching financial commitments by Lehigh University and goals for major leveraged funding from federal, industry, and private sources. Since 2006 COT has received substantial additional annual funding totaling over $4M through PDCED programs in university research and the Pennsylvania Initiative on Nanotechnology. COT programs have also successfully focused on federal Department of Defense needs, including $14M of research funding for joint activities with the Army Research Laboratory, and in 2010 is leading a $2.1M Photonic Integration Foundry joint industry program sponsored by the US Navy. With additional generous private donations, growing competitively-awarded research grants and industrial participation, COT has achieved many of its goals.

COT Facilities & Research Activities:

In addition to the existing COT expertise at the program launch, there have been 12 faculty added in COT-related research areas at Lehigh alone leading to over 20 Lehigh participants, with 10 more at Penn State. The additions include 7 new professors in Electrical and Computer Engineering, 3 new professors in Physics, and two professors in Mechanical Engineering and Biology, respectively, participating in the new Bioengineering activity. These additions have also led to a significant expansion of course offerings in optical technologies at both the undergraduate and graduate levels, a new Masters in Photonics degree, and significant growth in funded graduate Ph.D. research programs.

COT has provided for dramatic enhancements of the existing individual faculty laboratories at both Lehigh and Penn State, including a wide assortment of specialized optical testing and evaluation equipment. These include ultra-high-speed femtosecond pulse laser systems for advanced materials and device analysis, unique 50 GHz microwave characterization apparatus for highly accurate pulsed evaluation of un-mounted devices, 12.5 Gb/s BER test apparatus and 40 Gb/s optical communications oscilloscopes, and extensive optical amplification, tunable and fiber mode-locked lasers, and optical spectrum analyzers for WDM and nonlinear fiber test and evaluation systems, and unique sources for THz wave generation. Unique capabilities have been installed for confocal microscopy and spectroscopy, both for advanced optoelectronic and electro-optic materials analysis as well as for biological sample evaluation. These include a new near-field scanning optical microscope with operation extending into the UV for high-spatial-resolution imaging of photoluminescence from new GaN-based materials. Optics labs and incubator partner labs at Lehigh have been enhanced with over 30 vibration-isolation tables for research or product development. COT also benefits from the extensive optical programs in the Sherman Fairchild Center for Solid State Studies, which include a flexible electronics lab pursuing flexible OLED displays on metal film substrates, and CMOS processing capabilities currently contributing to research in silicon photonics.

Major facilities investments include the new Smith Family Laboratory for Optical Technologies, made possible in large part due to a private donation from the family of Lehigh alumnus Daniel E. Smith, Jr., providing infrastructure to pursue multidisciplinary research targeting new optical and optoelectronic materials and device structures. This facility houses two new epitaxial growth systems for GaN-based high band-gap UV materials, and GaAs-based and InP-based optoelectronic and electronic materials, and a full open-access shared clean room with lithography, wet and dry processing capability for fabricating research devices. Complementing existing facilities at Lehigh and Penn State, this provides for a critically-needed capability to bring faculty together from Electrical and Computer Engineering, Physics, Materials Science and Engineering, and other disciplines including Biology, Chemistry, Chemical Engineering, and Mechanical Engineering, to pursue new device and materials functionality in a coordinated team environment. Lehigh has also invested in a new fiber draw tower, making it one of the few universities with the capability to make its own optical fibers for research. Current focus is on new materials such as tellurite fibers and possibly future chalcogenide glass fibers, as well as new photonic crystal fibers with micro- and nano-patterned internal structure for unique dispersive and nonlinear optical properties. The latter has been recently enhanced with addition of a new extrusion fiber preform apparatus.

The key areas of continuing COT research focus and activity are:

1. **Advanced Optical Functionality in Glasses, Dielectrics, and Ferroelectrics – Leaders**: Dr. Ivan Biaggio & Dr. Himanshu Jain
2. **Semiconductor and Organic Optoelectronic Devices and Materials – Leaders**: Dr. Jim Hwang & Dr. Volkmar Dierolf
3. **Biophotonics – Leader**: Dr. Daniel OuYang

For more information, contact Thomas L. Koch, Director, Center for Optical Technologies, 205 Sinclair, Lehigh University, 7 Asa 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.; David Pankenier, Ph.D.; James Saeger, 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.; 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*

Murray H. Goodman Center for Real Estate Studies

621 Taylor Street; 610-758-4788

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@l (Integrated Real Estate at Lehigh). ire@l is a three- to four-year course of study open to all undergraduate students at Lehigh. The ire@l curriculum consists of five core courses, IPRE 001, IPRE 002, IPRE 301, BUS 347 and BUS 348, and a mandatory summer internship. Two optional courses, IPRE 101 and IPRE 102, are also part of the curriculum. Additional courses offered include FIN 336- Real Estate Finance, and GBUS 425 - Real Estate Financing and Investing. 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) 758-4788 or email sft0@lehigh.edu.

Philip and Muriel Berman Center for Jewish Studies

9 W. Packer Avenue; 610-758-4869, fax 610-758-4858

Ruth Knafo Setton, Ph.D., Writer-in-Residence and Interim Director; Laurence J. Silberstein, Ph.D., director; Chava Weissler, Ph.D.; Robert L. Cohn, Ph.D.; Nitzan Lebovic, Ph.D.; Associated faculty: Bunnie Piltch, M.A.; Roslyn Weiss, Ph.D.; Benjamin G. Wright III, Ph.D.

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.

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. The center also coordinates the Richard and Susan Master Visiting Professorship in Jewish Studies at the Pontifical Gregorian University in Rome, a program initiated by Philip and Muriel Berman of Allentown, Pa.

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, contact Dr. Ruth Setton, Interim Director, Philip and Muriel Berman Center for Jewish Studies, Lehigh University, 9 W. Packer Avenue, Bethlehem, PA 18015, 610 758-4869, 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.; Natalie Foster, Ph.D.; J. Gilchrist, Ph.D.; J. Grenestedt, Ph.D.; Ned Heindel, Ph.D.; A. Jagota, Ph.D.; Andrew Klein, Ph.D.; T. 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.; Gary Simmons, 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 Chromatrography), Gel Permeation and Gas Chromatography units, Electrophoretic Mobility apparatus, mechanical testing devices such as the srcew-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* or e-mail rp02@lehigh.edu, jer1@lehigh.edu, 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 J. Bishop, Ed.D.; Mary Beth Calhoon, Ph.D., George J. DuPaul, Ph.D.; Lee Kern, Ph.D.; Patricia Manz, Ph.D.; Ageliki Nicolopoulou, 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 developing training for educators working with students who are diagnosed as having Autism Spectrum Disorder. 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 homeschool 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*; Web site: *www.lehigh.edu/collegeofeducation/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 Research (Center for)

The Center for Social Research is a multidisciplinary organization designed to stimulate and conduct research involving the social and behavioral sciences.

Several disciplines are involved in the activities of the center: psychology, sociology, anthropology, and education. The center also cooperates with the university's other research centers and with several science and engineering departments.

Founded in 1965 as the Center for Business and Economics, the focus of the center was later broadened, and the name changed to the Center for Business, Economics and Urban Studies. The center's early activities included research on economics and business forecasting, and on transportation problems. The change to include urban studies broadened the center's scope to encompass the disciplines of political science, sociology, and history. In 1972, the center's scope was further broadened to include behavioral science and international affairs, and the present name was selected to more accurately reflect this broadened focus.

Interdisciplinary Research. The social perspective of the center's research is interdisciplinary in nature and is relevant to the community outside the university-local, regional, national, and international. Many research activities are based on a cooperative university-community relationship through which the research goals of the center are achieved and community needs met. Interdisciplinary research activities of the center are currently being conducted in the following areas:

Health and Human Development. Members of the departments of psychology, sociology/anthropology, and education, participate in research on health and human development. The program focuses on life from early childhood to maturity. Research interests include the effect of perinatal loss on families and family members; the influence of family and community on health; management aspects of organizations that serve elderly individuals; psychological aspects of aging; and, psychological aspects of late life physical disabilities such as stroke and amputation.

Families and Children. Members of the departments of psychology, sociology/anthropology, and education participate in studies pertaining to families and children. Research interests include family dynamics and child rearing practices and the emphasis on families included under the health and human development program. Current research focuses on the effect of child rearing practices on children's development of competence.

Program Evaluation. Members of the departments of psychology, sociology/anthropology, and economics, participate in research to evaluate the effects of a variety of programs. Particular emphasis is on improving program evaluation methodology. Current research interests include evaluation of several business, science and engineering programs in the university. Research has recently been conducted on the effect of compensatory education and social service programs.

For more information, write to Diane Hyland, Director, Center for Social Research, Lehigh University, 17 Memorial Drive East, Bethlehem, Pa. 18015.

Value Chain Research (Center for)

Rauch Business Center, 621 Taylor St.

Robert Trent, Ph.D. and Lawrence V. Snyder, Ph.D., co-directors; Liuba Belkin, Ph.D.; Jill Brown, Ph.D.; Frank Curtis, Ph.D.; William Forster, Ph.D.; Robert Giambatista, Ph.D.; Lin Lin, Ph.D; Doug Mahony, Ph.D.; Eugene Perevalov, Ph.D; Corinne Post, Ph.D.; Ted K. Ralphs, Ph.D; Catherine Ridings, Ph.D; Nada Sanders, Ph.D; Michael D. Santoro, Ph.D; Katya Scheinberg, Ph.D.; Susan Sherer, Ph.D.; Robert H. Storer, Ph.D; Aurelie C. Thiele, Ph.D; George R. Wilson, Ph.D; S. David Wu, Ph.D; Oliver Yao, Ph.D.; Zach Zacharia, Ph.D.

The Center for Value Chain Research (CVCR) is committed to promoting and conducting research and information exchange through the integration of emerging theory and best practices. The center's research focuses primarily, but not limited to, value chain planning and development activities, which connects corporate strategy with value chain execution.

Interdisciplinary Research. The CVCR is a joint venture between Lehigh University's P.C. Rossin College of Engineering and Applied Sciences and the College of Business and Economics. A core group of over 25 faculty members from both colleges is affiliated with the center. The center 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.

Research Activities. CVCR faculty perform research in a variety of topics, including logistics and operations, network organization and technology, and value network strategy. The research uses a wide range of tools and methodologies, including network design and analysis, financial engineering, mathematical programming and optimization, advanced planning and scheduling (APS), stochastic processes, auction and bidding algorithms, game theory and economic analysis, parallel and distributed computing, field studies, surveys, case studies, artificial intelligence, and data mining.

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.
- Brings together scholars and practitioners to establish a multi-disciplinary research agenda for information-enabled inter- and intra-organizational networks.
- Conducts semiannual symposiums, Professional Development Seminars, APICS Certification Courses, and Executive Round Tables.
- Disseminates research findings through professional conferences, scholarly publications, and curriculum development.

For more information, contact Prof. Robert Trent, Co-Director, Prof. Larry Snyder, Co-Director, or Joel Sutherland, Managing Director, Center for Value Chain Research, Lehigh University, Rauch Business Center, 621 Taylor Street, Bethlehem, PA 18015; (610-758-6428) or email joel.sutherland@lehigh.edu; Web site: *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 based on the Goodman 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 initiative that brings together Pennsylvania's people, ideas, and technology, and serves as a catalyst for advancing the state's technology economy. 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 high-quality 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 36,280 jobs.
- Established 420 new companies.
- Commercialized and developed 1,017 new products and processes.

The Ben Franklin program is structured to help companies achieve sustainable competitive advantage. BFTP/NEP is measured on the basis of the commercial success achieved by its clients as a direct result of assistance provided.

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®, a business incubator and post-incubator facility, on Lehigh's Mountaintop campus. Forty-eight successful companies have graduated from the BFTP/NEP incubator, together grossing more than $408 million in annual revenue last year and creating more than 4,500 jobs. TechVentures² will be completed in 2011

For more information, contact the Ben Franklin Technology Partners of Northeastern Pennsylvania, Lehigh University, 125 Goodman Drive, Bethlehem, PA 18015-3715; 610-758-5200; *www.nep.benfranklin.org*. E-mail: 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; and

For further information or assistance, please contact Jack Pfunder, MRC Executive Director at 610-758-5596 or 800-343-6732. Please visit our website at *www.mrcpa.org.*

Manufacturing Systems Engineering (Center for)

200 W. Packer Avenue; (610) 758-5157

Keith M. Gardiner, Ph.D., director; John P. Coulter, Ph.D.; Steven L. Goldman, Ph.D.; Mikell P. Groover, Ph.D.,; Parveen P. Gupta, Ph.D.; Jacob Y. Kazakia, Ph.D.; Roger N. Nagel, Ph.D.; John B. Ochs, 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 386 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 leadingedge 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, 45 graduate level elective courses (at least one elective must be an MSE-numbered course) and a 3or 6credit 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, 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/~inmse/gradprogram/*

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 05 and the Excel Competency program. BUS 05 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 Joseph Manzo, Director, The Philip Rauch Center for Business Communications, Lehigh University, 621 Taylor Street, Bethlehem, PA 18015-3117, or email 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; Christopher Jones, 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*)

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.

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.

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.

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.

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 midsized manufacturing or service companies to participate in international trade events. Specialized training events and seminars are also held throughout the year.

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.

LUMAC. The Lehigh University Management Assistance Counseling 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, Rauch Business Center, 621 Taylor Street, Bethlehem, PA 18015

V. Courses, Programs and Curricula

This section includes listings of undergraduate and graduate courses offered by Lehigh University. 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 early registration.

All academic departments and programs are listed in alphabetical order.

Credit Hours

The number in parentheses following each course title indicates the 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 semesters.

Apprentice Teaching and Cooperative Undergraduate Education

For details of these programs, see descriptions under "Apprentice Teaching" and "Cooperative Undergraduate Education," in section III.

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 must in order to be admitted to a course either obtain on line permission from the designated college or department officer or, file with the registrar at the time of registration and on a standard form provided, a waiver of prerequisites signed by the course instructor, the teaching department chair and either the chair of the student's major department or the associate dean. Academic work completed elsewhere must be attested in this manner as being substantially equivalent to prerequisites listed, unless the student's records in the Office of the Registrar show that the proper officers have so evaluated this preparation previously.

In a few cases, corequisites are indicated. In such instances the corequisite 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.

ED. This code plus the following number indicates that the course satisfies a number of hours of engineering design requirements for ABET accreditation.

Accounting

Professors: Paul R. Brown, Ph.D. (Texas-Austin), C.P.A.; Parveen P. Gupta, Ph.D. (Penn State), chair; Gopal V. Krishnan, Ph.D. (University of North Texas), C.P.A.; James A. Largay, III, Ph.D. (Cornell), C.P.A.; John W. Paul, Ph.D. (Lehigh), C.P.A.; Heibatollah Sami, Ph.D. (Louisiana State University), Kenneth P. Sinclair, Ph.D. (Massachusetts).

Associate Professors: Karen M. Collins, Ph.D. (VPI), C.P.A.; James A. Hall, Ph.D. (Oklahoma State).

Assistant Professors: David M. Folsom, Ph.D. (University of Iowa), Hye Seung Lee, A.B.D. (University of Arizona); Xu Li, Ph.D. (Massachusetts Institute of Technology); Yvonne Y. Lu, Ph.D. (Stanford University), Marietta Peytcheva, Ph.D. (Rutgers University), C.P.A.

Professor of Practice: Jay D. Brodish, B.S. (Lehigh University), C.P.A.; Joseph M. Manzo, M.B.A. (Lehigh University)

Lecturers: David J. Hinrichs, M.B.A. (Lehigh).

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 under Graduate Studies) 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:

1. Preparing and understanding general purpose financial statements for parties outside the firm.
2. Using accounting information for decision-making inside the firm.
3. 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.

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.

In addition to the existing sophomore prerequisites, Introduction to Financial Accounting (ACC 151) and Introduction to Managerial Accounting (ACC 152), accounting majors are required to take four junior-level, accounting core requirements (12 credits) and one concentration (9 credits):

Core Requirements (typically taken junior year)	**Credits**
Financial I and II (ACC 315 and 316)	6
Financial I and II (ACC 315 and 316)	6
Accounting Information Systems (ACC 311)	3
Cost Accounting (ACC 324)	3
	12
Concentration (typically taken senior year)–three courses, one of which is accounting	9
	21

The following three concentrations are available:

1. Public Accounting Assurance and Tax Services

This concentration is suited for students interested in entering public accounting. This concentration requires the core and the following 9-credit concentration:

- Fundamentals of Federal Income Taxation (ACC 307)
- Fundamentals of Auditing (ACC 320)
- Advanced Financial Accounting (ACC 317)

2. 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.

Because Lehigh's finance faculty determined that two courses, Investments (FIN 323), and Corporate Financial Policy (FIN 328), are both needed to have a core understanding of finance, this second concentration requires these two courses. Also, Analysis of Financial Statements, ACC 318, is positioned at the interface of accounting and finance.

- Investments (FIN 323)
- Corporate Financial Policy (FIN 328)
- Analysis of Financial Statements (ACC 318)

3. 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.

- Fundamentals of Auditing (ACC 320)
- Managing Information Systems Analysis and Design (BIS 311)
- Web Application Development (BIS 335) or E-Business Systems (BIS 342) or International Practicum (CSB 314)

The description and requirements of the Master of Science in Accounting and Information Analysis Program are found under Graduate Study and Research.

Undergraduate Courses

ACCT 108. Fundamentals of Accounting (3)
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)
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. Prerequisite: sophomore standing and successful completion of Excel competency exam.

ACCT 152. Introduction to Managerial Accounting (3)
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. Prerequisite: Acct 151.

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.

ACCT 307. Fundamentals of Federal Income Taxation (3)
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. Prerequisite: Acct 151.

ACCT 309. Advanced Federal Income Taxation (3)
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. Prerequisite: Acct 307.

ACCT 311. Accounting Information Systems (3)
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. Prerequisite: Acct 152 and BIS 111.

ACCT 315. Financial Accounting I (3)
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. Prerequisite: Acct 152.

ACCT 316. Financial Accounting II (3)
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. Prerequisite: Acct 315.

ACCT 317. Advanced Financial Accounting (3)
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. Prerequisite: Acct 315 or 316.

ACCT 318. Analysis of Financial Statements (3)
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. Prerequisite: Acct 316 (may be taken concurrently); open only to graduating seniors.

ACCT 320. Fundamentals of Auditing (3)
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: Acct 311 and 315.

ACCT 324. Cost Accounting (3)
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. Prerequisite: Acct 152.

ACCT 371. Directed Readings (1-3)
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. Prerequisite: preparation acceptable to the department chair.

ACCT 372. Special Topics (1-3)
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. Prerequisite: preparation in accounting acceptable to the program coordinator.

Graduate Courses

Course descriptions for the College of Business and Economics graduate courses can be found in this section (Section V) under the heading of Business and Economics Graduate Courses.

Africana Studies

Program Director. James Braxton Peterson, Ph. D. (U. Pennsylvania)

Office of Interdisciplinary Programs 610-758-3996; incasip@lehigh.edu

Africana Studies Faculty. William R. Scott, Ph.D. (Princeton), Professor of History; Elizabeth N. Fifer, Ph.D. (Michigan), Professor of English; Kashi Johnson, MFA (Pittsburgh), Associate Professor of Theatre; Seth Moglen, Ph.D. (UC Berkeley), Associate Professor of English; Heather Johnson, Ph.D. (Northeastern); Associate Professor of Sociology and Anthropology; Vera Fennell, Ph. D. (Chicago), Associate Professor of Political Science; Bruce Whitehouse, Ph. D. (Brown), Assistant Professor of Anthropology; Tanya L. Saunders Ph.D. (Michigan), Assistant Professor of Sociology and Anthropology; Saladin Ambar, Ph. D. (Rutgers), Assistant Professor of Political Science; Andrew L. Kaye, Ph.D. (Columbia), Adjunct Professor

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 all 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:

Introductory Course	(1)
Humanities	(3)
Social Sciences	(3)
Disciplinary Concentration	(3)

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 the introductory course and no less than two upper level courses in the field.

Core Courses: Core courses concentrate on subject material directly relevant to the study of past and present experiences of people of African descent.

AAS 3. Introduction to Africana Studies (4)
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. W. Scott (SS)

AAS 5. (HIST 5) African Civilization (4)
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. Staff (SS)

AAS 35. (THTR 35) Performance (2)
Performing in a department approved production. May be repeated for credit. (HU)

AAS 38. (ENGL 38) Introduction to African Literature (3)
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. Staff (HU)

AAS 64. (ECO 64, HIST 64) Plantation to Ghetto (2)
Examination of topics in the economic history of African Americans from the 1500s to the present. Explores the slave trade, slavery, post-Civil War South, the black family, migration, urbanization, and race and poverty. O'Brien, Scott (SS)

AAS 103. (SSP 103) Race and Ethnicity (4) fall
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." H. Johnson (SS)

AAS 104. (ANTH 104) Contemporary Issues in African Societies (4)
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? Whitehouse (SS)

AAS 106. (LAS 106, SSP 106) Race and Ethnicity in Latin America and the Spanish Speaking Caribbean (4)
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. Saunders (SS)

AAS 117. (PHIL 117) Race and Philosophy (4)
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. (HU)

AAS 120. (ENGL 120) Literature from Developing Nations (4)
Contemporary literature from Africa, Central and South America, and Asia. Prerequisite: six hours of freshman English. (HU) Cannot be taken pass/fail.

AAS 121. (ENGL 121) Topics in African-American Literature (4)
Selected works of African American literature and/or the literatures of the African Diaspora. May be repeated for credit as title varies. Prerequisite: six hours of first-year English. (HU) Cannot be taken pass/fail.

AAS 128. (MUSIC 128) Jazz History I (3) fall
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. Warfield (HU)

AAS 129. (MUSIC 129) Jazz History II (3) spring
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. Warfield (HU)

AAS 130. (HIST 130) African American History (4)
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. Staff (SS)

AAS 132. (THTR 132) Hip Hop Theatre (4)
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. Prerequisite: Audition. Consent given by instructor. (HU)

AAS 133 (LAS 133, MLL 133, FREN 133, HIST 133, POLS 133) Lehigh in Martinique: Globalization and Local Identity (4)
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.

AAS 138. Introduction to African American Literature (4)
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. Staff (HU)

AAS 140. (THTR 140) African American Theatre (4)
Foundations of African American theater: historical, literary, and practical. K. Johnson (HU)

AAS 144 (SSP 144) Global Hip Hop and Social Change (4)
Hip Hop has become a global phenomenon. In this course 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. Saunders (SS)

AAS 145. (WS 145) African American Women Writers (4)
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. Levy (HU)

AAS 148. Cultural Diversity in the Caribbean (4)
Cultural diversity in the Caribbean islands and the Guyanas, with emphasis on the African, Amerindian, and Indian influences. The sociological and cultural implications of the region's diversity, with special emphasis on ethnicity, slavery and indenture, emancipation and independence, modernization, immigration, the impact of tourism and the development of Creole cultures. Lecture and discussion. Staff (SS)

AAS 155. (SSP 155, LAS 155) Afro-Latino Social Movements in Latin America & the Caribbean (4)
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. Saunders (SS)

AAS 166. (SSP 166) Wealth and Poverty in the United States (4)
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. Johnson (SS)

AAS 177. (SSP 177) Cuba: Race, Revolution and Culture (4)
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.

AAS 179. (HIST 179) Black Political Thought in America (4)
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. Scott, Ambar (SS)

AAS 183 (ANTH 183) Peoples and Cultures of Africa (4)
Studies African modernity through a close reading of ethnographies, social stories, novels, and African feature films. Staff (SS)

AAS 230. (POLS 230) Social Movements and Legacies of the 1960s (4)
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. Morgan (SS)

AAS 263. Caribbean Artistic and Cultural Traditions (4)
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. Staff (HU)

AAS 310. (SSP 310, WS 310) Gender, Race and Sexuality: The Social Construction of Differences (4)
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 images have implications for the role racial, gender, and sexual identity plays in our understanding of the relationship between difference and inequality. Prerequisite: WS 001, or department permission. Saunders (SS)

AAS 312. (FREN 312) Modernity in the Maghreb (4)
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. Berrada

AAS 313. (SSP 313) Social Movements (4)
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. Munson (SS)

AAS 318. (ENGL 318) Topics in African-American Literature and Culture (4)
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.

AAS 324. (ANTH 324, GS 324) Globalization and Development in Africa (4)
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 neo-liberal 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"? Whitehouse (SS)

AAS 331. (HIST 331) United States and Africa (4)
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. Scott (SS)

AAS 332. (HIST 332) Slavery and the American South (4)
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. Staff (SS)

AAS 343. (ASIA 343, GS 343, POLS 343) Global Politics of Race: Asia and Africa (4)
An examination of the concept of "race" and its impact on domestic and international politics. V. Fennell (SS)

AAS 345. (SSP 345) Colonialism and the Black Radical Tradition (4)
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. Saunders (SS)

AAS 359. (HIST 359) History of South Africa (4)
South Africa’s history from its earliest human settlement to its emergence as a racist political order and transition to a nonracial democratic state. Includes comparisons with political thought and practices in the U.S. Scott (SS)

AAS 371, 372. Independent Study (1-3)
Independent study in advanced areas of Africana Studies. Independent research with an individual faculty member in the Africana Studies program. Consent of director (ND)

AAS 379. (SSP 379) Race and Class in America (4)
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. H. Johnson (SS)

AAS 381. Special Topics. (ND)

AAS 382. Seminar on a topic in Africana Studies. (ND)

Collateral Course

HIST 334	American City in the 20th Century

American Studies

American Studies Faculty.

Program Director: Edward Whitley, Ph.D. (Maryland), Director of American Studies and Associate Professor of English

610-758-3321; edw204@lehigh.edu

Art, Architecture and Design: Berrisford Booth, M.F.A. (Maryland Institute College of Art) Associate Professor

English: Edward J. Gallagher, Ph.D. (Notre Dame) Professor; Dawn Keetley, Ph.D. (Wisconsin) Associate Professor; Seth Moglen, Ph.D. (U.C. Berkeley) Associate Professor; Stephanie P. Watts, Ph.D.(Missouri-Columbia, Associate Professor; Mary C. Foltz, Ph.D. (University of Buffalo) Assistant Professor

History: Stephen H. Cutcliffe, Ph.D. (Lehigh) Professor; William R. Scott, Ph.D. (Princeton) Professor; Roger D. Simon, Ph.D. (Wisconsin) Professor; Gail A. Cooper, Ph.D. (U.C. Santa Barbara) Associate Professor; Monica Najar, Ph. D. (Wisconsin) Associate Professor; John Pettegrew, Ph.D. (Wisconsin) Associate Professor; John K. Smith, Ph.D. (Delaware) Associate Professor; Michelle LeMaster, Ph.D. (Johns Hopkins) Assistant Professor; Kim Carell-Smith, Ph.D. (Delaware) Professor of Practice.

Journalism: Jack Lule, Ph.D. (Georgia) Professor; Kathleen K. Olsen, PhD. (North Carolina) Associate Professor; Jeremy Littau, Ph.D. (Missouri); Assistant Professor

Political Science: Richard K. Mathews, Ph.D. (Toronto) Distinguished professor; Edward T. Morgan, Ph.D. (Brandies) Professor; Brian Pinaire, Ph.D. (Rutgers) Associate Professor; Albert Wurth, Ph.D. (North Carolina) Associate Professor

Religion Studies: Norman Giardot, Ph.D. (Chicago) Professor; Michael L. Raposa, Ph.D. (Pennsylvania) Professor

Sociology and Anthropology: James R. McIntosh, Ph.D. (Syracuse) Professor; Ziad Munson, Ph.D. (Harvard) Frank Hook, Associate Professor; Heather Johnson, Ph.D. (Northeastern)`Associate Professor; Jacqueline Krasas, Ph.D. (Southern California) Associate Professor; Tanya L. Saunders, Ph.D. (Michigan) Assistant Professor

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. In addition to the Theory and Method course, students must choose two humanities courses and two social science courses. Students must also take one special topics seminar. The other courses for the master's degree will be divided between; thesis credits, American Studies courses in areas other than history or literature/film. To fulfill the thesis requirement, students will write one longer thesis or two thesis papers that are aimed at conference presentation and/or publication.

Courses:

AMST 400. American Studies: Theory and Method (3)
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 (3)
Graduate seminar focused on one particular subject area in American Culture.

AMST 490. Master's Thesis (1-6)
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.

Applied Mathematics and Statistics

Professors. Vladimir Dabric, Ph.D. (Zagreb, Croatia); Bennett Eisenberg, Ph.D. (M.I.T); Wei-Min Huang, Ph.D. (Rochester); Garth Isaak, Ph.D. (Rutgers); Eric P. Salathe, Ph.D. (Brown); Joseph E. Yukich, Ph.D. (M.I.T.).

Associate Professors. Mark A. Skandera, Ph.D. (M.I.T.); Ramamirthan Venkataraman, Ph.D. (Brown); Linghai Zhang, Ph.D. (Ohio).

Assistant Professor. Soutir Bandyopadhyay, Ph.D. (Texas A&M); PingShi Wu, Ph.D. (U.C. Davis).

The Division of Applied Mathematics and Statistics was established within the Department of Mathematics to promote and administer undergraduate and graduate education in applied mathematics and statistics, and to foster interdisciplinary research in the mathematical sciences at Lehigh. Courses and programs offered by the division may be found under the departmental listing.

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.

The requirements for a BS in Applied Science program are a minimum of 129 credit hours including First Year Courses: ENGL 1 and 2; ENGR 1 and 5; CHM 30, PHYS 11 and 12; MATH 21 and 22. Other Natural Science: CHM 110 and 111; EES 21, 22, and 31; PHYS 21 and 22. Other Mathematics: MATH 21, 22, 23, 205, and 231. Required HSS courses: ECO 1, PHIL 128, and PSYC 1. Humanities & Social Science electives: 13 additional credits subject to college requirements. Major electives: 24 credits. Approved electives: 18 credits. For a Recommended Sequence of Courses, see http://www3.lehigh.edu/engineering/academics/appliedscience2.asp

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 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.

300. Apprentice Teaching (1-4)
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. The transcript will reflect the subject area in which the teaching was done.

Art, Architecture, and Design

Professors. Lucy Gans, M.F.A. (Pratt Institute); Ricardo Viera, M.F.A. (R.I.S.D.), director of Lehigh University Art Galleries; Anthony Viscardi, M.ARCH (Georgia Institute of Technology).

Associate Professors. Berrisford W. Boothe, M.F.A. (Maryland Institute College of Art); Anna M. Chupa, M.F.A. (University of Delaware); Amy Forsyth, M.ARCH (Princeton University); Bruce Thomas, Ph.D. (University of California, Berkeley).

Assistant Professors. B. Wesley Heiss, M.ARCH (Rice University); Marilyn Jones, M.F.A. (Marywood); Hyun-Tae Jung, M.Phil. (Columbia University); Nikolai Nikolov, M.Arch (Rice University); Nicholas Sawicki, Ph.D. (University of Pennsylvania);

Professor of Practice. Christine Ussler, M.ARCH (Columbia University).

Lecturer. Jason Travers, M.F.A. (University of Pennsylvania).

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.

Note: A student must achieve a 2.0 or higher in each major course.

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.

Art Major

56 credit hours required

Foundation (16 credit hours):

DES 3	Two-dimensional design (4)
DES 4	Three-dimensional design (4)
ART 11	Drawing I (4)

Plus one additional entry-level studio (4):

ART 13	Sculpture I (4)
ART 15	Figure I (4)
ART 35	Painting I (4)

History (16 credit hours):

ART 1	Art History I: Ancient to Medieval (4)
Or ARCH 1	Architectural History I (4)
ART 2	Art History II (4)
ART 220	20th-Century Art (4)

Plus one additional history course (4):

DES 66	Design History (4)
ART 121	Women in Art (4)
PHIL 123	Aesthetics (4)
ART 206	Medieval Art and Architecture (4)
ART 207	Renaissance Art and Architecture (4)
DES/THTR 129	History of Fashion and Style (4)

Studios (24 credit hours):

Six studio courses, at least two of which are at advanced level:

ART 13	Sculpture I (4)
ART 15	Figure I (4)
ART 34	Plein Air Painting (4)
ART 35	Painting I (4)
ART 52	Introduction to Video Recording and Editing (4)
ART 111	Drawing II (4)
ART 113	Sculpture II (4)
ART 115	Figure II (4)
ART 135	Painting II (4)
DES 148	Furniture Design I (4)
ART 177	Digital Photography I (4)
ART 211	Drawing III (4)
ART 213	Sculpture Workshop (4)
ART 215	Figure III (4)
ART 235	Painting III (4)

DES 248	Furniture Design II (4)
ART 277	Digital Photography II (4)
ART 352	Advanced Studio Practice (1-4)

Art History Major

33-43 credit hours are required.

Core Requirements (15 credit hours)

Core requirements consist of four courses.

One introductory sequence course in the history of art and architecture, from the following list:

ART 1	Art History I: Ancient to Medieval (4)
ARCH 1	Architectural History I (4)

One course in ancient art, from the following list:

ART 174	Greek Archaeology (3)
ART 176	Roman Archaeology (3)

One course in medieval to renaissance art, from the following list:

ART 206	Medieval Art and Architecture (4)
ART 207	Renaissance Art and Architecture (4)

One studio course, from the following list:

DES 3	Two-dimensional design (4)
DES 4	Three-dimensional design (4)
ART 11	Drawing (4)
ART 13	Sculpture I (4)
ART 15	Figure I (4)
ART 35	Painting I (4)
ART 177	Digital Photography I (4)
ARCH 211	Architectural Drawing /Analysis and Expressions (3)

Concentration (12-16 credit hours)

Concentration requirements consists of three to four courses. Students choose from one of three available concentrations areas: History of the Visual Arts, History of Architecture, and Museum Studies.

History of the Visual Arts

ART 2	Art History II (4)
ART 220	20th-Century Art (4)
ART 356	Advanced Seminar in Art History (4)

History of Architecture

ARCH 2	Architectural History II (4)
ARCH 210	20th-Century Architecture (4)
ARCH 107	American Architecture (4)

Museum Studies

ART 175	Introduction to Museum Work (4)
ART 275	Research, Collections Management and Exhibition Planning (4)
ART 276	Education, Communication and Exhibition Design (4)
ART 375	Museum Internship (1-4)

Electives (6-12 credit hours)

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). Choose from any of the courses listed above, as well as:

ART 69	Special Topics in Art History (1-4)
ART 121/WS 121	Women in Art (4)
ART 144/REL 144	Raw Visions (4)
ART 169	Special Topics in Art History (1-4)
ART 222	Seminar in Art History (4)
ART 269	Special Topics in Art History (1-4)
ART 370	Special Topics in Museum and Curatorial Studies (1-4)
ARCH 209	Architecture and Ideas (4)
ARCH 212	The Architecture of Carlos Scarpa/Theory and Practice (3)
ARCH 214	Architecture and the City since World War II (4)
ARCH 271	Special Topics in Architecture (1-4)
ARCH 335	Issues in Contemporary Architecture (4)
DES 66	Design History (4)
DES 266	History of Contemporary Design (4)
ANTH 175	Archaeology of Classical Cultures (4)
ANTH 178	Mesoamerican Archaeology (4)
HIST 333	American City to 1900 (3-4)
HIST 334	American City in the 20th Century (3-4)
HIST 339	Managing Nonprofit Organizations (4)
HIST 350	19th-Century Paris and the Invention of Modernity (4)
LAS265/SPAN265	Spanish and Latin American Cinema (4)
PHIL 123	Aesthetics (4)
PHIL 223	Figures and Themes in Aesthetics (4)
REL 189	Religion and the Visual Arts (4)
DES/THTR 129	History of Fashion and Style (4)

Architecture Major

65-66 credit hours are required.

Studio (38 credit hours)

DES 4	Three-dimensional design (4)
ARCH 43	Architectural Design I (4)
ARCH 143	Architectural Design II (6)
ARCH 243	Architectural Design III (6)
ARCH 343	Architectural Design IV (6)

Plus three additional studios (12):

DES 3	Two-dimensional design (4)
ART 11	Drawing I (4)
ART 13	Sculpture I (4)
ART 15	Figure I (4)
ART 34	Plein Air Painting (4)
ART 35	Painting I (4)
ART 52	Introduction to Video Recording and Editing (4)
ART 111	Drawing II (4)
ART 113	Sculpture II (4)
ART 115	Figure II (4)
ART 135	Painting II (4)
DES 148	Furniture Design I (4)
ART 177	Digital Photography I (4)
DES 248	Furniture Design II (4)
ARCH 211	Architectural Drawing /Analysis and Expressions (3)
ARCH 328	Architectural Representation (4)

History and Theory (19-20 credit hours)

ARCH 1	Architectural History I (4)
	Or
ART 1	Art History I: Ancient & Medieval (4)
ARCH 2	Architectural History II (4)
ARCH 210	20th-Century Architecture (4)

Plus two additional courses (7-8):

ARCH 107	History of American Architecture (4)
ARCH 174	Greek Archaeology (3)
ARCH 176	Roman Archaeology (3)
ARCH 187	Synthetic Space (4)
ARCH 209	Architecture and Ideas (4)
ARCH 212	The Architecture of Carlos Scarpa/Theory and Practice (3)
ARCH 214	Architecture and the City Since WWII (4)
ARCH 342	Theory of Form and Materials (4)
ARCH 335	Issues in Contemporary Architecture (4)
PHIL 123	Aesthtics (4)
HIST 334	American City in the Twentieth Century (3-4)
DES 66	Design History (4)

Materials and Technology (8 credits)

ARCH 157	Architectural Technology I (4)
ARCH 158	Architectural Technology II (4)

For the Architecture Major, students must fulfill the mathematics requirement with MATH 21 & 22 or MATH 51 & 52 or MATH 75/76 and MATH 22 or MATH 52; the physical science requirement must be filled with PHYS 10 or 11 and 12.

A typical first-semester might consist of ART 1 or ARCH 1, MATH 21 or MATH 51, DES 4, ENGL 1 and a first-year seminar. A second-semester schedule might include ARCH 2, MATH 22 or MATH 52, PHYS 10 or 11, PHYS 12 and ENGL 2.

Design Major

56 credit hours required

Foundation (12 credit hours):

DES 3	Two-dimensional Design (4) [required for graphic design concentration]
	Or
DES 4	Three-dimensional Design (4) [required for product design concentration]
ART 11	Drawing I (4)
DES 60	Design Process (4)

History and Theory (16 credit hours):

ART 2	Art History II: Renaissance to Present (4)
ART 220	20th-Century Art (4)
ART 68	Color Theory (4) [required for graphic design concentration]
	Or
DES 164	Ergonomics (4) [required for product design concentration]

And one of the following:

DES 66	Design History (4)
DES 266	History of Contemporary Design (4)
DES/THTR 129	History of Fashion and Style (4)

Core Concentration (28 credit hours):

Seven elective studio (28) <u>or</u> concentration in graphic design or product design.

Graphic Design:

DES 53	Introduction to Graphic Design (4)
DES 153	Graphic Design: Word and Image (4)
DES 253	Graphic Design: Brand Experience (4)

DES 311	Design Portfolio (1-4)

Plus three elective studios (12)

Product Design:

DES 40	Product Design I: Form, Process & Concept (4)
DES 140	Product Design II: Designing for Others (4)
DES 240	Product Design III: Material to Market (4)
	(or IPD class in consultation with advisor)
DES 311	Design Portfolio (1-4)

Plus three elective studios (12)

Undergraduate Courses in Art

ART 1. Art History: Ancient and Medieval (4) fall
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. Sawicki (HU)

ART 2. Art History: Renaissance to Present (4) spring
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. (HU) Sawicki.

ART 11. Drawing I (4)
Concepts and practice of drawing, both traditional and contemporary. Includes drawing from life and an introduction to materials and techniques. Staff (HU)

ART 13. Sculpture I (4)
Projects directed toward developing design in sculpture. Exploration of materials and their application. Emphasis on sculptural form as it relates to techniques. Gans (HU)

ART 15. Figure I (4)
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. Gans (HU)

ART 034. Plein Air Painting (4)
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. HU. Travers

ART 35. Painting I (4)
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 prerequisite: DES 3 or 4 or Art 11 or consent of instructor. Boothe (HU)

ART 37. Survey of Printmaking (4)
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. Prerequisite: DES 3 and students are encouraged to complete a drawing studio before taking this course. (HU).

ART 52. Introduction to Video Recording and Editing (4)
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. (HU) Chupa.

ART 68. Color Theory (4)
Application of color in design. Color in graphics, product, digital imaging, and all related fields of design. (HU)

ART 69. Special Topics in Art History (1-4)
Directed projects for students in the history of art or architecture. Prerequisites: consent of instructor. May be repeated for credit. (HU)

ART 73. Introductory Studio Practice (1-4)
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. Staff (ND)

ART 111. Drawing II (4)
Projects in creative drawing designed to build on concepts and practices initiated in basic drawing and life drawing. Prerequisite: ART 11. Staff (HU)

ART 113. Sculpture II (4)
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. Prerequisite: ART 13. Gans (HU)

ART 115. Figure II (4)
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. Prerequisite: ART 15. Gans (HU)

ART 121. (WS 121) Women in Art (4)
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. Gans (HU)

ART 135. Painting II (4)
A sustained exploration of paint media. Students concentrate on developing a body of related images using various media and approaches. Prerequisite: ART 35. Boothe (HU)

ART 144. (REL 144) Raw Vision: Creativity and Ecstasy in the Work of Shamans, Mystics, and Artist Outsiders (4)
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. Girardot (HU)

ART 152. Experimental Animation and Video (4)
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: Art 52. (HU) Chupa.

ART 169. Special Topics in Art History (1-4)
Directed projects for students in the history of art or architecture. Prerequisites: consent of instructor. May be repeated for credit. Staff (HU)

ART 174. (ARCH 174, CLSS 174, ANTH 174) Greek Archaeology (3)
Ancient Greek cultures from the neolithic to hellenistic periods. Reconstructions of Greek social dynamics from study of artifacts. Small (SS)

ART 176. (ARCH 176, CLSS 176, ANTH 176) Roman Archaeology (3)
Cultures of the Roman Empire. Reconstructions of social, political, and economic dynamics of the imperial system from study of artifacts. Small (SS)

ART 177. Digital Photography I (4)
Intensive work in photography as fine art using digital input and output. Lectures, demonstrations, critiques. (HU)

ART 206. Medieval Art and Architecture (3)
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. Prerequisite: Art 1. Staff (HU)

ART 207. Renaissance Art and Architecture (3)
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. Prerequisite: Art 2. Staff (HU)

ART 211. Drawing III (4)
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. Prerequisite: ART 111. Boothe or Gans (HU)

ART 213. Sculpture Workshop (4)
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: Art 13 and DES 4. Gans

ART 215. Figure III (4)
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. Prerequisite: ART 115. Gans (HU)

ART 220. 20thCentury Art (4)
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. Prerequisite: Art 2. (HU) Sawicki.

ART 222. Seminar in Art History (4)
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. May be repeated for credit. Prerequisites: Art 1 or Art 2, or permission of instructor. (HU)

ART 235. Painting III (4)
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. Prerequisite: ART 135 or consent of instructor. May be repeated for credit. Staff (HU)

ART 269. Special Topics in Art History (1-4)
Directed projects for advanced students in the history of art or architecture. Prerequisite: consent of instructor. May be repeated for credit. Staff (ND)

ART 273. Special Topics in Studio Practice (1-4)
Individually directed projects for advanced students capable of undertaking independent creative work in studio art. Prerequisite: consent of instructor. May be repeated for credit. Staff (ND)

ART 277. Digital Photography II (4)
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. Prerequiste: Art 177 or permission of instructor. May be repeated for credit. (HU) Chupa.

ART 311. Art Portfolio (1-4)
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. Prerequisite: Junior standing and consent of instructor. (ND)

ART 350. Special Topics in Graphic Design and Theory Seminar (1-4)
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: DES 253. Staff (ND)

ART 352. Advanced Studio Practice (1-4)
Advanced studio for art or architecture majors under guidance of faculty. Oral and written critiques. Variable media. May be repeated for credit. Prerequisites: Third level (200 numbered) course of a studio art discipline and permission of instructor. Staff (HU)

ART 353. Graphic Design Internship (1-4)
Practical infield experience in a communication design field. Preapproved a semester in advance by instructor and host organization. A minimum of 15 hours per week. Prerequisite: DES 253. Staff (ND)

ART 356: Advanced Seminar in Art History (4)
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. Prerequisites: Art 1 or Art 2, or permission of instructor. (HU) Staff

ART 373. Studio Art Internship (1-4)
Practical infield experience in an artist's studio or art-related apprenticeship opportunity. Requires approval a semester in advance by instructor and host organization. Staff (ND)

Undergraduate Courses in Museum Studies

ART 175. Introduction to Museum Work (4)
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 handson experience. Students complete several interactive (PB & CL) exercises/projects. Viera. (ND)

ART 275. Research, Collections Management and Exhibition Planning (4)
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. Prerequisite: Art 175. Viera. (ND)

ART 276. Education, Communication and Exhibition Design (4)
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. Prerequisite: Art 175. Viera (ND)

ART 370. Special Topics in Museum and Curatorial Studies (1-4)
Special project and/or internship for graduate and advanced undergraduates. May be repeated for credit. Prerequisite: Art 275 or 276 or equivalent course in anthropology, public history or education technology. Viera (ND)

ART 375. Museum Internship (1-4)
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. Prerequisite: Art 275 or 276 or departmental permission. Viera. (ND)

Undergraduate Courses in Architecture

ARCH 1. Architectural History I (4) fall
Survey of architecture from earliest building to the Renaissance, examined in the context of culture formation, design concepts, and the built environment. Thomas (HU)

ARCH 2. Architectural History II (4) spring
Survey of architecture from the Renaissance to the present, examined in the context of culture formation, design concepts, and the built environment. Thomas (HU)

ARCH 10. (CEE 10) Engineering/Architectural Graphics and Design (3) Fall
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.

ARCH 43. Architectural Design I (4)
Fundamental design studio for architecture majors. Composition, spatial concepts; precedent; materials and detail; light and color in architecture. Instruction in basic communication techniques. Prerequisite: DES 4. Reserved for declared Architecture majors. Staff (ND)

ARCH 107. History of American Architecture (4) spring
Survey of American building from European colonization to the present. Prerequisite: ART/ARCH 1 and ARCH 2 or permission of instructor. Thomas. (HU)

ARCH 143. Architectural Design II (6)
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. Prerequisite: ARCH 43. Staff (ND)

ARCH 157. Architectural Technology I (4)
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. Prerequisite: declared architecture major. (ND) Nikolov.

ARCH 158. Architectural Technology II (4)
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. Prerequisite: declared architecture major. (ND) Nikolov.

ARCH 161. (THTR 161) Performing Arts Venue Design and Technology (4)
Designing theatres. Theatre equipment systems and acoustics. Function and form. (HU).

ARCH 171. Special Topics in Architecture (1-4)
Directed projects for students in architecture. Student must initiate contact with sponsoring professor. Prerequisite: Major standing in department and/or permission of instructor. Staff (ND)

ARCH 174. (ART 174, CLSS 174, ANTH 174) Greek Archaeology (3)
Ancient Greek cultures from the neolithic to hellenistic periods. Reconstructions of Greek social dynamics from study of artifacts. Small (SS)

ARCH 176. (ART 176, CLSS 176, ANTH 176) Roman Archaeology (3)
Cultures of the Roman Empire. Reconstructions of social, political, and economic dynamics of the imperial system from study of artifacts. Small (SS)

ARCH 187. Synthetic Space (4)
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. Prerequisite: declared architecture major or permission of instructor. (ND) Nikolov

ARCH 209. Architecture and Ideas (4)
Examination of philosophical, technological, and cultural forces shaping Western architecture and urbanism. Prerequisites: ART/ARCH 1 and ARCH 2 or permission of instructor. Writing intensive. Thomas (HU)

ARCH 210. 20thCentury Architecture (4)
History and theories of modern and contemporary architecture. Analysis of buildings, architects, theories and manifestos from the early 20th century to the present. Prerequisite: Art 1 or Arch 1 and Arch 2 or permission of instructor. (HU) Jung.

ARCH 211. Architectural Drawing/Analysis and Expressions (3) Italy
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. Viscardi (ND)

ARCH 212. The Architecture of Carlos Scarpa/Theory and Practice (3) Italy
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. Viscardi (HU)

ARCH 214 Architecture and the City since WWII (4)
Architectural and urban theories and projects from 1945 to the present. Analysis of the relationship between architecture and the city. Prerequisite: Art or ARCH 2 or permission of instructor. (HU) Jung.

ARCH 243. Architectural Design III (6)
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: ARCH or Art 1, 143. Staff (ND)

ARCH 253 (HIST 253). Paris, the Planning of a Metropolis (3) Paris
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. Savage (HU)

ARCH 254. Modern Architecture in France: New Directions (3) Paris
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. Staff (HU)

ARCH 271. Special Topics in Architecture (1-4)
Directed projects for advanced students in architecture or architectural criticism. Prerequisites: ARCH 1 and 143. Major standing in the department or consent of instructor. Student must contact sponsoring professor and complete a contract sheet at preregistration. May be repeated for credit. Staff (ND)

ARCH 311. Portfolio (1)
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. Prerequisite: ARCH 243. Staff (ND)

ARCH 328. Architectural Representation (4)
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. Prerequisite: ARCH 243. Ussler (ND)

ARCH 335: Issues in Contemporary Architecture (4)
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: Art 1 or Arch 1 and Arch 2 or permission of instructor. (HU) Jung.

ARCH 342. Theory of Form and Materials (4)
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. Permission of instructor required. Viscardi (ND)

ARCH 343. Architectural Design IV (6)
Continuation of ARCH 243. The design of buildings and building groups, with the emphasis on urban design and the city. Prerequisite: Arch 1 or Art 1, Arch 243, and one art studio. Staff (ND)

Undergraduate Courses in Design

DES 3. Two-Dimensional Design (4)
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. (ND) Travers

DES 4. Three-Dimensional Design (4)
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. (ND)

DES 40. Product Design I: Form, Process and Concept (4)
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. Prerequisite: DES 3 or ART 11, and DES 4 or department permission. (HU)

DES 50. (THTR 50) Stage Lighting (4)
An introduction to the art and practice of lighting design for the stage. History of theatrical lighting design. (HU)

DES 53. Introduction to Graphic Design (4)
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: DES 3.(HU) Jones

DES 60. Design Process (4)
Students will study how an idea becomes a final design by analyzing their own actions and role designers play in the development of products, graphic design (online and print), and time-based media. (HU)

DES 66. Design History (4)
History of product design, graphic design and time-based media in artistic, cultural, technological, and business contexts. (HU)

DES 70. Web Design I (4)
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: DES 3 (ND)

DES/MLL/ASIA 79: Digital Bridges (2) HU
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. Wang.

DES 80. Computer Imaging I (4)
Introduction to 3D computer modeling, animation, and rendering, commonly used in the entertainment industry. Students create and edit an original 3D animated movie. Students will also learn about 2D and 3D visualization techniques, used in the creation of storyboards and the narrative of the movie. Prerequisite: DES 3, ART 11 or 15, or department permission. (HU)

DES 87. (THTR 87) Scenography I (4)
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. (HU) Fall

DES 111. (THTR 111) Sound Design (4)
Techniques, materials, and methods of designing sound for theatrical production. (HU)

DES 129 (THTR 129, WS 129). History of Fashion and Style (4)
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. (HU)

DES 140. Product Design II: Designing for Others (4)
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. Prerequisite: DES 40. (ND)

DES 148. Furniture Design I (4)
Design methodology, fabrication techniques, and methods of design presentation. Prerequisite: DES 4. (HU) Forsyth

DES 153. Graphic Design: Word and Image (4)
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. Prerequisite: DES 53. (HU) Jones

DES 154. (THTR 154) Scene Painting (4)
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. (HU)

DES 164. Ergonomics (4)
Introduction to physical, emotional, and psychological ways design interacts with people. Analyze real design problems and create solutions. (HU)

DES 170. Web Design II (4)
Creation of dynamic content in web design. Various 2D animation software applications and simple scripting will be explored. Prerequisite: DES 70. (ND)

DES 180. Computer Imaging II (4)
Creation of original 3D models, renderings, and animations, while learning advanced modeling techniques, character animation, particles, and compositing. Prerequisite: DES 80. (ND)

DES 187. (THTR 187) Scenography II (4)
Includes beginning scene design, lighting design, and costume design principles and techniques. Introduction to design history. Significant texts, scenographic design and media techniques in graphic and three-dimensional solutions. Introduction to drafting and mechanical perspective. Prerequisite: DES/THRT 87 or permission. (HU)

DES 211. (BUS 211, ENGR 211, ME 211) Integrated Product Development (IPD) 1 (3) spring
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. Prerequisite: junior standing in business, economics, arts, design or engineering. Mechanical Engineering students must register for ME 211. (ND)

DES 212. (BUS 212, ENGR 212, ME 212) Integrated Product Development (IPD) 2 (2) fall
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. Prerequisite: BUS/DES/ENGR/ME 211. (ND)

DES 240. Product Design III: Materials to Market (4)
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. Prerequisite: DES 40. (ND).

DES 248. Furniture Design II (4)
Advanced fabrication. Contemporary art issues and furniture history. Prerequisite: DES 148. (HU) Forsyth

DES 253. Graphic Design: Brand Experience (4)
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. Prerequisite: DES 53. (HU) Jones

DES 260. Exhibit Design (4)
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. (HU)

DES 266. History of Contemporary Design (4)
History of modern design from mid19th 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. (HU)

DES 268. Advanced Design Projects (1-4)
Advanced projects or studies applying Design Arts practices or theories. Prerequisite: consent of instructor. May be repeated for credit. Department permission required. (ND)

DES 280. Computer Imaging III (4)
Advanced animation with emphasis on experimental techniques and new technologies in animation and motion graphics. Emphasis on effects, compositing, and the use of digital technology in the postproduction process. Students will work on various assignments to gain a firsthand understanding of how various tools and techniques are used to create realistic effects. Prerequisite: DES 180. (ND)

DES 287. (THTR 287) Scenography III (4)
Includes advanced scene design, lighting design, and costume design principles and techniques. Design history projects in specific periods. Complex design problems of traditional texts. Emphasis on color and color theory. Prereq. DES/THTR 187 or permission. (HU) Spring

DES 311. Design Portfolio (1-4)
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. Prerequisite: DES 253, DES 240 or DES 280.

DES 370. Special Topics in Design (1-4)
Current topics in design, with selected readings, discussions, and studio work as required. May be repeated for credit. Prerequisite: two 100-level Design courses. Department permission. (ND)

DES 375. Design Internship (1-4)
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. (ND)

DES 387. (THTR 387) Scenography IV (4)
Advanced problem solving of nontraditional design problems, experimental approaches and solutions, contemporary issues in environmental design. Design history focus on contemporary design trends and nontraditional history. Prereq DES/THTR 287 or permission. (HU)

Arts and Sciences

ARTS 250. Communications, Cultures, Behaviors and Attitudes (4)
Writing-intensive experiential focus on communications, development of social roles and life skills required for effective functioning in a changing society in America and globally. Models of group processes; small group projects; communications; critical thinking and its application to course content; cognitive processes in handling individual differences in race, gender, class, religion, disabilities, sexual harassment, religions of the world, sexual orientation, and culture; synthesis of class experiences with readings and discussions; and social role implications on choices. The application of lessons learned in the course to real life situations such as structured fieldwork will be required in addition to in class work. As part of the "hands-on" experience, students will be required to provide regular written and oral reports of activity and then write a detailed analysis/assessment report of particular issues and lessons learned. Students may not receive credit for both Arts 250 and Comm 65. (ND)

ARTS 251. Fieldwork (1)
Structured fieldwork for students who have previously taken Arts 250. Students will be required to work on specific projects and provide some regular written and oral reports of activity and then write a detailed analysis/assessment report of particular issues and lessons learned. Prerequisite: 4 credits of Arts 250 and instructor's consent. (ND)

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.

freshman year, first semester (14-16 credit hours)

ENGL 1	Composition/Literature I	3
MATH 21	Calculus I	4
PHY 11	Intro Physics I	4
PHY 12	Intro Physics Lab I	1
(Dept) 90	College Seminar or FYC	2-4

freshman year, second semester (17 credit hours)

ENGL 2	Composition/Literature II	3
MATH 22	Calculus II	4
CHM 25	Intro Chemical Principles	4
ENGR 1	Engineering Computations	3
ENGR 5	First-Year Design Experience	3

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. When a large number of credits is required to complete the two degrees and distribution requirements, the College of Arts and Sciences social science distribution credits may be satisfied by a single course, Eco 1 (Principles of Economics).

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 may meet distribution requirements in the College of Arts and Sciences while also satisfying most 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 not 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 167-171 credits is needed for the Bachelor of Science in Civil Engineering and the Bachelor of Art in Architecture degrees.

sophomore year, first semester (18 credits)

MATH 23	Calculus III (4)

MECH 3	Elementary Engineering Mechanics (3)
CEE 10	Engineering/Architectural Graphics and Design (3)
DES 4	Three-Dimensional Design (4)
ART/ARCH 1	Art/Architectural History I (4)

sophomore year, second semester (19 credits)

MATH 205	Linear Methods (3)
MECH 12	Strength of Materials (3)
PHY 21	Introductory Physics II (4)
PHY 22	Introductory Physics Lab II (1)
______	Art Studio Elective (4)

junior year, first semester (17 credits)

MAT 33	Engineering Materials and Processes (3)
CEE 123	Civil Engineering Materials (1)
CEE 11	Surveying (1)
CEE 12	Civil Engineering Statistics (2)
CEE 121	Mechanics of Fluids (3)
ARCH 43	Architectural Design I (4)
_______	Engineering Science Elective [Mech 102, ME 104 or ECE 81/83] (3)

junior year, second semester (19 credits)

CEE 117	Numerical Methods in Civil Engineering (2)
CEE 222	Hydraulic Engineering (3)
ARCH 143	Architectural Design II (6)
ECO 1	Principles of Economics (4)
_______	Architectural History Elective* (4)

senior year, first semester (17 credits)

CEE 142	Fundamentals of Soil Mechanics (3)
CEE 159	Structural Analysis I (4)
ARCH 243	Architectural Design III (6)
ARCH 157	Architectural Technology I (4)

senior year, second semester (19 credits)

CEE 202	Civil Engineering Planning and Engineering Economics (3)
CEE 242	Principles and Practice of Geotechnical Engineering (3)
CEE 262	Fundamentals of Steel Structural Design (3)
or CEE 264	Fundamentals of Concrete Structural Design (3)
ARCH 343	Architectural Design IV (6)
ARCH 210	20th Century Architecture (4)

fifth year, first semester (14-15 credits)

CEE 203	Professional Development (2)
______	Civil Engineering Approved electives** (8-9)
______	Architectural History Elective* (4)

fifth year, second semester (17 credits)

CEE 170	Introduction to Environmental Engineering (4)
CEE 290	Civil Engineering Capstone Design*** (3)
______	Civil Engineering Approved elective** (6)
______	Art Studio Elective (4)

**The College of Arts and Sciences requires a junior writing intensive course. This may be filled by an appropriate choice of elective.*

***Of 17 CEE approved elective credits required for Civil Engineering <u>three</u> credits are satisfied by Arch 343.*

****Multidisciplinary teaming versions of CEE 205 or CEE 381 can be substituted with departmental permission.*

Asian Studies

Program Director: Nicola Tannenbaum

610-758-3829; nt01@lehigh.edu

Professors. Nicola Tannenbaum, Ph.D. (Iowa), Sociology and Anthropology, Program Director; Constance Cook, Ph.D. (U.C., Berkeley), Modern Languages and Literature; Norman Girardot, Ph.D. (Chicago), Religion Studies; Kenneth Kraft, Ph.D. (Princeton), Religion Studies; David Pankenier, Ph.D. (Stanford), Modern Languages and Literature; Raymond Wylie, Ph.D. (London, England), Professor Emeritus, International Relations.

Associate Professors. Gail Cooper, Ph.D. (U.C., Santa Barbara), History; Vera Leigh Fennel, Ph.D. (Chicago); Kiri Lee, Ph.D. (Harvard), Modern Languages and Literature; Michael Mendelson Ph.D. (San Diego), Philosophy; Robert Rozehnal, Ph.D. (Duke), Religion Studies; Amardeep Singh, Ph.D. (Duke), English.

Assistant Professors. Nandini Deo, Ph.D. (Yale); John Jirik, Ph.D. (Texas at Austin); Yuping Zhang, Ph.D. (University of Pennsylvania).

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:

IX. A. 2 years (or 16 credits) of an Asian language which is not the student's native language;

B. 3 courses (or 10 credits) of humanities and social science courses under the 200 level (see list below);

X. 2 courses from either:

A. Advanced language and culture, or

B. Humanities and social sciences. At least one course must be at the 300 level.

The academic advisor is Dr. Nicola Tannenbaum, Director, Asian Studies Program. Students may also request an advisor from among the Asian Studies faculty above.

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 minor advisor, Dr. Nicola Tannenbaum, Director, 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).

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). Asian Studies offers a limited number of study abroad scholarships.

I. Core Requirements

A. Language and Culture: Chinese or Japanese or other approved Asian languages to intermediate level (2 years); or 4 courses (16 credits), based on placement, chosen from the following *:

ASIA 91	Elementary Asian Language and Culture Abroad (1-8)
ASIA 191	Intermediate Asian Language and Culture Abroad (1-8)
CHIN, JPNS 91	Language and Culture Abroad I (1-8)
CHIN, JPNS 191	Language and Culture Abroad II (1-8)
CHIN 001	Beginning Chinese Reading & Writing I (2)
CHIN 002	Beginning Chinese Reading & Writing II (2)
CHIN 003	Beginning Spoken Chinese I (2)
CHIN 004	Beginning Spoken Chinese II (2)
CHIN 011	Intermediate Chinese Reading & Writing I (2)
CHIN 012	Intermediate Chinese Reading & Writing II (2)
CHIN 013	Intermediate Spoken Chinese I (2)
CHIN 014	Intermediate Spoken Chinese II (2)
CHIN 111.	Advanced Chinese Reading & Writing I (2)
CHIN 112	Advanced Chinese Reading & Writing II (2)
CHIN 113	Advanced Spoken Chinese I (2)
CHIN 114	Advanced Spoken Chinese II (2)
JPNS 1	Elementary Japanese I (4) fall
JPNS 2.	Elementary Japanese II (4) spring
JPNS 11	Intermediate Japanese I (4) fall
JPNS 12	Intermediate Japanese II (4) spring
JPNS 141	Advanced Japanese I (4) fall
JPNS 142	Advanced Japanese II (4) spring
JPNS 145	Advanced Japanese Conversation and Culture I (4)
JPNS 146	Advanced Japanese Conversation and Culture II (4)

**Note: Students with prior knowledge of Chinese or Japanese will be placed on the basis of a competence test. Native speakers placing out of one Asian language will be required to study another Asian language.*

B. Humanities and Social Science: 3 courses (minimum 10 credits) Chosen from the following:

ASIA 12 (REL 12)	Introduction to Asian Religions (4)
ASIA 60 (REL 60)	Religions of South Asia (4)
ASIA 61 (IR 61)	Pacific Asian International Relations (4)
ASIA 64 (REL 64)	Religions of China (4)
ASIA 65 (REL 65)	Religions of Japan (4)
ASIA 67 (REL 67)	Japanese Civilization (4)
ASIA 68 (MLL 68)	Japanese Language: Past and Present (4)
ASIA 73 (GCP 73, MLL 73, WS 73)	Film, Fiction, and Gender in Modern China (4)
ASIA 74 (MLL 74)	Chinese Cultural Program (1-8)
ASIA 75 (HIST 75, MLL 75)	Chinese Civilization (4)
ASIA 76 (HIST 76, MLL 76)	Understanding Contemporary China (4)
ASIA 77 (REL 77)	The Islamic Tradition (4)
ASIA 78 (MLL 78)	Asian-American Studies (4)
ASIA 79 (DES 79, MLL79)	Digital Bridges (2)
ASIA 100	Seminar in Asian Studies (1-4)
ASIA 114 (SSP 114)	Social Issues in Contemporary China (4)
ASIA 125 (MLL 125)	Immortal Images: Traditional Chinese Literature in Translation (4)
ASIA 127 (MLL 127)	ORIENTations: Approaches to Modern Asia (4)
ASIA 140 (PHIL 140)	Eastern Philosophy (4)
ASIA 145 (REL 145)	Islam and the Modern World (4)
ASIA 146 (REL 146)	Islam in South Asia (4)
ASIA 160 (REL 160)	The Taoist Tradition (4)
ASIA 161 (IR 161)	China in World Affairs (4)
ASIA 162 (REL 162)	Zen Buddhism (4)
ASIA 163 (IR 163)	Japan in World Affairs (4)
ASIA 165 (GCP 165, MLL 165)	Love and Revolution in Shanghai (4)
ASIA 166 (GCP 166, REL 166)	Religious Nationalism in South Asia (4)
ASIA 167 (REL 167)	Engaged Buddhism (4)
ASIA 168 (REL 168)	Buddhism in the Modern World (4)
ASIA 169 (REL 169)	Classics of Asian Religion (4)
ASIA 170 (HIST 170)	The Last Samurai (4)
ASIA 175 (GCP 175, REL 175)	Sufi Saints and Muslim Missionaries (Lehigh India Summer Program) (4)
ASIA 177 (HIST 177, MLL 177)	China enters the modern age (4)
ASIA 187 (ANTH 187)	Peoples of Southeast Asia (4)
ASIA 188 (ANTH 188)	Southeast Asians in Southeast Asia and America (4)
ASIA 201 (POLS 201, GS 201)	Democracy and Dictatorship in South Asia (4)

II. Advanced Electives

Two courses (7 or 8 credits) chosen from the following, 1 course of which must be at the 300 level:

A. Language and Culture:

CHIN 251	Special Topics (1-4)
CHIN 252	Business Chinese (1-2)
CHIN 253	Chinese Fiction (1-2)
CHIN 254	Intensive Conversation (1-2)
CHIN 255	Newspaper Readings in Chinese (1-2)
JPNS 290	Special Topics (1-4)
ASIA 291	Advanced Asian Language and Culture Abroad (1-8)
CHIN, JPNS 291	Language and Culture Abroad III (1-8)
CHIN 371	Advanced Readings in Chinese (1-4)
JPNS 390	Special Topics (1-4)

B. Humanities and Social Sciences:

ASIA 201 (POLS 201, GS 201)	Democracy and Dictatorship in South Asia (4)
ASIA 220 (REL 220)	Classics of Asian Religion (4)
ASIA 221 (REL 221)	Topics in Asian Religions (4)
ASIA 234 (REL 234)	Buddhist Visions of a Good Society (4)
ASIA 240 (PHIL 240)	Figures/Themes in Eastern Philosophy (4)
ASIA 247 (REL 247)	Islamic Mysticism (4)
ASIA 254 (REL 254)	Buddhism and Ecology (4)

ASIA 337 (ANTH 337, REL 337)	Buddhism and Society (4)
ASIA 339 (POLS 339, GS 339)	The Rise of the State in Modern East Asia (4)
ASIA 340 (HIST 340)	Japanese Industrialization (3-4)
ASIA 343 (POLS 343, AAS 343, GS 343)	Global Politics of Race: Asia and Africa (4)
ASIA 361	Internship in Asian Studies (1-4)
ASIA 364. (IR 364)	International Relations of Pacific Asia (4)
ASIA 371.	Advanced Readings in Asian Studies (1-4)
ASIA 381.	Special Topics in Asian Studies (1-4)
ASIA 386 (GCP 386)	Chinese Culture in a Multinational Workplace (3)
ASIA 391	Senior Seminar in Asian Studies (1-4)
ASIA 399	Senior Thesis in Asian Studies (1-4)

C. Other suitable courses at LVAIC or other approved institutions in the United States.

D. Other suitable courses in approved study abroad programs in Asia.

Undergraduate Courses

For descriptions of beginning, intermediate, and advanced Chinese and Japanese language courses, please refer to the Modern Languages and Literature course listings in section V.

ASIA 12. (REL 12) Introduction to Asian Religions (4)
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. (HU)

ASIA 60. (REL 60) Religions of South Asia (4)
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. Rozehnal. (HU)

ASIA 61. (IR 61) Pacific Asian International Relations (4)
Introduction to Pacific Asian international relations, with emphasis on post1945 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. Wylie (SS)

ASIA 64. (REL 64) Religions of China (4)
History and meaning of the major forms of Chinese religion, especially Confucianism and Neo-Confucianism, Taoist mysticism, Buddhism (Ch'an/Zen), and popular religion.Girardot. (HU)

ASIA 65. (REL 65) Religions of Japan (4)
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. Kraft. (HU)

ASIA 67. (REL 67) Japanese Civilization (4)
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. Kraft. (HU)

ASIA 68. (MLL 68) Japanese Language: Past and Present (4)
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. Prerequisite JPNS 1. Lee (HU)

ASIA 73. (GCP 73, MLL73, WS 73) Film, Fiction, and Gender in Modern China (4)
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. Cook (HU)

ASIA 74. (MLL 74) Chinese Cultural Program (1-8)
A summer program in China, taught in English. (HU)

ASIA 75. (HIST 75, MLL 75) Chinese Civilization (4)
The development of traditional Chinese thought, beliefs, technology, and institutions from a historical perspective, from earliest times to China's encounter with the West. Pankenier (H/S)

ASIA 76. (HIST 76, MLL 76) Understanding Contemporary China (4)
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. Pankenier (SS)

ASIA 77. (REL 77) The Islamic Tradition (4)
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. Rozehnal. (HU)

ASIA 78. (MLL 78) Asian-American Studies (4)
A survey of issues concerning Asians living in the United States from the perspectives of history, language, literature, and film. (HU)

ASIA 79. (DES 79, MLL 79) Digital Bridges (2)
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. (HU)

ASIA 91. Elementary Asian Language and Culture Abroad (1-8)
Elementary language and culture abroad other than Chinese or Japanese. (HU)

ASIA 100. Seminar in Asian Studies (1-4)
Topics in Asian Studies.May be repeated for credit. (HU/SS depending on topic)

ASIA 114. (SSP 114) Social Issues in Contemporary China (4)
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: in equality 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.

ASIA 125. (MLL 125) Immortal Images: Traditional Chinese Literature in Translation (4)
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. Cook (HU)

ASIA 127. (MLL 127, GCP 127) ORIENTations: Approaches to Modern Asia (4)
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? Pankenier. (H/S)

ASIA 140. (PHIL 140) Eastern Philosophy (4)
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. (HU)

ASIA 145. (GCP 145, REL 145) Islam and the Modern World (4)
Examines how numerous Muslim thinkers, religious scholars, modernists, and Islamistshave 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. Rozehnal. (HU)

ASIA 146. (REL 146) Islam in South Asia (4)
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. Rozehnal. (HU)

ASIA 160. (REL 160) The Taoist Tradition (4)
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"). Girardot. (HU)

ASIA 161. (IR 161) China in World Affairs (4)
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. Wylie. (SS)

ASIA 162. (REL 162) Zen Buddhism (4)
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.)Kraft. (HU)

ASIA 163. (IR 163) Japan in World Affairs (4)
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. Wylie. (SS)

ASIA 165. (GCP 165, MLL 165) Love and Revolution in Shanghai (4)
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 area. Students will write research papers on aspects of historical or modern Shanghai, and present their results to the class. They will also be responsible for Course Site and in-class discussions of assigned readings and films. Cook. (HU)

ASIA 166. (REL 166, GCP 166) Religious Nationalism in South Asian (4)
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. (HU)

ASIA 167. (REL 167) Engaged Buddhism (4)
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. Kraft. (HU)

ASIA 168. (REL 168) Buddhism in the Modern World (4)
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 presentday concerns? Kraft. (HU)

ASIA 170. (HIST 170) The Last Samurai(4)
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. Cooper. (HU)

ASIA 175. (GCP 175, REL 175) Sufi Saints and Muslim Missionaries (Lehigh India Summer Program) (6)
This month-long summer study-travel program in north India focuses on the intersection of religion and politics among South Asia's dynamic Muslim communities. The course focuses in particular on two distinct traditions of Islamic piety: Sufism (Islamic mysticism) and the conservative, transnational political movement, the Tablighi Jama'at. Students travel to a range of important historical sites, mosques, Sufi shrines and university campuses and engage local experts through a series of guest lecturers. Rozenhal (HU)

ASIA 177. (HIST 177, MLL 177) China Enters the Modern Age (4)
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. Pankenier (H/S)

ASIA 187. (ANTH 187) Peoples of Southeast Asia (4)
Peoples and cultures of Burma, Laos, Cambodia, Thailand, Malaysia, Singapore, Indonesia, and the Philippines.World view, religion, economy, politics, and social organization.Tannenbaum. (SS)

ASIA 188. (ANTH 188) Southeast Asians in Southeast Asia and America (4)
In this course we explore the ways in which different peoples lived in Southeast Asia, why they moved to America, and the ways in which this move affected their cultures. Topics explored include: aspects of their culture, particularly religion and social organizations, motivations for migrating (including war, political, and economic reasons), and their adaptations to America and American responses to their presences. No prerequisites. Tannenbaum. (H/S)

ASIA 191. Intermediate Asian Language and Culture Abroad (1-8)
Intermediate language and culture abroad other than Chinese and Japanese. (HU)

ASIA 201. (POLS 201, GS 201) Democracy and Dictatorship in South Asia (4)
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? Deo (SS)

ASIA 220. (REL 220) Classics of Asian Religion (4)
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? Kraft, Girardot (HU)

ASIA 221. (REL 221) Topics in Asian Religions (4)
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. Girardot, Kraft, Rozenhal. (H/S)

ASIA 234 (REL 234) Buddhist Visions of a Good Society (4)
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. Kraft. (HU)

ASIA 240. (PHIL 240) Figures/Themes in Eastern Philosophy (4)
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. May be repeated more than once for credit. Prerequisite: One HU designated course in philosophy (HU)

ASIA 247. (REL 247) Islamic Mysticism (4)
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. Rozehnal. (HU)

ASIA 254. (REL 254, ES 254) Buddhism and Ecology (4)
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? Kraft. (HU)

ASIA 291. Advanced Asian Language and Culture Abroad (1-8)
Advanced language and culture abroad other than Chinese and Japanese. (HU)

ASIA 337. (REL 337, ANTH 337) Buddhism and Society (4)
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.Tannenbaum. (SS)

ASIA 339. (GS 339, POLS 339) The Rise of the Modern State in Modern East Asia (4)
An examination of Asian nationalism in the construction of the modern state form in Asia. (SS)

ASIA 340. (HIST 340) Japanese Industrialization (3-4)
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 nineteenth century. Cooper. (SS)

ASIA 343. (AAS 343, GS 343, POLS 343) Global Politics of Race: Asia and Africa (4)
An examination of the concept of "race" and its impact on domestic and international politics. Fennel. (SS)

ASIA 361. Internship in Asian Studies (1-4)
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)

ASIA 364. (IR 364) International Relations of Pacific Asia (4)
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. Prerequisite: IR 61, 161, 163 or 164. Wylie. (SS)

ASIA 371. Advanced Readings in Asian Studies (1-4)
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)

ASIA 381. Special Topics in Asian Studies (1-4)
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)

ASIA 386. (GCP 386) Chinese Culture in a Multinational Workplace (3)
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 391. Senior Seminar in Asian Studies (1-4)
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)

ASIA 399. Senior Thesis in Asian Studies (1-4)
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)

Astronomy and Astrophysics

Professors. George E. McCluskey, Jr., Ph.D. (Pennsylvania), head; Gary G. DeLeo, Ph.D.(Connecticut).

Assistant Professors. M. Virginia McSwain, Ph.D. (Georgia State). 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 educa tion, 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 21, 22, 23, and 205	[15]

Basic and Intermediate-Level Science

MATH 21, 22, 23, and 205	[15]
ASTR 7/8	(4)
PHY 11/12 or 10/12	(5)
PHY 21/22 or 13/14	(4-5)
PHY 31, 262	(5)
CHM 30	(4)
EES 21, 22	(4)
24 cr. hr. at 100 level or above	(2-4)
	[28-31]

Intermediate - Advanced Astronomy/Astrophysics

ASTR/PHY/EES 105	(4)

ASTR/PHY 110	(1)
ASTR/PHY 301 or 302	(4)
	[9]

Approved Electives

Two additional physics/astronomy courses at the 200 level or above	(6)
Two additional science or mathematics courses at the 200 level or above	(6)
	[12]

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 12, PHY 212, EES 31, BIOS 41.

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 21, 22, 23, 205, (320 or 332)	[18]

Basic and Intermediate-Level Science

PHY 11/12 or 10/12	(5)
PHY 21/22 or 13/14	(4-5)
PHY 31, 212, 215, (262 or 352)	(12-13)
CHM 30	(4)
EES 21, 22	(4)
2-4 cr. hr. at 100 level or above	(2-4)
	[31-35]

Intermediate - Advanced Astronomy/Astrophysics

ASTR/PHY/EES 105	(4)
ASTR/PHY 110	(1)
ASTR/PHY 301, 302	(8)
ASTR/PHY (332 or 342 or 350)	(3)
	[16]

Approved Electives

Three additional physics/astronomy courses at the 200 level or above	(9)
One additional science course (not physics or astronomy) at the 100 level or above	(3)
	[12]

A total of 123 credit hours are required for the Bachelor of Science in Astrophysics.

Recommended sequence of courses for the first two years

Freshman Year

B.A. Astronomy		**B.S. Physics**	
Fall	*Spring*	*Fall*	*Spring*
ENGL 1 (3)	ENGL 2, 4 (3)	ENGL 1 (3)	ENGL 2, 4 (3)
EES 21 (4)	PHY 11 (4)	PHY 11 (4)	EES 21 (4)
MATH 21 (4)	PHY 12 (1)	PHY 12 (1)	MATH 22 (4)
ASTR 7/8 (4)	MATH 22 (4)	MATH 21 (4)	Col Sem and/or Dist Req (3-6)
	Col Sem (3-4)	Col Sem or* Dist req (3-4)	

Sophomore Year

PHY 21 (4)	PHY 31 (3)	PHY 21 (4)	PHY 31 (3)
PHY 22 (1)	MATH 205 (3)	PHY 22 (1)	MATH 205(3)
MATH 23 (4)	ASTR 110 (1)	MATH 23 (4)	ASTR 110 (1)
ASTR 105 (4)	Appr. Elec. (3)	ASTR 105 (4)	Appr. Elec. (3)
Dist req (3-4)	Dist req (4-7)	Dist req (3-4)	Dist req (4-7)

** If the College Seminar is deferred until spring, students may choose to select ASTR 7 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:

Academic Performance: Minimum grade point average of 3.50 in astronomy and physics courses used to satisfy the major degree requirements.

1. Research or Project-Based/Creative Activity: completion of approved* 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
2. Additional Course Work: Completion of at least one approved* 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/PHY 350 or PHY 372.

**specific approvals are granted by the Program Director*

The minor program in Astronomy. The requirements for a minor in astronomy are:

PHY 11/12 and 21/22

ASTR 105, 301, and 302

One ASTR course at the 300 level

Two courses (minimum of 6 credit hours) selected from the following:

Any ASTR course (except ASTR 7 or 8) CSC 17, MATH 208, 231, PHY 31, 213, 215, 348, 362.

The minor program must be designed in consultation with the program director.

Undergraduate Courses in Astronomy/Astrophysics

ASTR 7. (PHY 7) Introduction to Astronomy (3) fall
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. (NS)

ASTR 8. (PHY 8) Introduction to Astronomy Laboratory (1) fall
Laboratory to accompany ASTR/PHY 7. (NS)

ASTR 105. (PHY 105, EES 105) Planetary Astronomy (4) fall
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. McCluskey (NS)

ASTR 110. (PHY 110) Methods of Observational Astronomy (1)
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. McCluskey (NS)

For Advanced Undergraduates and Graduate Students

ASTR 301. (PHY 301) Modern Astrophysics I (4) fall
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 10 and 13, or PHY 11 and 21, MATH 22 or 52. McSwain (NS)

ASTR 302. (PHY 302) Modern Astrophysics II (4) spring
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 10 and 13, or PHY 11 and 21, MATH 22 or 52. McCluskey (NS)

ASTR 332. (PHY 332) High-Energy Astrophysics (3) spring, odd-numbered years
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. Prerequisites: MATH 23 or 33 previously or concurrently, and PHYS 21. McCluskey (NS)

ASTR 342. (PHY 342) Relativity and Cosmology (3) spring, even-numbered years
Special and general relativity. Schwarzschild and Kerr black holes. Supermassive stars. Relativistic theories of the origin and evolution of the universe. Prerequisites: MATH 23 or 33 previously or concurrently, and PHY 21. McCluskey (NS)

ASTR 350. Topics in Astrophysics (3) fall/spring
For science or engineering majors who desire to study an active area of research in astrophysics. Individual supervision. Prerequisites: ASTR 301, and MATH 23 or 33 and PHY 21. May be repeated for credit with the consent of the program director. (NS)

ASTR 372. Special Topics in Astronomy (1-4)
Selected topics not sufficiently covered in other courses. May be repeated for credit. (NS)

ASTR 472. Special Topics in Astronomy (1-4)
Selected topics not sufficiently covered in other courses. May be repeated for credit.

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

I. College and University Requirements (25)

a. ENGL 1, 2 (6)

b. First Year Seminar (3)

c. Non-science electives: 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.

II. Collateral Science Requirements (at least 24)

a. Physics 10, 12, 13, 22 (or 11, 12, 21, 22) (9 or 10)

b. Mathematics 51, 52, 43 (or 21, 22, 23) and a statistics course (at least 12)

c. Survey of Computer Science 12 or Engineering 1 (3)

III. Required Chemistry Courses (25)

a. Introductory Chemistry 40, 41 (8*)

b. Organic Chemistry 110, 111, 112, 113 (8)

c. Inorganic Chemistry 307 (3)

d. Physical Chemistry 194 (3)

e. Analytical Chemistry 332 (3)

**The Chemistry 30/31 sequence may be substituted.*

IV. Required Biological Science courses (25 minimum)

a. Biology Core I: Cellular and Molecular and Laboratory 41, 42 (4)

b. Biology Core II: Genetics 115 (3)

c. Biochemistry 371, 372, 377 (9)

d. Advanced Laboratory (4)

e. Electives in Biological Sciences (3 hours minimum*)

f. Technical Writing (2 hours minimum)

**The three credit hours of biological sciences electives are chosen with the approval of the adviser.*

Model Pattern Roster

Freshman year

CHM 40, 41	Concepts, Models, and Experiments I and II (8)
BIOS 41, 42	Biology Core I: Cell and Molecular and Laboratory (4)
MATH 51, 52 **or**	Survey of Calculus I and II (7)
MATH 21, 22	Calculus I and II (8)
Dept 90	College Seminar (3)
ENGL 1,2	Composition and Literature (6)
PHY 10, 12 **or**	General Physics I and Laboratory (5)
PHY 11, 12	Introductory Physics I and Laboratory (5)

Sophomore year

CHM 110, 111, 112, 113	Organic Chemistry and Laboratory (8)
PHY 13, 22 **or**	General Physics II and Laboratory (4)
PHY 21, 22	Introductory Phys. II and Laboratory
MATH 43 **or**	Linear Algebra (3)
MATH 23	Calculus III
BIOS 130	Biostatistics*
BIOS 115	Biology Core II: Genetics

**A statistics course from the MATH department could also fulfill the statistics requirement*

Junior year

CHM 194	Physical Chemistry for Biological Sciences (3)
CHM 332	Analytical Chemistry (3)
BIOS 371, 372	Elem. of Biochemistry I and II (6)
BIOS 377	Biochem. Lab (3)
CSE 12	Survey of Computer Science (3)
	Technical Writing (2)

Senior year

BIOS	Advanced laboratory course(s)
BIOS	elective
CHM 307	Advanced Inorganic Chemistry (3)

Bioengineering Program

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: 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) Mechanical Engineering; Sabrina Jedlicka Ph.D. (Purdue) Materials Science and Engineering; Linda Lowe-Krentz, Ph.D. (Northwestern) Biological Sciences; Yaling Liu (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; Xaiohui Zhang (Miami) Mechanical Engineering and Mechanics.

Associated Program Faculty: Filbert Bartoli, Ph.D. (Catholic Univ.) Electrical and Computer 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 Perevalov, Ph.D. (Texas) Industrial Systems Engineering; Neal G. Simon, Ph.D. (Rutgers) Biological

Sciences; John Spletzer, Ph.D. (Pennsylvania) Computer Science and Engineering; Dimitrios Vavylonis, Ph.D. (Columbia) Physics; Dimitri Vazenov, 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 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 our students will:

1. Apply modern engineering methodologies to bioengineering problems.
2. Employ concepts from physical and life sciences, and mathematics as part of their problem solving processes.
3. Contribute and function well in the collaborative and interdisciplinary environments required to solve complex biomedical and biotechnology problems.
4. Solve bioengineering problems with an understanding of the ethical, societal, and regulatory issues.
5. Communicate effectively in both oral and written forms.
6. Demonstrate ongoing learning during their professional careers

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/photonics 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 (33 credits)

Engl 1	Composition and Literature (3)
Engl 2	Composition and literature: Fiction, Drama, Poetry (3)
Phil 116	Bioethics (4)
Engr 1	Engineering Computations (3)
Eco 1	Principles of Economics (4)
	Electives to satisfy HSS depth and breadth requirements (13)
	Free Electives (3)

Mathematics (18 credits)

Math 21	Calculus I (4)
Math 22	Calculus II (4)
Math 23	Calculus III (4)
Math 205	Linear Methods (3)
Math 231	Probability and Statistics (3)

Chemistry (12 credits)

Chem 30	Intro. Chemical Principles and Laboratory (4)
Chem 31	Chemical Equilibria in Aqueous Systems (4)
Chem 110, 111	Organic Chemistry I and Lab (4)

Physics (10 credits)

Physics 11,12	Intro. Physics I and Lab (5)
Physics 21,22	Intro. Physics II and Lab (5)

Biological Sciences (8 credits)

BioS 41 and 42	Biology Core I: Cellular and Molecular and Lab (4)
BioS 115/116	Biology Core II: Genetics and Lab (4)

Integrated Bioengineering (16 credits)

Required by all Three Tracks

BioE 01	Freshman Seminar I, Introduction to Bioengineering I: Philosophy to Practice (Pass/Fail) (1)
BioE 02	Freshman Seminar 2, Introduction to Bioengineering II: Current Topics (Pass/Fail) (1)
BioE 110	Elements of Bioengineering (4)
BioE 210	Bioengineering Physiology (4)
Engr 211	Integrated Product Development I (IPD) (3)
Engr 212	Integrated Product Development II

	(IPD) (2)
BioE 225	cGMP Good manufacturing practice and regulatory affairs for bioengineers (1)

Engineering Requirement by Track

Biopharmaceutical Engineering Track (23 credits)

Chem 112	Organic Chemistry II (3)
BioE 343	Integrated Biotechnology Laboratory (3)
Mat 33	Engineering Materials and Processes (3)
ChE 31	Material and Energy Balance (3)
ChE 210	Chemical Engineering Thermodynamics (4)
ChE 211	Chemical Reactor Design (3)*
BioE 296	Bioengineering Fluid Mechanics (4) or ChE 44 Fluid Mechanics (4)

**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.*

Bioelectronic/Biophotonics Track (22 credits)

ECE 108	Signals and Systems (4)
BioE 331	Integrated Bioelectronics/Photonics Laboratory (2)
ECE 81	Principles of Electrical Engineering (4)
ECE 123	Electronic Circuits (3) or Phy 190 Electronics (3)
ECE 202	Introduction to Electromagnetics (3) or Phy 212 Electricity and Magnetism I (3)
Mech 3	Fundamentals of Engineering Mechanics (3)
Mat 33	Engineering Materials and Processes (3)

Cell and Tissue Engineering Track (22 credits)

BioE 120,121	Biomechanics and Laboratory (4)
BioE 357	Biostructural Mechanics Laboratory (2)
Mech 3	Fundamentals of Engineering Mechanics (3)
Mech 12	Strength of Materials (3)
Mat 33	Engineering Materials and Processes (3)
MAT 205	Thermodynamics of Macro/Nanoscale Materials (3) or
ME 104	Thermodynamics (3) or Phy 340 Thermal Physics (3)
BioE 296	(Bioengineering Fluid Mechanics) (4) or ME 231 Fluid Mechanics (3)

Bioengineering Electives

Students must take three (3) credits from the following:

BioE 341	Biotechnology I (3)*
BioE 321 (Phy 321)	Biomolecular & Cellular Mechanics (3)
BioE 349	Metabolic Engineering (3)

** Students in the Biopharmaceutical Engineering track are required to take BioE 341, since it is a prerequisite for BioE 343.*

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 10, BioE 20, BioE 132, BioE 142, BioE 242, and BioE 290.

Typical four-year course schedule for BS in Bioengineering

Freshman year, first semester (same for all three tracks) (14 credits)

BioE 1	Freshman Seminar (1) (Pass/Fail)
Chm 30	Introductory Chemical Principles and lab (4)
Math 21	Calculus I (4)
Engr 1	Engineering Computations (3)
English 1	Composition and Literature (3)

Freshman year, second semester (same for all three tracks) (15 credits)

BioE 2	Freshman Seminar 2 (1) (Pass/Fail)
BioS 41/42	Biology Core I: Cellular and Molecular and Lab (4)
Math 22	Calculus II (4)
Phy 11/12	Introductory Physics I and Lab (5)
Engl 2	Composition and Literature II (3)

Biopharmaceutical Engineering Track

Sophomore year first semester (16 credits)

BioE 110	Elements of Bioengineering (4)
Math 23	Calculus III (4)
PHYS 21/22	Introductory Physics II and Lab (5)
ChE 31	Material and Energy Balances of Chemical Processes (3)

Sophomore year second semester (16 credits)

BioE 210	Introduction to Engineering Physiology (4)
BioE 020	Bioengineering Sophomore Seminar (1)
Chm 31	Chemical Equilibria in Aqueous Systems (4)
Math 205	Linear Methods (3)

ChE 210	Chemical Engineering Thermodynamics (4)

Junior year, first semester (18 credits)

Chm 110, 111	Organic Chemistry I and Lab (4)
BioS 115/116	Biology Core II: Genetics and Lab (4)
BioE 341	Biotechnology I (3)
BioE 225	cGMP Good Manufacturing Practice and Regulatory Affairs for Bioengineers (1)
Math 231	Probability and Statistics (3)
	Elective (3)

Junior year, second semester (17 credits)

ENGR 211	Integrated Product Development I (3)
BioE 296	Bioengineering Fluid Mechanics (4) or ChE 44 Fluid Mechanics (4)
ChE 211	Chemical Reactor Design (3)
Chm 112	Organic Chemistry II (3)
ECO 1	Principles of Economics (4)

Senior year, first semester (17 credits)

ENG 212	Integrated Product Development II (2)
BioE 343	Integrated Biotechnology Laboratory (3)
MAT 33	Engineering Materials and Processing (3)
	Electives (9)

Senior year, second semester (16) credits

Phil 116	Bioethics (4)
	Electives (12)

Bioelectronics/Biophotonics Track

Sophomore year, first semester (17 credits)

BioE 110	Elements of Bioengineering (4)
Math 23	Calculus II (4)
ECE 81	Principles of Electrical Engineering (4)
Phy 21/22	Introductory Physics II and Lab (5)

Sophomore year, second semester (17 credits)

BioE 210	Introduction to Engineering Physiology (4)
BioE 020	Bioengineering Sophomore Seminar (1)
Math 205	Linear Methods (3)
Chm 31	Chemical Equilibria of Aqueous Systems (4)
ECE 121/123	Electronic Circuits and Lab (5)

Junior year, first semester (17 credits)

BioS 115/116	Biology Core II: Genetics and Lab (4)
Chm 110, 111	Organic Chemistry I and Lab (4)
Mat 33	Engineering Materials and Processes (3)
ECE 108	Signals and Systems (4)
BioE 225	cGMP Good Manufacturing Practice and Regulatory Affairs for Bioengineers (1)

Junior year, second semester (18 credits)

Math 231	Probability and Statistics (3)
ENG 211	Integrated Product Development I (3)
BioE 331	Integrated Bioelectronics/Photonics Laboratory (2)
Mech 3	Fundamentals of Engineering Mechanics (3)
Eco 1	Principles of Economics (4)
	Elective (3)

Senior year, first semester (17 credits)

ENG 212	Integrated Product Development II (2)
ECE 202	Introduction to Electromagnetics (3) or Phy 212 Electricity and Magnetism I (3)
	Electives (12)

Senior year, second semester (17 credits)

Phil 116	Bioethics (4)
	Electives (13)

Cell and Tissue Engineering Track

Sophomore year, first semester (16 credits)

BioE 110	Elements of Bioengineering (4)
Mech 3	Fundamentals of Engineering Mechanics (3)
Math 23	Calculus III (4)
Phy 21/22	Introductory Physics II and Lab (5)

Sophomore year, second semester (18 credits)

BioE 210	Introduction to Engineering Physiology (4)
BioE 020	Bioengineering Sophomore Seminar (1)
Math 205	Linear Methods (3)
Chm 31	Chemical Equilibria in Aqueous Systems (4)
Mat 33	Engineering Materials and Processes (3)
MAT 205	Thermodynamics of Macro/Nanoscale Materials (3)

Junior year, first semester (16 credits)

BioE 120/121	Biomechanics and Biomechanics Laboratory (4)
Chm 110, 111	Organic Chemistry I and Lab (4)
Mech 12	Strength of Materials (3)

BioS 115/116	Biology Core II: Genetics and Lab (4)
BioE 225	cGMP Good manufacturing practice and regulatory affairs for bioengineers (1)

Junior year, second semester (18 credits)

Math 231	Probability and Statistics (3)
ENG 211	Integrated Product Development I (3)
BioE 296	Bioengineering Fluid Mechanics (4) or ME 231 Fluid Mechanics (3)
BioE 357	Integrated Biostructural Mechanics Laboratory (2)
	Electives (6)

Senior year, first semester (18 credits)

ENG 212	Integrated Product Development II (2)
ECO 1	Principles of Economics (4)
	Electives (12)

Senior year, second semester (17)

Phil 116	Bioethics (4)
	Electives (13)

Undergraduate Courses

BioE 1. Freshman Seminar 1, Introduction to Bioengineering 1: Philosophy to Practice (1) fall
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 2. Freshman Seminar 2, Introduction to Bioengineering II: Current Topics (1) spring
Overview of a broad spectrum of current topical areas in biotechnology and bioengineering and their applications in health care and medicine. Pass/Fail

BioE 10. Bioengineering Sophomore Seminar I: Literature Research (1) fall
Literature research on current bioengineering and biotechnology topics to assemble information for producing a written research proposal.

BioE 20. Bioengineering Sophomore Seminar II: Research Proposal (1) spring
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) fall
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 BioS 41 and 42.

BioE 120/121Biomechanics and Biomechanics Laboratory (3/1) fall
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) Coprerequisite MECH 3.

BioE 132. Bioengineering Research 1 (2) fall
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. Prerequisite junior standing and permission of instructor.

BioE 142 Bioengineering Research 2 (2) spring
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. Prerequisite BioE 132 or permission of instructor.

BioE 210. Introduction to Engineering Physiology (4) spring
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. Prerequisite BioE 110, BioS 41 and 42.

BioE 225. GMP Good manufacturing practice and regulatory affairs for bioengineers (1) fall
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.

BioE 242. Bioengineering Research 3 (2) fall
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. Prerequisite BioE 142 or permission of instructor.

BioE 290 Bioengineering Thesis (13) spring
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. Prerequisite BioE 242 or ENG 212 or permission of instructor.

BIOE 308 (CSE 308) Bioinformatics: Issues and Algorithms (3)
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: CSE 17 or CSE 18 or permission of the instructor.

BioE 315 (ME 315) Bioengineering Statistics (3) spring
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: Math 231 or equivalent.

BioE 320 (CSE 320) Biomedical Image Computing and Modeling (3)
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. Prerequisite: Math 205 and CSE 109, or consent of instructor.

BioE 321 (Phy 321) Biomolecular & Cellular Mechanics (3)
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, Math 231, and Phy 13/22 or 21/22, or permission of the instructor.

BioE 324 (MAT 324) Introduction to Organic Biomaterials (3) spring
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: BioE 110 or consent of instructor.

BioE 325 (MAT 325) Inorganic Biomaterials (3) Fall
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 BioE 110 or MAT 33, or consent of instructor.

BIOE 326 (MAT 326) Biomimetic and Bio-enabled Materials (3)
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: MAT 33 or BIOE 110.

BioE 331 (PHY 331) Integrated Bioelectronics/Biophotonics Laboratory (2) spring
Experiments in design and analysis of bioelectronics circuits, micropattering 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 13/22 or Phy 21/22 and ECE 81 or Phy 190, or permission of instructor.

BIOE 339 (CHE 339) Neuronal Modeling and Computation (3)
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: ENGR 1 and Math 205.

BioE 341 (CHE 341) Biotechnology I (3) fall
Applications of material and energy balances; heat, mass, and momentum transfer; enzyme and microbial kinetics; and mathematical modeling to the engineering design and scaleup of bioreactor systems. Prerequisites: BioS 41, ChE31, and CHM 31; the consent of the instructor. Closed to students who have taken BioE 441 (CHE 441).

BioE 342 (CHE 342). Biotechnology II (3) spring
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. Prerequisite: ChE 31 and CHM 31; and the consent of the instructor. Closed to students who have taken BioE 442 (CHE 442).

BioE 343 Integrated Biotechnology Laboratory (3) fall and spring
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. Prerequisite BioE 110, ChE 341, and permission of instructor.

BioE 344 (CHE 344). Molecular Bioengineering (3)
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: Math 205 and Math 231, or senior standing in BIOE.

BIOE 349 Metabolic Engineering (3)
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: Math 205 and Math 231.

BioE 350 Special Topics (1-4) fall and spring
Special topics of study in bioengineering. Permission of Instructor.

BioE 357 Integrated Biostructural Mechanics Laboratory (2) fall and spring
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. Prerequisite: BioE 110 and permission of instructor.

Graduate Program

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.

Major Requirements

Candidates for the doctor of philosophy degree are required to complete a minimum of 72 credits. Specific course requirements are ENGR 452, BioS 411, two additional core courses from an approved list of courses, twelve credits of adviser-approved technical electives at the 300-level or higher, and six credits of dissertation research. An additional 42 credits of electives and/or dissertation research are required to reach the required 72 credits. Students must pass a qualification exam, typically taken after three semesters of study, as well as an oral defense of the dissertation, and a final written dissertation.

Candidates for the master of science degree are required to complete a minimum of 30 credits. Specific course requirements are ENGR 452, BioS 411, two additional core courses from an approved list of courses, twelve credits of adviser-approved technical electives at the 300-level or higher, and six credits of thesis research, culminating in a written thesis. An oral defense of thesis research is dependent upon the requirements of the student's adviser.

Advanced Courses in Bioengineering

BIOE 408 (CSE 408). Bioinformatics: Issues and Algorithms (3)
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: CSE 17 or CSE 18 or permission of the instructor.

BioE 420 (CSE 420) Biomedical Image Computing and Modeling (3)
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. Prerequisite: Math 205 and CSE 109, or consent of instructor.

BioE 421 Biomolecular & Cellular Mechanics (3)
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 BioE 321. The lecture content will be the same as in BioE 321, but students enrolled in BioE 421 will have more advanced assignments. Closed to students who have completed BioE 321. Prerequisites: Graduate standing or permission of instructor.

BioE 424 Introduction to Organic Biomaterials (3) spring
Overview of the field of biomaterials, covering basic concepts in biomaterials, biological response and biomaterial applications. This course is a graduate version of BioE 324 (MAT 324). While the lecture content will be the same as the 300-level course, students enrolled in BioE 424 will have more advanced assignments. Closed to students who have completed BioE 324 (MAT 324).

BIOE 426 (MAT 426) Biomimetic and Bio-enabled Materials (3)
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). Prerequisites: Graduate standing in Bioengineering or Materials Science and Engineering, or permission of the instructor.

BIOE 439 (CHE 439) Neuronal Modeling and Computation (3)
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). Prerequisites: Graduate standing in Bioengineering or Chemical Engineering, or permission of instructor.

BioE 441 (CHE 441) Biotechnology I (3) fall
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 (CHE 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 449 (CHE 449) Metabolic Engineering (3)
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. Prerequisite: Graduate standing in Chemical Engineering or Bioengineering, or permission of instructor.

BioE 450 Special Topics (1-4) fall / spring
Special topics of study in bioengineering. Permission of instructor.

BioE 447. (CHE 447) Molecular Bioengineering (3)
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).

Biological Sciences

Professors. Murray Itzkowitz, Ph.D. (Maryland), Chair; Barry Bean, Ph.D. (Rockefeller); Michael J. Behe, Ph.D. (Pennsylvania); Lynne Cassimeris, Ph.D. (North Carolina); David Cundall, Ph.D. (Arkansas); Linda J. Lowe-Krentz, Ph.D. (Northwestern); John Nyby, Ph.D. (Texas); Jeffrey A. Sands, Ph.D. (Penn State); Jill Schneider, Ph.D. (Wesleyan); Neal Simon, Ph.D. (Rutgers); Jennifer Swann, Ph.D. (Northwestern).

Associate Professors. Matthias Falk, Ph.D. (Heidelberg); Mary Kathryn Iovine, Ph.D. (Washington U.); Michael R. Kuchka, Ph.D. (Carnegie Mellon); Stefan Maas, Ph.D. (Heidelberg); Colin Saldanha, Ph.D. (Columbia); Robert V. Skibbens, Ph.D. (North Carolina); Vassie C. Ware, Ph.D. (Yale).

Assistant Professors. Michael Burger, Ph.D. (Texas); Amy Camp, Ph.D. (Harvard); Amber M. Rice, Ph.D. (North Carolina).

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.

B.A. with Major in Biology

College and university requirements for all majors (25 credit hours)

ENGL 1, 2	Composition and Literature (6)
	First Year Seminar (3)
	Social Sciences (8)
	Humanities (8)

Major Program (49-50 credit hours)

Biology (30 credit hours)

BIOS 41	Biology Core I: Cellular and Molecular (3)
BIOS 42	Biology Core I: Cellular and Molecular Laboratory (1)
BIOS 115	Biology Core II: Genetics (3)
BIOS 116	Biology Core II: Genetics Laboratory (1)
BIOS 120	Biology Core III: Integrative and Comparative (4)
Electives	*Biology electives

**Approved electives (18 credit hours, no more than 3 cr. from the following courses: 161, 261, 262, 391, 393, College scholar project, not BIOS 130).*

Mathematics (7-8 credit hours)

MATH 51	Survey of Calculus I (4)
MATH 52	Survey of Calculus II (3) **or**
MATH 12	Basic Statistics (4) **or**
BIOS 130	Biostatistics (4)

Collateral Sciences (12 credit hours)

CHM 30	Introduction to Chemical Principles (4)
CHM 110, 111	Organic Chemistry I and lab (3,1)
CHM 112, 113	Organic Chemistry II and lab (3,1)

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 as above (25 credit hours)

Major Program (73-74 credit hours)

Biology (37 credit hours)

BIOS 41	Biology Core I: Cellular and Molecular (3)
BIOS 42	Biology Core I: Cellular and Molecular Lab (1)
BIOS 115	Biology Core II: Genetics (3)
BIOS 116	Biology Core II: Genetics Laboratory (1)
BIOS 120	Biology Core III: Integrative and

	Comparative (4)
BIOS 317	Evolution (3)
Electives	*Biology electives (22)

**Biology electives must include one course from list A, one course from list B 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.*

List A

BIOS 234	Comparative Vertebrate Anatomy (4)
BIOS 276	Behavioral Neuroscience II (3)
BIOS 313	Vertebrate Histology (4)
BIOS 314	Vertebrate Development (4)
BIOS 335	Animal Behavior (3)
BIOS 337	Behavioral Ecology (3)
BIOS 382	Endocrinology of Behavior (3)

List B

BIOS 324	Bacteriology (3)
BIOS 345	Molecular 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)

Mathematics (11-12 credit hours minimum)

MATH 21, 22	Calculus I, II (8) or
MATH 51, 52	Survey of Calculus I, II (7)
BIOS 130	Biostatistics (4)

Collateral Sciences (25 credit hours)

CHM 30, 31 or 40, 41	Introductory Chemistry I, II (8)
CHM 110, 112	Organic Chemistry I, II (6)
CHM 111, 113	Organic Chemistry Laboratory I, II (2)
PHY 10	General Physics I (4) or
PHY 11	Introductory Physics I (4)
PHY 12	Introductory Physics Laboratory I (1)
PHY 13	General Physics II (3)
PHY 22	Physics Lab II (1)

Recommended B.S. Biology Sequence

Freshman year

BIOS 41	Biology Core I: Cellular and Molecular (3)
BIOS 42	Biology Core I: Cellular and Molecular Laboratory (1)
MATH 51, 52	Survey of Calculus I, II (7)
CHM 30, 31	Introductory Chemistry I, II (8)

Sophomore year

BIOS 115	Biology Core II: Genetics (3)
BIOS 116	Biology Core II: Genetics Laboratory (1)
CHM 110, 111, 112, 113	Organic Chemistry and Laboratory (8)
BIOS 120	Biology Core III: Integrative and Comparative (4)
BIOS 130	Biostatistics (4)

Junior year

PHY 10, 12	General Physics I and Laboratory (5)
PHY 13, 22	General Physics II and Laboratory (4)

Approved biology electives including one from list A and one from list B (9-12)

Senior year

BIOS 317	Evolution (3)

Biology electives including at least 4 credits of laboratory (10-14)

Minor in Biology

A minor in biology may be achieved by completing the following requirements (17-18 credits):

BIOS 41, 42	Biology Core I: Cellular and Molecular and Laboratory (4)
BIOS 115, 116	Biology Core II: Genetics and 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 or 4)

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 (27 credits)

BIOS 41	Biology Core I: Cellular and Molecular (3)
BIOS 42	Biology Core I: Cellular and Molecular Laboratory (1)
BIOS 115	Biology Core II: Genetics (3)
BIOS 116	Biology Core II: Genetics Laboratory (1)
BIOS 120	Biology Core III: Integrative and Comparative (4)
BIOS 130	Biostatistics (4)
BIOS 276	Central Nervous System and Behavior (3)
BIOS 277	Experimental Neuroscience Laboratory (2)
BIOS 365	Neurobiology of Sensory Systems (3)
BIOS 382	Endocrinology of Behavior (3)

Major Electives (6 credits)

Any 300-level BIOS course (except BIOS 347, 383, 387, 388, 391, or 393) not fulfilling another BNS requirement above.

CHM 31	Chemical Equilibria in Aqueous Systems (4) or
CHM 41	Concepts, Models and Experiments II (4)
PSYC 117	Cognitive Psychology (4)
PSYC 153	Personality (4)
PSYC 176	Mind and Brain (4)

Math and Science Requirements for the B.A. (23-24 credits)

MATH 21, 22	Calculus I, II (8) or
MATH 51, 52	Survey of Calculus I, II (7)
CHM 30	Introduction to Chemical Principles (4) or
CHM 40	Concepts, Models and Experiments I (4)
CHM 110, 112	Organic Chemistry (6)
CHM 111, 113	Organic Chemistry Laboratory I, II (2)
PSYC 1	Introduction to Psychology (4)

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 John Nyby.

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 (27 credits)

BIOS 41	Biology Core I: Cellular and Molecular (3)
BIOS 42	Biology Core I: Cellular and Molecular Laboratory (1)
BIOS 115	Biology Core II: Genetics (3)
BIOS 116	Biology Core II: Genetics Laboratory (1)
BIOS 120	Biology Core III: Integrative and Comparative (4)
BIOS 130	Biostatistics (4)
BIOS 276	Central Nervous System and Behavior (3)
BIOS 277	Experimental Neuroscience Laboratory (2)
BIOS 365	Neurobiology of Sensory Systems (3)
BIOS 382	Endocrinology of Behavior (3)

Additional Biological Sciences Requirements for the B.S. (8-10 credits)

BIOS 371, 372	Elements of Biochemistry I & II (6)
BIOS 234	Comparative Vertebrate Anatomy (4) or
BIOS 377	Biochemistry Laboratory (3) or
BIOS 368	Cell Biology Laboratory (2). If this course is elected, Cell Biology BIOS 367 must be taken as an elective

Advanced BIOS Course Requirement [Take 1 of the following: (3-4 credits)]

BIOS 369	Comparative Physiology of Vertebrate Systems (3-4)
BIOS 384	Eukaryotic Signal Transduction (3)
BIOS 395	Neuropharmacology (3)

Math and Science Requirements for the B.S. (36-38 credits)

MATH 21, 22	Calculus I, II (8) or
MATH 51, 52	Survey of Calculus I, II (7)
CHM 30	Introduction to Chemical Principles (4) and
CHM 31	Chemical Equilibria in Aqueous Systems (4) or
CHM 40	Concepts, Models and Experiments I (4) and
CHM 41	Concepts, Models and Experiments II (4)
CHM 110, 112	Organic Chemistry I, II (6)
CHM 111, 113	Organic Chemistry Laboratory (2)
PHY 10, 12	General Physics I and Laboratory (5) or
PHY 11, 12	Introductory Physics I and Laboratory (5)
PHY 13, 22	General Physics II and Laboratory (4) or
PHY 21, 22	Introductory Physics II and Laboratory (5)
PSYC 1	Introduction Psychology (4)

Major Electives (6 credits)

Any 300-level BIOS course (except BioS 347, 383, 387, 388, 391, or 393) not fulfilling another BNS requirement above.

PSYC 117	Cognitive Psychology (4)
PSYC 153	Personality (4)
PSYC 176	Mind and Brain (4)

B.A. with Major in Molecular Biology

Requirements for the B.A. in Molecular Biology

College and university requirements (see above).

Biology (34-35 credit hours)

BIOS 41, 42	Biology Core I: Cellular and Molecular (3) and Lab (1)
BIOS 115, 116	Biology Core II: Genetics (3) and Lab (1)
BIOS 120	Biology Core III: Integrative and Comparative (4)
BIOS 324	Bacteriology (3) or
BIOS 328	Immunology (3) or
BIOS 353	Virology (3)
BIOS 325	Bacteriology Lab (2) or
BIOS 368	Cell Biology Lab (2) or
BIOS 377	Biochemistry Lab (3)
BIOS 371	Elements of Biochemistry I (3)
BIOS 345, 346	Molecular Genetics (3) and Lab (2)
BIOS 367	Cell Biology (3)

BIOS approved electives (6 credit hours)

Mathematics (7-8 credit hours)

MATH 21, 22 or Calculus I, II (8)

MATH 51, 52	Survey of Calculus I, II (7)

Chemistry (16 credit hours)

CHM 30	Introduction to Chemical Principles (4)
CHM 31	Chemical Equilibria in Aqueous Systems (4)
CHM 110, 111, 112, 113	Organic Chemistry I, II and Lab I, II (8)

Physics (9 credit hours)

PHY 10, 12 or General Physics I and Lab I (5)

PHY 11, 12	Introductory Physics I and Lab (5)
PHY 13, 22	General Physics II and Lab (4)

The B.S. in Molecular Biology

Requirements for the B.S. in Molecular Biology

Major Program (82-85 credit hours)

Mathematics (11-12 credit hours)

MATH 21, 22 or Calculus I, II (8)

MATH 51, 52	Survey of Calculus I, II (7)
BIOS 130	Biostatistics (4)

Chemistry (16 credit hours)

CHM 30	Introduction to Chemical Principles (4)
CHM 31	Chemical Equilibria in Aqueous Systems (4)
CHM 110, 112	Organic Chemistry I, II (6)
CHM 111, 113	Organic Chemistry Laboratory (2)

Physics (9-10 credit hours)

PHY 10 (or 11)	General Physics I (4)
PHY 12	Introductory Physics Laboratory I (1)
PHY 13 (or 21)	General Physics II (3 or 4)
PHY 22	Physics Lab II (1)

Molecular Biology (46-47 credit hours)

BIOS 41	Biology Core I: Cellular and Molecular (3)
BIOS 42	Biology Core I: Cellular and Molecular Lab (1)
BIOS 115	Biology Core II: Genetics (3)
BIOS 116	Biology Core II: Genetics Laboratory (1)
BIOS 120	Biology Core III: Integrative and Comparative (4)
BIOS 324	Bacteriology (3) or
BIOS 328	Immunology (3) or
BIOS 353	Virology (3)
BIOS 325	Bacteriology Laboratory (2) or
BIOS 368	Cell Biology Laboratory (2) or
BIOS 377	Biochemistry Laboratory (3)
BIOS 345	Molecular Genetics (3)
BIOS 346	Molecular Genetics Laboratory (2)
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)

Recommended sequence for the B.S. in Molecular Biology Freshman year

BIOS 41	Biology Core I: Cellular and Molecular (3)
BIOS 42	Biology Core I: Cellular and Molecular Laboratory (1)
MATH 21, 22	Calculus I, II (8)
CHM 30	Introduction to Chemical Principles (4)
CHM 31	Chemical Equilibria in Aqueous Systems (4)

Sophomore year

BIOS 115	Biology Core II: Genetics (3)
BIOS 116	Biology Core II: Genetics Laboratory (1)
BIOS 120	Biology Core III: Integrative and Comparative (4)
CHM 110, 112	Organic Chemistry I,II (6)
CHM 111, 113	Organic Chemistry Laboratory (2)
PHY 10, 12	General Physics I and Lab (5)
PHY 13, 22	General Physics II and Laboratory (4)

Junior year and Senior year

BIOS 324	Bacteriology (3) or
BIOS 328	Immunology (3) or

BIOS 353	Virology (3)
BIOS 325	Bacteriology Laboratory (2) or
BIOS 368	Cell Biology Laboratory (2) or
BIOS 377	Biochemistry Laboratory (3)
BIOS 345	Molecular Genetics (3)
BIOS 346	Molecular Genetics Laboratory (2)
BIOS 371, 372	Elements of Biochemistry I, II (6)
BIOS 367	Cell Biology (3)
BIOS 381	Physical Biochemistry (3)

BIOS Approved Molecular Biology Electives (12)

Molecular Biology Minor

The molecular biology minor program consists of BIOS 41 (3), 42 (1), 115 (3), 116 (1), 345 (3), 346 (2), and a minimum of 4 additional credits of BIOS coursework at the 200 or 300 level. Collateral coursework must include: MATH 51 or 21 (4), CHM 30 (4), and CHM 110 (3).

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 388).

Undergraduate Courses in Biological Sciences

Courses with numbers below 010 are intended for nonmajors and may not be used to satisfy any life science major or minor requirement.

BIOS 1. Biology for Non-Majors (3 or 4)
Basic and applied biology for nonscience majors. May not be used in satisfaction of life science major or minor programs. Focus of topics at the discretion of the instructor. May be taught with (4 credits) or without (3 credits) a laboratory. (NS)

BIOS 7. Human Reproduction (3)
Basic and applied human reproductive biology for nonscience majors. May not be used in life science major or minor programs. (NS)

BIOS 8. Drugs and Behavior (3)
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. (NS)

BIOS 10. Bioscience in the 21st Century (4)
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. (NS)

BIOS 41. Biology Core I: Cellular and Molecular (3)
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. Pre- or corequisite: CHM 30 or 40. (NS)

BIOS 42. Biology Core I: Cellular and Molecular Lab (3)
Experiments, observations, and discussions related to the principal topics covered in BIOS 41. Corequisite: BIOS 41.

BIOS 115. Biology Core II: Genetics (3)
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. Prerequisite: BIOS 41. (NS)

BIOS 116. Biology Core II: Genetics Laboratory (1)
Laboratory work that demonstrates major principles of genetics: included are experiments on microorganisms and the common fruit fly, Drosophila melanogaster. Prerequisite: BIOS 115, preferably concurrently.

BIOS 120. Biology Core III: Integrative and Comparative (4)
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: BIOS 115, 116 (NS).

BIOS 121. Comparative/ Integrative Biology for BIOS Minors(3)
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. Prerequisite: Non-major status and BIOS 115. (NS)

BIOS 130. Biostatistics (4)
Elements of statistics and probability theory with emphasis on biological applications. Statistical analysis of experimental and observational data. Prerequisite: BIOS 41 and MATH 52 or MATH 22 (ND)

BIOS 161. Supervised Research (1-3) fall/spring
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. Prerequisite: BIOS 41 and consent of instructor. (ND)

BIOS 202. Biomedical Externship (1-3)
Analysis of individualized experiences at external biomedical clinical or research sites. Limited enrollment. May not be taken for passfail grading. May be taken only once and may not be used to satisfy any life science major or minor requirement. Prerequisite: Consent of department chair required. (NS)

BIOS 233. Invertebrate Zoology (4)
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. Prerequisite: BIOS 120. (NS)

BIOS 234. Comparative Vertebrate Anatomy (4)
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. Prerequisite: BIOS 120. (NS)

BIOS 235. Human Physiology (4)
Movement, digestion, respiration, circulation and excretion. Sensory systems, hormonal and electrical signal transduction, reproduction. Writing intensive. Prerequisite: BIOS 120 (NS)

BIOS 241. Vertebrate Natural History (4)
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. Prerequisite: BIOS 120. (NS)

BIOS 251. Writing and Biological Sciences (3)
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. Prerequisite: Major status and consent of department. (NS)

BIOS 261. Special Topics in Biological Sciences (1-3)
Research, conferences and reports on selected topics not covered in the general undergraduate offerings. May be taken more than once for credit. Prerequisite: Major status and consent of instructor. (NS)

BIOS 262. Research Proposal (3)
Literature and methods of research in area of department faculty expertise. Requires development of detailed proposal for research to be performed in senior year. Prerequisites: Major in any biological sciences degree program; junior standing; GPA of 3.0 in major; and consent of department. (NS)

BIOS 276. Central Nervous System and Behavior (3)
Neuronanatomy and neurophysiology of animal and human behavior. Feeding, thirst, sleep, emotions, learning, and psychopathology. Prerequisite: BIOS 120. (ND)

BIOS 277. Experimental Neuroscience Laboratory (2)
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: BIOS 276. (NS)

For Advanced Undergraduates and Graduate Students

BIOS 307. Male Reproductive Biology (1-3)
Molecular, cellular, and genetic aspects of the mammalian male reproductive system. Prerequisites: BIOS 120 and consent of instructor (NS).

BIOS 313. Vertebrate Histology (4)
Microstructural and ultrastructural properties of vertebrate cells and tissues. Techniques of tissue preparation. Two lectures and two labs. Prerequisite: BIOS 120 (NS)

BIOS 314. Vertebrate Development (4)
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. Prerequisite: BIOS 120 (NS)

BIOS 315. Neuropharmacology (3)
Mechanisms of drug action in the central nervous system. Pharmacokinetics/pharmacodynamics. Depressants, stimulants, analgesics, and psychedelics. Treatments for neuropsychiatric disorders. Drug abuse. Prerequisite: BioS 276 (NS)

BIOS 317. Evolution (3)
Mechanisms of evolution, emphasizing genetic structure and variation of populations, and isolation. Origin of species and higher taxa. Rates of evolution, extinction. Prerequisite: BIOS 120 (NS)

BIOS 320. The Business of Life Science (3)
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 Biological Sciences. Prerequisite: BIOS 120 or consent of instructor. (ND)

BIOS 324. Bacteriology (3)
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: CHM 110 and BIOS 120. (NS)

BIOS 325. Bacteriology Laboratory (2)
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. Corequisite: BIOS 324.

BIOS 328. Immunology (3)
Distinction of "self" and "nonself" through humoral and cellular mechanisms. Antigens; biochemical structures, cellular mechanisms, genetic control and processing, phylogenetic distribution, diseased states. Prerequisite: BIOS 120. (NS)

BIOS 329. Herpetology (3)
Biology of amphibians and reptiles. Two lectures, one laboratory or field trip per week. Prerequisite: BIOS 120. (ND)

BIOS 334. Species and Speciation (3)
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. Prerequisite: BIOS 317.

BIOS 335. (PSYC 335) Animal Behavior (3)
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. (NS)

BIOS 336. Animal Behavior Laboratory (2)
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. Corequisite: BIOS 335 or 337.

BIOS 337. Behavioral Ecology (3)
Social systems of vertebrate and invertebrate groups. Emphasis on ecological and evolutionary factors that influence social behavior. Prerequisite: BIOS 120. (NS)

BIOS 340. Molecular Basis of Disease (3)
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. Prerequisite: BIOS 120 (NS)

BIOS 345. Molecular Genetics (3)
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. Prerequisite: BIOS 120 or BIOS 115 plus BIOE 210. (NS)

BIOS 346. Molecular Genetics Laboratory (2)
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. Corequisite: BIOS 345.

BIOS 347. Advanced Topics in Genetics (3)
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: BIOS 345 or consent of department chair. (NS)

BIOS 353. Virology (3)
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 virushost interactions. Special attention given to human pathogenic viruses. Prerequisite: BIOS 120 and CHM 112. (NS)

BIOS 356. Human Genetics and Reproduction (3)
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. Prerequisite: BIOS 120. (NS)

BIOS 365. Neurobiology of Sensory Systems (3)
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. Prerequisite: BIOS 276.

BIOS 367. Cell Biology (3)
Molecular aspects of cell biology. Emphasis on membrane structure and function, organelle biogenesis, cell motility, the cytoskeleton, and extracellular matrix. Prerequisite: BIOS 120 or BIOS 115 plus BIOE 210. (NS)

BIOS 368. Cell Biology Laboratory (2)
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. Coor prerequisite: BIOS 367. Consent of Department. (NS)

BIOS 369. Comparative Physiology of Vertebrate Systems (3-4)
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. Prerequisite: BIOS 120. (NS)

BIOS 371. (CHM 371) Elements of Biochemistry I (3) fall
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. Prerequisite: one year of organic chemistry. (NS)

BIOS 372. (CHM 372) Elements of Biochemistry II (3) spring
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. Prerequisite: BIOS 371 and BIOS 41 or consent of the instructor. (NS)

BIOS 374. Sex Determinism and Differentiation (3)
An examination of the primary scientific literature on how sex is conferred on a zygote. Hormonal and non-hormonal mechanisms of sexual differentiation. Neural correlates of sex, gender, and sexual orientation. Prerequisite: BIOS 367 or BIOS 371 or BIOS 382.

BIOS 376. Classical & Molecular Embryology (3)
Differentiation of multicellular organisms from a single cell. Axis determination; gradients; induction and pattern formation viewed through modern analysis of regulated gene expression. Prerequisite: BIOS 345 (previously or concurrently). (NS)

BIOS 377. (CHM 377) Biochemistry Laboratory (3) fall
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. Prerequisite: BIOS/CHM 371 previously or concurrently and BIOS 41 or consent of instructor. (ND)

BIOS 378. (CHM 378) Biochemical Preparations (1-3) spring
A laboratory course involving the preparation or isolation, purification and identification of chemicals of biological origin. Prerequisites: BIOS/CHM 377 and 372, previously or concurrently. (ND)

BIOS 381. Physical Biochemistry (3)
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. Prerequisite BIOS/CHM 371 and BIOS 41. (NS)

BIOS 382. (PSYC 382) Endocrinology of Behavior (3)
Hormonal effects upon animal and human behavior. Emphasis on neuroendocrinology of steroid hormone involvement in reproductive behaviors. Prerequisite: BIOS 177 or BIOS 120. (NS)

BIOS 383. Biological Sciences Colloquia (1)
Analysis of weekly colloquia in the biological sciences. For senior majors in the biological sciences. May be taken twice for credit. (ND)

BIOS 384. Eukaryotic Signal Transduction (3)
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. Prerequisite: BIOS 365, 367, 372, or 382.

BIOS 387. Biological Sciences Honors Seminar (1)
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. (ND)

BIOS 388. Biological Sciences Honors Seminar (1)
Continuation and extension of BIOS 387. Departmental permission required. (ND)

BIOS 391. Undergraduate Research (1-3)
Laboratory research under tutorial with a faculty member. May be taken more than once for credit. Prerequisites: junior standing, and consent of instructor. (ND)

BIOS 393. Thesis (3)
Literature review and design of project in selected area, execution of the project, final report and presentation. Departmental permission. Intended for senior majors in BIOS only. May be repeated one time for additional credit. Prerequisite: Consent of instructor. (ND)

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, Section III.

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 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.

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, 372 Elements of Biochemistry I and II, BIOS 469, 470 Biochemical Problem Solving I and II, CHM 423 BioOrganic Chemistry, BIOS 345 Molecular Genetics, and a seminar course. BIOS 408 or CHM 400 must also be completed before beginning research.

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. The Animal Behavior and Evolution track requires that students take 4 core courses with at least one course taken from each of the following three core areas: (1) Animal Behavior/Evolution (courses include BIOS 409, 439, 334). (2) Behavior/Neuroanatomy (BIOS 453, 475) and (3) Development/Neurophysiology (BIOS 416, 450). The Neuroscience track requires that students take both BIOS 453 and 416, and one course from each of the following core areas: (1) Developmental/Endocrinology (BIOS 450, 457), (2) Animal Behavior/Evolution (BIOS 409, 439, 334), (3) Cell/Molecular Neuroscience (411, 421, 422, 431, 432). BIOS 401 and two semesters of BIOS 406 are required. Depending on the student's background, additional courses may be required.

In the molecular biology program, research areas include microbial evolution and genetics, plant and animal molecular genetics, eukaryotic cell biology, and regulation of gene expression. Required core courses include BIOS 345 Molecular Genetics, BIOS 371 Elements of Biochemistry I, BIOS 372 Elements of Biochemistry II, BIOS 411 Advanced Cell Biology, BIOS 421 Molecular Cell Biology I, and BIOS 422 Molecular Cell Biology II. Additional courses to reach 24 credits are chosen from upper level electives in molecular biology, cell biology, and biochemistry.

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.

Graduate Courses in the Biological Sciences

BIOS 401. Professional Skills for Biological Sciences Graduate Students (3)
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. No prerequisites. Required of all Integrative Biology graduate students.

BIOS 404. (PSYC 404) Behavioral Neuroscience (3)
Theoretical and empirical issues in biopsychology. Prerequisite: Graduate standing or consent of instructor.

BIOS 405. Special Topics in Molecular Biology (1-3)
Research, conferences, and reports on selected topics not covered in the general graduate offerings. May be taken more than once for credit.

BIOS 406. Biological Sciences Seminar (1)
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.

BIOS 407. Research in Biological Science (1-9)
Laboratory investigations in one of the department's research areas.

BIOS 408. Responsible Conduct of Science (0)
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)
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. Prerequisite BIOS 234, BIOS 317, or permission of instructor.

BIOS 410. Special Topics in Behavioral and Evolutionary Bioscience (1-3)
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)
Cell structure and biochemistry, as related to specialized cell functions.

BIOS 412. Metabolic Influences on Behavior (3)
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. Prerequisite: BIOS 404 and consent of instructor.

BIOS 414. Sexual Differentiation (3)
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. Prerequisite: BIOS 404 and consent of instructor.

BIOS 415. Neuropharmacology (3)
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. Prerequisite: BIOS 404 and consent of instructor.

BIOS 418. Analysis of Reproduction and Mating Systems (3)
Study of reproduction and sexuality in plants and animals with emphasis on current hypotheses as reported in the literature. Topics include hermaphroditism, neoteny, larval forms, parental investment, complex life cycles, population structure. Readings from primary source material and review articles. One review paper and one research proposal are required, and together with readings forms the basis for discussion sections and examinations. Prerequisite: Consent of the department.

BIOS 420. Pheromonal Communication (3)
Mechanisms of pheromone synthesis, biochemistry, sensory transduction, neuroanatomy/neuroendocrinology, and adaptive significance. Prerequisite: BIOS 404 and consent of instructor.

BIOS 421. Molecular Cell Biology I (3)
Molecular aspects of cell structure, cell motility, intracellular transport; and biomembrane dynamics. Prerequisite: BIOS 411 or equivalent.

BIOS 422. Molecular Cell Biology II (3)
Molecular aspects of gene expression, including genome structure and replication, RNA synthesis/processing, and protein synthesis. Prerequisite: BIOS 345 or equivalent.

BIOS 424. Advanced Neurobiology of Sensory Systems (3)
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.

BIOS 425. Male Reproductive Biology (1-3)
Molecular, cellular, and genetic aspects of the mammalian male reproductive system. Prerequisite: Permission of instructor.

BIOS 427. Techniques in Cell and Molecular Biology (3)
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)
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)
Current research problems in cell biology. May be repeated when a different topic is offered. Prerequisite: BIOS 367 or BIOS 411.

BIOS 432. Advanced Topics in Molecular Genetics (3)
Current research in molecular genetics. May be repeated when a different topic is offered. Prerequisite: BIOS 345 or equivalent.

BIOS 433. Advanced Topics in Developmental Biology (3)
Current research problems in developmental biology. May be repeated when a different topic is offered. Prerequisite: BIOS 345 or equivalent.

BIOS 437. (CHM 437) Pathophysiological Chemistry (3)
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. Prerequisite: consent of the department.

BIOS 439. Advanced Behavioral Ecology (3)
Critical evaluation of the theoretical foundation in sociobiology. Emphasis placed on kinship, altruism, mate choice, parental investment, parent-offspring conflict, etc. Lectures and seminars. Prerequisite: BIOS 317 or equivalent. Not open to students who have taken BIOS 337.

BIOS 445. Systematics and Evolution (3)
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. Prerequisite: BIOS 317.

BIOS 450. Developmental Neurobiology (3)
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)
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. Prerequisites: Permission of instructor.

BIOS 456. Human Genetics and Preproduction (3)
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)
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. Prerequisite: BIOS 382 or permission of instructor.

BIOS 464. Molecular Biology of Eukaryotic Organisms (3)
Comparative analysis of several eukaryotes as model systems in cell biology, developmental biology, genetics, and molecular biology. Prerequisite: BIOS 345 or equivalent.

BIOS 466. Structure and Function of RNAs and Ribonucleoprotein Complexes (3)
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. Prerequisite: BIOS 345 or equivalent.

BIOS 467. (CHM 467) Principles of Nucleic Acid Structure (3)
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. Prerequisites: one year of biochemistry and one year of physical chemistry or permission of the department.

BIOS 468. (CHM 468) Principles of Protein Structure (3)
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. Prerequisites: one year of biochemistry and one year of physical chemistry or permission of the department.

BIOS 469. (CHM 469) Biochemical Problem Solving I (1)
Applications of material covered in BIOS/CHM 371 including techniques used in research. Prerequisite: BIOS/CHM 371 previously or concurrently.

BIOS 470. (CHM 470) Biochemical Problem Solving II (1)
Applications of concepts covered in BIOS/CHM 372 including techniques used in research. Prerequisite: BIOS/CHM 372 previously or concurrently.

BIOS 471. (CHM 471) Eukaryotic Signal Transduction (3)
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. Prerequisite: BIOS/CHM 372 or BIOS 411.

BIOS 472. (CHM 472) Lipids and Membranes (3)
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. Prerequisite: BIOS/CHM 372 or consent of department.

BIOS 479. (CHM 479) Biochemical Techniques (3)
Laboratory studies of the techniques and principles involved in the isolation, identification, and biochemical transformation of carbohydrates, lipids, nucleic acids and proteins. Prerequisite: BIOS 371 or its equivalent previously or concurrently.

BIOS 480. (CHM 480) Advanced Biochemical Preparations (1-3)
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. Prerequisite: consent of the department.

BIOS 483. Special Topics in Behavioral Neuroscience (3)
Examination of the biological substrates of behavior. Topics may include animal communication, sociobiology, behavioral endocrinology, or behavior genetics. May be repeated for credit. Prerequisite: BIOS 404 or consent of department.

BIOS 488. Seminar in Neuroscience, Behavior, and Evolution (1)
Advanced seminar in current research developments. May be taken more than once for 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

Business

The designation of "business" refers to general business courses.

Undergraduate Courses

BUS 05. Values Based Decision Making for Business (1)
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 1. Introduction to Business (3)
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 173. Non-Major Summer Internship (1)
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. Prerequisite: completion of a minimum of 24 college credits.

BUS 211. Integrated Product Development (IPD) 1 (3) spring
Business, engineering and design art 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. Prerequisite: Junior standing in business, economics, arts or engineering.

BUS 212. Integrated Product Development (IPD) 2 (2) fall
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. Prerequisite: Bus 211/ENGR 211.

Bus 347. Practicum in Real Estate I (2) fall
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; tenant 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.

Bus 348. Practicum in Real Estate II (2) spring
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.

Each group also studies the financial characteristics of comparable properties. The course culminates in an end-of-semester written and oral presentation by each group before a panel of academic and practitioner judges. The group judged to have performed the most outstanding analysis is awarded a cash prize. Prerequisites: Bus 347–Practicum in Real Estate I.

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 first Monday in March. An admissions committee comprised of the business minor program director, associate dean for the undergraduate CBE programs, 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 Geraldo M. Vasconcellos, Allen DuBois Distinguished Professor of Finance & Economics (gmv0@lehigh.edu). Professor Vasconcellos' office is in the Rauch Business Center.

Business Minor Courses

BUS 125. Behavioral Skills Workshop (1) fall
BUS 125 is a course that will have as its aim to equip students to work with others in a business setting in making business decisions. The focus of the class will be on effective decision making and will include such topics as group and team decision making, conflict resolution and negotiation, ethical decision making, and creative problem solving. This course will be offered as a series of intensive workshops in the fall semester and will heavily focus on experiential learning. Prerequisite: ECO 1. Co-requisite: BUS 126.

BUS 126. Information Analysis and Financial Decision Making I (3) fall
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. Prerequisite: ECO 1. Co-requisite: BUS 125.

BUS 127. Information Analysis and Financial Decision Making II (3) spring
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. Prerequisite: BUS 126.

BUS 225. Developing, Producing, and Marketing Products and Services I (3) fall
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. Prerequisite: BUS 127.

BUS 226. Developing, Producing, and Marketing Products and Services II (3) spring
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. Prerequisite: BUS 225.

BUS 326. Business Strategy (1 credit hour. Spring.)
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. Co-requisite: BUS 226.

Business Information Systems

Program director. Catherine M. Ridings, Ph.D. (Drexel), *associate professor management*

Program faculty. Susan A. Sherer, Ph.D. (Pennsylvania) Kenan professor of information technology management; James A. Hall, Ph.D. (Oklahoma State), associate professor accounting; Lin Lin, Ph.D. (Arizona), assistant professor management; Yuliang Yao, Ph.D. (Maryland), associate professor management; Chitra Nayar, M.B.A. (Iowa), lecturer; Dennis S. Praedin, B.A. (Muhlenberg); adjunct professor

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 (4):

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 in IS (3)

Elective Courses (Choose 2):

ACCT 311	Accounting Information Systems (3)
BIS 333	Enterprise Security and Risk Management
BIS 342	E-business Enterprise Applications (3)
BIS 372*	Special Topics in Information Systems (3)
CSB 314	International Practicum (Lehigh in Prague) (3)

**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.*

Undergraduate Courses

BIS 111. Introduction to Information Systems (3)
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. Prerequisite: Excel competency.

BIS 311. Managing Information Systems Analysis and Design (3)
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. Prerequisite: BIS 111 or consent of instructor.

BIS 324. Business Data Management (3)
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. Prerequisite: BIS 311.

BIS 333. Enterprise Security and Risk Management (3)
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. Prerequisite: BIS 311.

BIS 335. Web Application Development for Business (3)
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: BIS 111.

BIS 342. (SCM 342) e-Business Enterprise Applications (3)
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: BIS 111 or consent of the instructor.

BIS 350. Project Management (3)
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. Prerequisites: completion of all other courses in either BIS or Management major.

BIS 360. Business Information Systems Practicum (3)
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. Prerequisites: Junior standing in the College of Business and Economics.

BIS 371. Directed Readings (1-3)
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. Prerequisite: preparation in information systems acceptable to program coordinator.

BIS 372. Special Topics in Information Systems (1-3)
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. Prerequisite: preparation in information systems acceptable to program coordinator.

BIS 373. Business Information Systems Internship (1-3)
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. Prerequisites: BIS 311, declaration of a BIS major or minor, junior standing, and department approval.

Course descriptions for the College of Business and Economics graduate courses can be found in this section (Section V) under the heading of Business and Economics Graduate 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)

Choice of either:
- BIS 335 Web Application Development for Business (3)

-or-
- BIS 342 E-Business Enterprise Applications (3)

-or-
- BIS 333 Enterprise Security and Risk Management (3)

Business and Economics Graduate Courses

MBA Prerequisites

GBUS 401. Financial Reporting for Managers and Investors (3)
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.

ECO 401. Basic Statistics for Business and Economics (3)
Descriptive statistics, probability and probability distributions, estimation, hypothesis testing, correlation and regression, chi-square analysis and analysis of variance. Computer applications.

MBA Program Core Courses

MBA 401. Introduction to the Organization and its Environment (2)
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)
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, GBUS 401 or equivalent.

MBA 403. Managing Information (4)
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: MBA 401, GBUS 401 and ECO 401 or equivalents.

MBA 404. Managing Products and Services (4)
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. Prerequisite: MBA 401.

MBA 405. Managing People (4)
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. Prerequisite: MBA 401.

MBA 406. Integrative Experience (3)
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: MBA 401, MBA 402, MBA 403, MBA 404, MBA 405.

Accounting Electives

GBUS 413. Advanced Management Accounting (3)
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. Prerequisite: MBA 403 or a course in cost accounting.

GBUS 414. Financial Statement Analysis and Interpretation (3)
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. Prerequisite: GBUS 401 and MBA 402 or permission of the instructor.

GBUS 437. Federal Taxation and Business Decisions (3)
Impact of federal taxation on the structure and timing of business decisions. Problem-solving methods and research techniques from a managerial perspective. Prerequisite: ACCT 307.

Finance Electives

GBUS 419. Financial Management (3)
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. Prerequisite: MBA 402 or equivalent background. Students not possessing the relevant prerequisites must obtain waivers from the designated finance faculty representative.

GBUS 420. Investments (3)
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. Prerequisite: MBA 402 or equivalent background. Students not possessing the relevant prerequisites must obtain waivers from the designated finance faculty representative.

GBUS 421. Advanced Investments (3)
Advanced topics relating to specific areas within investment finance such as valuation/security analysis; portfolio/risk

mamangement; fixed investment securities;mutual funds; hedge funds; microstructure; and trading. May be repeated. Prerequisites: GBUS 420 or designed finance faculty representative approval

GBUS 422. Derivatives and Risk Management (3)
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: GBUS 420, or Designated Finance Faculty Representative Approval.

GBUS 424. Advanced Topics in Financial Management (3)
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: GBUS 419 or designated finance representative approval.

GBUS 425. Real Estate Financing and Investing (3)
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: GBUS 420, or designated finance faculty representative approval.

GBUS 426. Financial Markets and Institutions (3)
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. Prerequisite: GBUS 420, or designated finance faculty representative approval.

GBUS 431. Quantitative Finance (3)
Relationship of quantitative models to financial theory and applications. Capital budgeting, portfolio selection, security evaluation, cash management, inventory policy and credit analysis. Prerequisite: GBUS 419 or designated finance faculty approval.

Management Electives

GBUS 440. Human Resource Management (3)
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)
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. Prerequisites: completion of MBA background courses (or equivalent) and permission of the instructor.

GBUS 444. Managerial Communication Skills (3)
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)
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)
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)
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)
The control of physical distribution and inventories; the flow of information, products and cash through the integrated supply chain.

GBUS 454. E-Commerce and Marketing Strategy (3)
Impact of e-commerce technologies on firms, industries, and markets. Covers the technologies used in e-commerce, changes in organization structure, industry and behavior, and sales and marketing strategies such as attracting visitors to websites, promotion, distribution, service, pricing, branding, advertising, consumer behavior, measuring effectiveness, societal effects, disintermediation, reintermediation, and strategy implementation. Prerequisite: MBA 403.

GBUS 455. E-Business Enterprise Applications (3)
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. Business Process Redesign with Information Systems (3)
Current topics on the principles, implementation and critical success factors of deploying information systems enabled quality management and process innovation within organizations. Techniques and tools used in implementing quality and process innovation from a managerial and practical perspective. Prerequisite: MBA 403.

GBUS 457. Managing the IS Resource (3)
The issues and management techniques involved in administering the information systems/resource activities in the organization. Management of IS professionals, development and management of project teams, user client relationships, managing vendors, emerging technologies and planning processes. Prerequisite: MBA 403.

GBUS 458. Strategic Information Systems (3)
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. Prerequisite: MBA 403.

GBUS 459. Survey of Project Management (3)
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 solves 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.

Marketing Electives

GBUS 460. Strategic Marketing Management (3)
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.

GBUS 462. Pharmaceutical Marketing
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. Prerequisites: Graduate students only.

GBUS 464. Business-to-Business Marketing (3)
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)
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. Prerequisites: Graduate student status plus two years of postgraduate work experience.

GBUS 466. Marketing Research and Analysis (3)
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.

GBUS 470. Marketing Communications Strategies (3)
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)
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. Prerequisite: MBA 404.

GBUS 472. Strategies for Services Marketing (3)
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.

International Business Electives

GBUS 473 International Finance (3)
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: GBUS 419, or designated finance faculty representative approval.

GBUS 474. Legal Aspects of International Business (3)
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
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.

Management of Technology Electives

GBUS 481. Technology, Operations and Competitive Strategy (3)
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)
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 494. Field Projects (1-4)
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.

Corporate Entrepreneurship (Venture Series)

GBEN 401. The Business Plan I: Strategic Considerations (2)
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. 2 Credits

GBEN 402. The Business Plan II: Operating Strategies and Implementation (2)
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. 2 Credits

GBEN 403. Anatomy of Entrepreneurship: Startups and Established Companies (1)
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. 1 Credit

GBEN 404. Market Opportunity: Targeting Strategies and Selling Tactics (1)
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. 1 Credit

GBEN 405. Intellectual Property: Management and Valuation (1)
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. 1 Credit

GBEN 406. Performing a Business Enterprise Audit: Developing an Industry Perspective (1)
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. 1 Credit

GBEN 407. Processes and Infrastructure: Creating Production and Delivery (1)
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. 1 Credit

GBEN 408. The New Venture Organization: Management, Design, and Governance (1)
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. 1 Credit

GBEN 409. Financial Forecasting: Developing Pro Forma Financial Statements (1)
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. 1 Credit

GBEN 410. Financing StartUps: Seeking Outside Venture Capital (1)
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. 1 Credit

GBEN 411. Establishing Credit Facilities: AssetBased and Cash Flow Financing (1)
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.1 Credit

GBEN 412. Developing Exit Strategies: Concepts and Approaches (1)
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. 1 Credit

GBEN 413. Integrative Experience/New Venture Internship (1-4)
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.

Project Management Electives
Must be taken as sequenced courses and may not be taken individually.

PMGT 401. Project Management: Course Framework & Project Leader Assessment (1)
Introduction to the Project Management Certification Course; syllabus, requirements and deliverables. Students will become acquainted with: the terminology, nine knowledge areas, relationships to other disciplines, project management context and processes. 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)
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. Prerequisite: PMGT 401.

PMGT 403. Project Management: Initiating the Project and Planning Scope and Schedule (2)
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: PMGT 401, PMGT 402

PMGT 404. Project Management: Planning Resources, Communication, Quality and Risk Management (2)
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: PMGT 401, PMGT 402, PMGT 403

PMGT 405. Project Management: Project Leader Communications Expertise and Evaluating Team Performance (1)
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: PMGT 401, PMGT 402, PMGT 403, PMGT 404

PMGT 406. Project Management: Implementing and Managing Projects (2).
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: PMGT 401, PMGT 402, PMGT 403, PMGT 404, PMGT 405

PMGT 407. Project Management: Controlling Performance and Assessing Outcomes (2)
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: PMGT 401, PMGT 402, PMGT 403, PMGT 404, PMGT 405, PMGT 406

PMGT 408. Project Management: Problem Solving, Decision Making and Ethics (1)
This 2day 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: PMGT 401, PMGT 402, PMGT 403, PMGT 404, PMGT 405, PMGT 406, PMGT 407

Accounting

M. S. Core Courses

MACC 401. Professional Issues in Accounting - Negotiation (1)
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. MACC 401, 402 and 403 are prerequisites to the balance of the MSAIA core course sequence. Open only to MSAIA students.

MACC 402. Professional Issues in Accounting - Case Analysis (1)
Introduces business case analysis. Cases will be dissected, analyzed and discussed. A range of business topics will be used to demonstrate the case method. MACC 401, 402 and 403 are prerequisites to the balance of the MSAIA core course sequence. Open only to MSAIA students.

MACC 403. Professional Issues in Accounting - Ethics (1)
Examines ethical issues as they relate to business. Through debate and case studies, students will be challenged to determine what are acceptable and ethical business practices, primarily in an international environment, and how these practices relate to the highly diverse elements that comprise today's complex, global enterprises. MACC 401, 402 and 403 are prerequisites to the balance of the MSAIA core course sequence. Open only to MSAIA students.

MACC 412. Information Systems Auditing (3)
Modern information technology auditing and impact of computer controls on operational efficiency and external auditing under Sarbanes-Oxley Act. Focuses on key threats and audit procedures relating to operating systems, data management, systems development, electronic commerce, organization structure, computer center operations, Enterprise Resource Planning (ERP) systems, and revenue and expenditure cycles. Issues in fraud prevention and detection. Emphasizes data extraction software for auditing and integrates ACL and SAP into auditing scenarios. Prerequisites: Accounting 311, Accounting 320, MACC 401, 402 and 403.

MACC 413.The Corporate Financial Reporting Environment (3)
Uses theory and research results to study financial reporting's role in providing decision-useful information to capital market participants. Topics include the financial reporting revolution, efficient markets theory and research, economic consequences and Positive Accounting Theory, conflict between owners and managers, executive compensation, earnings management, standard-setting, the FASB's conceptual framework, and International Financial Reporting Standards. Prerequisites: Accounting 316, MACC 401, 402 and 403.

MACC 420. Consulting Process and Practice in Professional Accounting (3)
Consulting and advisory processes relates to accounting firms and internal consultation in industry. Focuses on consulting process life cycle: gaining and retaining clients, developing proposals and engagement letters, defining client needs and diagnosing problems, collecting and analyzing data, documenting findings, developing solutions and recommendations, and managing projects. Uses case studies and outside speakers. Students complete a real life consulting project and present findings orally and in writing. Prerequisites: MACC 401, 402 and 403.

MACC 424. Corporate Governance and Business Risk (3)
Focuses on assurance and risk management services offered by public accounting firms. Integrating topics from accounting, auditing, ethics, economics, risk management, internal control, and business strategy, the course develops an in-depth understanding of how corporate governance and business risk issues relate to assurance practice in today's post Sarbanes-Oxley environment. Students complete an assurance and risk management engagement for a "real-life" small-to-medium size client. Prerequisite: MACC 401, 402 and 403, and MACC 412 or concurrent.

MACC 427. Analyzing Accounting Information for Management and Business Solutions (3)
Examines the interaction of accounting information, business models, financial analysis and information technology to resolve complex business problems. Topics include using control systems to guide business strategies, creating performance measurement systems, evaluating strategic profit performance, linking internal operations to external markets, and balancing profit, growth, management attention, earnings quality analysis and business valuation. Prerequisite: MACC core or concurrent; taken during the last semester of the program.

Economics

M.S. And Ph.D. Core Courses

ECO 401. Basic Statistics for Business and Economics (3)
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)
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. Prerequisite: Calculus and ECO 401 or equivalent.

ECO 411. History of Economic Thought (3)
Selected topics in the history of economic thought, with special attention to the origins of modern economic theory. Prerequisite: a graduate course in economic theory.

ECO 412. Mathematical Economics (3)
Applications of various mathematical techniques in the formation and development of economic concepts and theories. Prerequisite: consent of the instructor.

ECO 413. Advanced Microeconomics Analysis (3)
A survey of methods of decision making at the microeconomic level; price theory and econometric applications. Prerequisite: ECO 402 or equivalent.

ECO 414. Advanced Topics in Microeconomics (3)
Resource allocation and price determination. Theories of choice of consumers, firms, and resource owners under various market forms. Prerequisite: ECO 413 or equivalent.

ECO 415. Econometrics I (3)
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. Prerequisite: ECO 401 or equivalent.

ECO 416. Econometrics II (3)
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: ECO 415 (or equivalent) and calculus.

ECO 417. Advanced Macroeconomic Analysis (3)
Macroeconomic theory and policy. Emphasis on theoretical models and policy implications.

ECO 418. Advanced Topics in Macroeconomics (3)
Models of employment, income and growth in monetary economies. Policies for economic stability and growth. Prerequisite: ECO 417 or equivalent.

ECO 425. Cost Benefit Analysis (3)
Theory and methods of cost benefit analysis; efficiency and equity as criteria in program evaluation; proper measurement of market and nonmarket costs and benefits; consideration of risk, uncertainty, appropriate discounting techniques and distributional consequences; applications to the evaluation of health care policies and therapies. Prerequisites: ECO 401 and ECO 402 or equivalents; ECO 357 or ECO 415; statistical software beyond Excel; or instructor permission.

ECO 429. Monetary Theory (3)
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) The economics of public spending and taxation; principles of government debt management; theories of budgeting and cost-benefit analysis and public choice.

ECO 436. Economic History of the United States (3)
Analysis of the colonial economy, transition to industrialization, and the role of trade and transportation in America's development. A consideration of the importance of slavery to the 19th century American economy and other New World economies. Origin and development of banking and financial markets. Prerequisites: ECO 401 and ECO 402 or equivalents.

ECO 440. Labor Economics I (3)
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: ECO 401 and ECO 402 or equivalents.

ECO 441. Labor Economics II (3)
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 ECO 402 and ECO 415 or equivalents.

ECO 447. Economic Analysis of Market Competition (3)
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: ECO 401 and ECO 402 or equivalents; 2 semesters calculus; or instructor permission.

ECO 451. Urban Economics (3)
The application of traditional and spatial economics to the location of economic activity focusing on the urban economic problems of business location, housing, land value, land use, and intraurban transportation. ECO 453. Government Regulation of Business (3) Analysis of the economic justification for government regulation of private enterprise. Topics include antitrust policy, utilities, and health, safety and environmental regulation. Prerequisite: ECO 402 or equivalent.

ECO 454. Economics of Environmental Management (3)
Economic theory of natural resources. Optimal policies for the development of renewable and nonrenewable resources and environmental quality. Prerequisite: ECO 402 or equivalent.

ECO 455. Health Economics I (3)
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: ECO 402 and ECO 415 or equivalents.

ECO 456. Industrial Organization (3)
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. BioPharmaceutical Economics (3)
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: ECO 401 and ECO 402 or equivalents or instructor permission.

ECO 460. Time Series Analysis (3)
Classical decomposition of time series, trend analysis, exponential smoothing, spectral analysis and Box Jenkins autoregressive and moving average methods.

ECO 461. Forecasting (3)
Methods of economic and business forecasting.

ECO 463 (IE 458). Topics in Game Theory (3)
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 microeconomic problems including industrial organization, international trade, and finance. Prerequisites: Two semesters of calculus, ECO 412 and ECO 413, or permission of the instructor.

ECO 464. Applied Econometrics I (3)
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. Prerequisite: ECO 416 or equivalent.

ECO 465. Applied Econometrics II (3)
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. Prerequisite: ECO 416 or equivalent.

ECO 466. Health Economics II (3)
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: ECO 402 and ECO 416 or equivalents.

ECO 471. International Economic Development (3)
An introduction to the basic theoretical concepts in international economic development and an evaluation of their application by means of a representative sample of the literature.

ECO 472. International Trade Theory (3)
Theories of comparative advantage, factor price equalization, trade and welfare, tariffs, trade and factor movements. Prerequisite: ECO 413 or consent of the chair.

ECO 473. International Monetary Economics (3)
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. Prerequisite: ECO 417 or consent of the chair.

ECO 480. Economics of Technological Change (3)
Explores theoretical models and empirical evidence on the economics of innovation and technical change. Includes examination of: the role of technology in competitiveness, industrial structure, and economic growth; alternative models of the innovative process; incentives for and other conditions affecting research and development; the evaluation of the justifications for government support of R&D. Prerequisite: ECO 402 or equivalent.

ECO 490. Master's Thesis

ECO 492. Special Topics in Economics (1-3)
Extended study of an approved topic not covered in scheduled courses. May be repeated for credit.

ECO 493. Doctoral Pre-Dissertation Research Project (1-9)
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

Chemical Engineering

http://www.che.lehigh.edu/blog/

Professors. Philip A. Blythe, Ph.D. (Manchester, England); Hugo S. Caram, Ph.D. (Minnesota); Manoj K. Chaudhury, Ph.D. (SUNY-Buffalo), Franklin J. Howes Jr. Professor; Mohamed S. El-Aasser, Ph.D. (McGill), *VP for International Affairs*; Alice P. Gast, PhD. (Princeton), *President*; James T. Hsu, Ph.D. (Northwestern); Anand Jagota (Cornell), *Director of Bioengineering*; Andrew Klein, Ph.D. (North Carolina State); Mayuresh V. Kothare, Ph.D. (California Institute of Technology) R. L. McCann Professor; William L. Luyben, Ph.D. (Delaware); Anthony J. McHugh, Ph.D. (Delaware), Ruth H. and Sam Madrid Professor, *Chair*; Arup K.

Sengupta, Ph.D. (Houston); Cesar A. Silebi, Ph.D. (Lehigh); Israel E. Wachs, Ph.D. (Stanford), G. Whitney Snyder Professor.

Associate Professor. James F. Gilchrist, Ph.D. (Northwestern).

Assistant Professors. Bryan W. Berger, Ph.D. (Delaware); Steven McIntosh Ph.D. (UPenn); Jeetain Mittal - Ph.D. (UT-Austin); P.C. Rossin Assistant Professor Mark A. Snyder, Ph.D. (Delaware).

Professor of Practice. Lori Herz, Ph.D. (Rutgers); Susan F. Perry, Ph.D. (Penn State); Kemal Tuzla, Ph.D. (Istanbul Technical), Associate Chair.

Adjunct Professor. Vincent G. Grassi, Ph.D. (Lehigh); Shivaji Sircar, Ph.D. (Pennsylvania).

Principal Research Scientists. Eric S. Daniels, Ph.D. (Lehigh).

Emeritus Professors. Marvin Charles, Ph.D. (Brooklyn Polytechnic); John C. Chen, Ph.D. (Michigan), Dean emeritus; Arthur E. Humphrey, Ph.D. (Columbia), provost emeritus; William E. Schiesser, Ph.D. (Princeton); Leslie H. Sperling, Ph.D. (Duke); Fred P. Stein, Ph.D. (Michigan)

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. participate in lifelong learning through graduate studies, research, and continuing education.
3. contribute as successful practitioners, developers and/or leaders addressing technological and societal challenges.
4. recognize the societal, ethical, and technical implications of their work as it affects the environment, safety, and health of citizens worldwide.

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. Each project is hosted by a company and carried out under the supervision of a Lehigh faculty member.

Minors and Specializations: Technical minors are available in biotechnology, computer science, environmental engineering, manufacturing systems, materials science and engineering, and polymer science and engineering. Chemical Engineering also offers specialization certificates in polymer science, biotechnology, and process modeling and control. 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*

Requirements of the Major - 131 credit hours are required for graduation with the degree of bachelor of science in chemical engineering.

freshman year (see Recommended Freshman Year)

sophomore year, first semester (16 credit hours)

CHE 31	Material and Energy Balances of Chemical Processes (3)
CHM 31	Chemical Equilibria in Aqueous Systems (4)
PHY 21	Introductory Physics II (4)
PHY 22	Introductory Physics Laboratory II (1)
MATH 23	Calculus III (4)

sophomore year, second semester (17 credit hours)

CHE 44	Fluid Mechanics (3)
CHE 210	Chemical Engineering Thermodynamics (4)
CHE 179	Professional Development (1)
BIOS 41	Introduction to Cell and Molecular Biology (3)
MATH 205	Linear Methods (3)
	elective (3)

junior year, first semester (17 credit hours)

CHE 151	Introduction to Heat Transfer (3)
CHE 201	Methods of Analysis in Chemical Engineering (3)
CHM 110	Organic Chemistry I (3)
CHM 111	Organic Chemistry Laboratory I (1)
CHM 341	Molecular Structure, Bonding and Dynamics (3)
	electives (4)

junior year, second semester (18 credit hours)

CHE 244	Mass Transfer and Separation Processes (3)
CHE 211	Chemical Reactor Design (3)
CHM 112	Organic Chemistry II (3)
CHM 343	Physical Chemistry Laboratory (2)
	electives (7)

senior year, first semester (18 credit hours)

CHE 202	Chemical Engineering Laboratory I (2)
CHE 233	Process Design I (3)
CHE 242	Introduction to Process Control and Simulation (3)
	electives (10)

senior year, second semester (15 credit hours)

CHE 203	Chemical Engineering Laboratory II (2)
ECE 83	Principles of Electrical Engineering (3)
CHE 234	Process Design II (3)
	electives (7)

There are five types of electives:

5. Humanities/Social Sciences: See the requirements set by the P.C. Rossin College of Engineering and

Applied Science (Section 3). Note that ECO 1 is required, as well as Freshman English.

6. Three credit hours from approved courses in other engineering departments (BioE, CEE, CSE, ECE, ISE, MEM, MSE).
7. Chemistry: 3 credit hours of CHM 300-level or higher, or CHE 380.
8. Chemical Engineering: 3 credit hours of CHE 300 level or higher.
9. Free electives: 6 credit hours in any subject area.

Electives in (2) to (5) above can be combined with any technical minor in RCEAS.

Undergraduate Courses

CHE 31. Material and Energy Balances of Chemical Processes (3) fall
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. Prerequisite: CHEM 30 or equivalent and ENG 1 previously or concurrently.

CHE 44. Fluid Mechanics (3) spring
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 85. Undergraduate Research (1)
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) fall
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. Prerequisite: CHE 44.

CHE 171 (CEE 171, EMC 171, ES171) Fundamentals of Environmental Technology (4)
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. Prerequisite: EES (ES) 002, or one advanced science course or permission of instructor. Not available to students in RCEAS.

CHE 179. Professional Development (1) spring
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)
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)
A continuation of the project begun under CHE 185. Prerequisite: CHE 185 or consent of the department chair. Can be repeated up to a total of three credits.

CHE 201. Methods of Analysis in Chemical Engineering (3) fall
Analytical and numerical methods of solution applied to dynamic, discrete and continuous chemical engineering processes. Laplace Transforms. Methods of analysis applied to equilibrium, characteristic value and non-linear chemical engineering problems. Prerequisite: MATH 23 and CHE 44.

CHE 202. Chemical Engineering Laboratory I (2) fall
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. Prerequisite: CHE 151.

CHE 203. Chemical Engineering Laboratory II (2) spring
Laboratory experience with more complex chemical processing situations including processes involving chemical reactions and those controlled automatically. Prerequisite: CHE 244 and CHE 210.

CHE 210. Chemical Engineering Thermodynamics (4) spring
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. Prerequisite: CHE 31.

CHE 211. Chemical Reactor Design (3) spring
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. Prerequisite: CHE 210 or equivalent.

CHE 233. Process Design I (3) fall
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: CHE 211, CHE 242 and CHE 244.

CHE 234. Process Design II (3) spring
Continuation of CHE 233. Prerequisite CHE 233.

CHE 242. Introduction to Process Control and Simulation (3) fall
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: CHE 201, CHE 151, and ENGR 1.

CHE 244. Mass Transfer and Separation Processes (3) spring
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: CHE 31 and CHE 44.

CHE 280. Unit Operations Survey (3) spring
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) fall
Fundamentals of material balances, fluid mechanics and heat transfer. Prerequisites: 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 and department permission.

CHE 282. Chemical Engineering Fundamentals II (4) spring
Fundamentals of heat and mass transfer, process energy balances and unit operations. Prerequisites: CHE 281, or equivalent, and department permission.

CHE 283. Chemical Engineering Fundamentals III (4) fall
Fundamentals of thermodynamics, reaction kinetics and reactor analysis, and applied mathematics. Prerequisites: CHE 281 and 282 and department permission.

For Advanced Undergraduates and Graduate Students

CHE 306 (MATH 306) Introduction to Biomedical Engineering and Mathematical Biology (3)
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: MATH 205.

CHE 331. Separation Processes (3)
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. (MAT 334, EES 338) Electron Microscopy and Microanalysis (4) fall
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. Prerequisite: consent of the department chair.

CHE 339 (BIOE 339) Neuronal Modeling and Computation (3)
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: ENGR 1 and Math 205.

CHE 341 (BIOE 341). Biotechnology I (3) fall
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. Prerequisites: BioS 41, ChE31, and CHM 31; the consent of the instructor. Closed to students who have taken CHE 441 (BIOE 341 and 441).

CHE 342 (BIOE 342). Biotechnology II (3) spring
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. Prerequisite: ChE 31 and CHM 31; and the consent of the instructor. Closed to students who have taken CHE 442 (BIOE 342 and 442).

CHE 344 (BIOE 344). Molecular Bioengineering (3)
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: Math 205 and Math 231, or senior standing in ChE.

CHE 346. Biochemical Engineering Laboratory (3)
Laboratory and pilot-scale experiments in fermentation and enzyme technology, tissue culture, and separations techniques. Prerequisites: CHE 341, previously or concurrently; and the consent of the instructor. Closed to students who have taken CHE 446.

CHE 350. Special Topics (1-3)
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.

CHE 364. Numerical Methods in Engineering (3)
Survey of the principal numerical algorithms for: (1) functional approximation, (2) linear and nonlinear algebraic equations, (3) initial and boundary-value ordinary differential equations and (4) elliptic, hyperbolic and parabolic partial differential equations. Analysis of the computational characteristics of numerical algorithms, including algorithm structure, accuracy, convergence, stability and the effect of computer characteristics, e.g., the machine epsilon and dynamic range. Applications of mathematical software in science and engineering.

CHE 373. (CEE 373) Fundamentals of Air Pollution (3)
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. Prerequisite: senior standing in the College of Engineering and Applied Science.

CHE 374 Environmental Catalysis (3)
Pollution emissions in the USA (NOx, SOx, NH3, 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 NOx, etc.) Prerequisite: Senior standing and instructor approval

ChE 375 (CEE 375) Environmental Engineering Processes (3) Fall
Processes applied in environmental engineering for air pollution control, treatment of drinking water, municipal wastewater, industrial wastes, hazardous/toxic wastes, and enviroinmental remediation. Kinetics, reactor theory, mass balances, application of fundamental physical, chemical and biological principles to analysis and design. Prerequisite: CEE 170 or equivalent.

CHE 376 (ME 376) Energy: Issues & Technology (3)
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. Prerequisites: college-level introductory courses in chemistry, physics and mathematics and instructor approval.

CHE 380. Senior Research Project – OSI (1-3) fall/spring
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. Prerequisite: Senior standing and departmental approval. The course may be repeated for up to six credits.

CHE 386. Process Control (3)
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. Prerequisite: CHE 242 or equivalent.

CHE 387. (ECE 387, ME 387) Digital Control (3)
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). Prerequisite: CHE 386 or ECE 212 or ME 343 or consent of instructor.

CHE 388. (CHEM 388, MAT 388) Polymer Synthesis and Characterization Laboratory (3)
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. Prerequisite: senior level standing in CHE, CHM or MAT, or permission of the instructor. (ES 2), (ED 1)

CHE 389. (ECE 389, ME 389) Control Systems Lab (2) spring
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. Prerequisite: CHE 242, ECE 212, or ME 343. (ES 1), (ED 1)

CHE 391. (CHEM 391) Colloid and Surface Chemistry (3)
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. Prerequisite: Permission of the instructor.

CHE 392. (CHM 392) Introduction to Polymer Science (3) fall
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. Prerequisite: CHM 187 or equivalent.

CHE 393. (CHM 393, MAT 393) Physical Polymer Science (3) fall
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. Prerequisite: senior level standing in CHE, CHEM, or MAT, or permission of the instructor.

CHE 394. (CHM 394) Organic Polymer Science I (3) spring
Organic chemistry of synthetic high polymers. Polymer nomenclature, properties, and applications. Functionality and reactivity or 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. Prerequisites: one year of physical chemistry and one year of organic chemistry. (NS)

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

All candidates for the Master of Science degree are required to complete a research report or thesis for which six hours of graduate credit are earned. Course selection is done individually for each student, although CHE 400, CHE 410, CHE 415 and CHE 452 are required.

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.

Advanced Courses in Chemical Engineering

CHE 400. Chemical Engineering Thermodynamics (3) fall
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. Prerequisite: an introductory course in thermodynamics.

CHE 401. Chemical Engineering Thermodynamics II (3) spring, every other year
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)
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. Prerequisite: CHE 211.

CHE 413. Heterogeneous Catalysis and Surface Characterization (3)
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) spring
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. Prerequisite: CHE 452 or equivalent.

CHE 419. (MECH 419) Asymptotic Methods in the Engineering Sciences (3)
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 428. Rheology (3)
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. Prerequisite: Permission of the instructor.

CHE 430. Mass Transfer (3)
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. (ECE 433, ME 433) State Space Control (3)
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. Prerequisite: ME 343 or ECE 212 or CHE 386 or consent of instructor.

CHE 434. (ECE 434, ME 434) Multivariable Process Control (3)
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. Prerequisite: CHE 433 or ME 433 or ECE 433 or consent of instructor.

CHE 436. (ECE 436, ME 436) Systems Identification (3)
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-imbedding techniques for nonlinear system parameter identification included. Prerequisite: CHE 433 or ME 433 or ECE 433 or consent of instructor.

CHE 437. (ECE 437, ME 437) Stochastic Control (3)
Linear and nonlinear models for stochastic systems. Controllability and observability. Minimum variance state estimation. Linear quadratic Gausian control problem. Computational considerations. Nonlinear control problem in stochastic systems. Prerequisite: CHE 433 or ME 433 or ECE 433 or consent of instructor.

CHE 438. Process Modeling and Control Seminar (1) fall/spring
Presentations and discussions on current methods, approaches, and applications. Credit cannot be used for the M.S. degree.

CHE 439 (BIOE 439) Neuronal Modeling and Computation (3)
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). Prerequisites: Graduate standing in Chemical Engineering or Bioengineering, or permission of instructor.

CHE 440. Chemical Engineering in the Life Sciences (3)
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. Prerequisite: Bachelor's degree in science or engineering.

CHE 441 (BIOE 441). Biotechnology I (3) fall
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 (BIOE 442). Biotechnology II (3) spring
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)
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. Prerequisite: Consent of the instructor.

CHE 446. Biochemical Engineering Laboratory (3)
Laboratory and pilot-scale experiments in fermentation and enzyme technology, tissue culture, and separations techniques. Prerequisites: CHE 341 and CHE 444 or CHE 342 previously or concurrently. Closed to students who have taken CHE 346.

CHE 447 (BIOE 447). Molecular Bioengineering (3)
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)
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. Prerequisite: Consent of the instructor.

CHE 449 (BIOE 449) Metabolic Engineering (3)
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. Prerequisite: Graduate standing in Chemical Engineering or Bioengineering, or permission of instructor.

CHE 450. Special Topics (1-12)
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)
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 (ME/ENGR 452). Mathematical Methods in Eng. I (3) Fall
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 Apprentice Teaching (1)
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. Prerequisites: Graduate student in ChE department. Course may be repeated for up to three credits.

CHE 455. Seminar (1-3) fall/spring
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)
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 464. Numerical Methods in Engineering (3)
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. (CE 473) Environmental Separation and Control (3)
Theory and application of adsorption, ion exchange, reverse osmosis, air stripping and chemical oxidation in water and wastewater treatment. Modeling engineered treatment processes. Prerequisite: CE 470 or consent of the instructor.

CHE 480. Research (3)
Investigation of a problem in chemical engineering.

CHE 481. Research (3)
Continuation of CHE 480.

CHE 482. (CHM 482, MAT 482) Mechanical Behavior of Polymers (3)
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. (CHM 483) Emulsion Polymers (3) fall
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. (CHM 485, MAT 485) Polymer Blends and Composites (3) spring, every other year
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. Prerequisite: any introductory course in polymers.

CHE 486. Polymer Processing (3)
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, calendering, coating, molding, fiber spinning and elastic phenomena. Prerequisite: CHE 392 or equivalent.

CHE 487. Polymer Interfaces (3) spring, every other year
An intensive study of polymer surfaces and interfaces, with special emphasis on thermodynamics, kinetics, and techniques for characterization. Chemistry and physics of adsorbed polymer chains. Diffusion and adhesion at polymer-polymer interfaces, especially as related to mechanical properties such as fracture and toughness will be described. Prerequisite: Introductory polymer course.

CHE 492. (CHM 492) Topics in Polymer Science (3)
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. Prerequisite: CHEM 392 or equivalent.

Chemistry

Professors. Robert A. Flowers, II, Ph.D. (Lehigh), chair, Danser Distinguished Faculty Chair in Chemistry; Ned D. Heindel, Ph.D. (Delaware), Howard S. Bunn Professor of Chemistry; Steven L. Regen, Ph.D. (M.I.T.), University Distinguished Professor; Keith J. Schray, Ph.D. (Penn State).

Associate professors. Gregory S. Ferguson, Ph.D. (Cornell); Natalie Foster, Ph.D. (Lehigh); Tianbo Liu, Ph.D. (SUNY at Stony Brook); James E. Roberts, Ph.D. (Northwestern).

Assistant professors. K. Jebrell Glover, Ph.D. (California-San Diego); Kai Landskron, Ph.D. (Ludwig Maximillians-Munich); David T. Moore, Ph.D. (UNC-Chapel Hill); Marcos M. Pires, Ph.D. (Purdue); Damien Thévenin, Ph.D. (Delaware); Dmitri V. Vezenov, Ph.D. (Harvard).

Professors of Practice. Rebecca S. Miller, Ph.D. (Duke), *graduate administrator*; R. Sam Niedbala, Ph.D. (Lehigh).

Active emeriti. Kamil Klier, Ph.D. (Czechoslovak Academy of Science, Prague); Daniel Zeroka, Ph.D. (University of Pennsylvania).

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 Chemistry 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.

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)

B.S. Chemistry Analytical/Physical

B.S. Chemistry Polymers

B.S. Chemistry Materials {*, a, **}

B.A. Chemistry

B.A. Chemistry Business

B.A. Chemistry Health Professions {*, a or b, **}

B.S. Pharmaceutical Chemistry {*, a or b, **}

B.S. Biochemistry (interdepartmental degree) {*, a or b, **}

*	*Common Chemistry Core*
**	*Courses required for specific concentration*
a	*Path A*
b	*Path B*

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 30 and CHM 40 have similar course content. If both courses are taken, only credit for CHM 40, the more advanced course, will be awarded.

Common Chemistry Core

CHM 40/41 (or CHM 30/31)	8 credits	Introductory chemistry
CHM 110,111,112,113	8 credits	Organic Chemistry
CHM 332	3 credits	Analytical chemistry
See Concentrations	3-8 credits	Physical chemistry
CHM 201*	2 credits	Technical writing
CHM 301**	1 credit	Undergraduate seminar
CHM 307	3 credits	Advanced inorganic chemistry
		Total = 25 credits

**Other writing intensive courses may be substituted with the approval of the advisor but any substitute course should have a science focus.*

***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 21	4 credits	Calculus I
Math 22	4 credits	Calculus II
Math 23	4 credits	Calculus III
Math 205	3 credits	Linear methods
Phy 11,12	5 credits	Introductory Physics I and lab
Phy 21,22	5 credits	Introductory Physics II and lab
Engr 1 or CSE 15	3 credits	Survey of Computer Science
		Total=28 credits

Path B

Math 51	4 credits	Survey of Calculus I
Math 52	3 credits	Survey of Calculus II
Math 43	3 credits	Survey of Linear Methods
Phy 10,12	5 credits	General Physics I and lab
Phy 13,22	4 credits	General Physics II and lab
		Total=19 credits

Specializations

B.S. Chemistry (ACS certified Degree)

Common core, Path A, and the following

CHM 334	3 credits	Advanced chemistry laboratory I
CHM 335	3 credits	Advanced chemistry laboratory II
CHM 341	3 credits	Molecular Structure, Bonding and Dynamics
CHM 342	3 credits	Thermodynamics and Kinetics
CHM 343	2 credits	Physical chemistry laboratory
CHM 371	3 credits	Elements of biochemistry I
CHM 3**	3 credits	Adv. Chem. elective ***
		Total = 20 credits

****See list of choices which follows.*

Advanced Chemistry Elective Requirement

One 3-credit course selected from the following:

CHM 358	Advanced Organic Chemistry
CHM 372	Elements of Biochemistry II
CHM 376	Advanced Chemistry Research Lab
CHM 391	Colloid and Surface Chemistry
CHM 392	Introduction to Polymer Science
CHM 393	Physical Polymer Science
CHM 394	Organic Polymer Science
PHY 363	Physics of Solids

B.S. Chemistry - Analytical/Physical Concentration

Common core, Path A, and the following

CHM 334	3 credits	Advanced chemistry laboratory I
CHM 335	3 credits	Advanced chemistry laboratory II
CHM 341	3 credits	Molecular Structure, Bonding and Dynamics
CHM 342	3 credits	Thermodynamics and Kinetics
CHM 343	2 credits	Physical chemistry laboratory
		Total = 14 credits

B.S. Chemistry - Polymers Concentration

Common core, Path A, and the following

CHM 341	3 credits	Molecular Structure, Bonding and Dynamics
CHM 342	3 credits	Thermodynamics and Kinetics
CHM 343	2 credits	Physical chemistry laboratory
CHM 388	3 credits	Polymer synthesis and characterization lab
CHM 393	3 credits	Physical polymer science
CHM 394	3 credits	Organic polymer science
		Total = 17 credits

B.S. Chemistry - Materials Concentration

CHM 334	3 credits	Advanced chemistry laboratory I
CHM 335	3 credits	Advanced chemistry laboratory II
CHM 341	3 credits	Molecular Structure, Bonding and Dynamics
CHM 342	3 credits	Thermodynamics and Kinetics
CHM 343	2 credits	Physical chemistry laboratory
MAT 33	3 credits	Engineering materials and processing
		Total = 17 credits

B.A. Chemistry

Common core, Path A or B and the following:

CHM 341, CHM 342 or CHM 194	3 credits	Physical chemistry
CHM 343	2 credits	Physical chemistry laboratory
	3 credits	CHM elective
		Total = 8 credits

B.A. Chemistry - Business Concentration

Common core, Path A or B, and the following:

CHM elective	3 credits	
CHM 341, CHM 342, or CHM 194	3 credits	Physical chemistry
CHM 343	2 credits	Physical chemistry laboratory
ECO 1	4 credits	Principles of economics
BUS 125	1 credit	Behavioral skills workshop
BUS 126	3 credits	Information analysis and financial decision making I
BUS 127	3 credits	Information analysis and financial decision making II
BUS 225	3 credits	Developing, producing, and marketing products and services I
BUS 226	3 credits	Developing, producing, and marketing products and services II
BUS 326	1 credit	Business strategy
MATH 12***	4 credits	Basic Statistics
		Total = 30 credits

B.A. Chemistry - Health Professions Concentration

Common core, Path A or B, and the following:

CHM elective	3 credits	
CHM 341 or 342 or 194	3 credits	Physical chemistry
CHM 343	2 credits	Physical chemistry laboratory
BIOS 115, 116	4 credits	Biology Core II: Genetics & Genetics Laboratory
BIOS 41,42	4 credits	Biology Core I: Cellular and Molecular
MATH 12***	4 credits	Statistics

Additional courses in BioS are recommended.

Total = 20 credits

B.S. Pharmaceutical Chemistry

Common core, Path A or B, and the following:

CHM 194 (or 341 or 342)	3 credits	Physical Chemistry for Biological Sciences
CHM 358	3 credits	Advanced organic
CHM 371	3 credits	Elements of biochemistry I
CHM 372	3 credits	Elements of biochemistry II
CHM 3**	3 credits	Advanced chemistry elective
BIOS 41,42	4 credits	Biology Core I: Cellular and Molecular
BIOS 115	3 credits	Biology Core II: Genetics
MATH 12***	4 credits	Basic Statistics
		Total = 26 credits

****MATH 12 may be substituted by any statistics course.*

Model Roster When Path A is Followed

freshman year (29-30 credits)

	College Seminar (3-4)
Chm 40	Concepts, Models and Experiments I (4)
Chm 41	Concepts, Models and Experiments II (4)
Engl 1	Composition and Literature I (3)
Engl 2	Composition and Literature II (3)
Math 21	Calculus I (4)
Math 22	Calculus II (4)
Phy 10	General Phys. I (4)
Phy 12	Intro. Phys. Lab I (1)

sophomore year (32 credits)

Chm 110	Organic Chemistry I (3)
Chm 112	Organic Chemistry II (3)
Chm 111	Organic Chemistry Lab I (1)
Chm 113	Organic Chemistry Lab II (1)
Phy 21	Intro. Phys. (4)
Phy 22	Intro. Phys. Lab (1)
Math 23	Calculus III (4)
Math 43	Survey of Linear Methods (3)
Engr 1 or CSE 12	Engineering Computations (3) or Survey of Computer Science (3)
	distribution requirements - free electives (9)

Note that some concentrations would insert courses such as MATH 12, BIOS 41/42 (B.S. Pharmaceutical Chemistry), ECO 1 (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

freshman year (29-30 credits)

	College Seminar (3-4)
Chm 40	Concepts, Models and Experiments I (4)
Chm 41	Concepts, Models and Experiments II (4)

Engl 1	Composition and Literature I (3)
Engl 2	Composition and Literature II (3)
Math 51	Survey of Calculus 1 (4)
Math 52	Survey of Calculus II (3)
Phy 10	Intro. Phys. I (4)
Phy 12	Intro. Phys. Lab I (1)

sophomore year (30 credits)

Chm 110	Organic Chemistry I (3)
Chm 112	Organic Chemistry II (3)
Chm 111	Organic Chemistry Lab I (1)
Chm 113	Organic Chemistry Lab II (1)
Phy 13	General Phys. (3)
Phy 22	General Phys. Lab (1)
Math 43	Survey of Linear Algebra (3)
	distribution requirements - free electives (15)

Note that some concentrations would insert courses such as MATH 12, BIOS 41/42 (B.S. Pharmaceutical Chemistry), ECO 1 (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

I. College distribution	24 credits
II. Physics, math, and computing	28 credits
III. Chemistry	46 credits
IV. Unrestricted electives	25 credits
Total credits	123 credits

Model Roster

freshman year (30-31 credits)

A student should follow the normal freshman year in the College of Engineering and Applied Science and observe the following note.

Note: It is recommended that, where possible, students planning to major in chemistry take Chemistry 40 in the fall semester and Chemistry 41 in the spring semester of the freshman year. For such students the elective in the spring semester is displaced to a subsequent semester. The Chemistry 30/31 sequence may be substituted.

sophomore year, first semester (17 credits)

CHM 110	Organic Chemistry I (3)
CHM 111	Organic Chemistry Laboratory I (1)
PHY 21	Introductory Physics II (4)
PHY 22	Introductory Physics Laboratory II (1)
MATH 23	Calculus III (4)
	modern foreign language requirement (4)

(See details in introduction)

sophomore year, second semester (15 credits)

CHM 112	Organic Chemistry II (3)
CHM 113	Organic Chemistry Laboratory II (1)
MATH 205	Linear Methods (3)
Eco 1	Economics (4)
	Humanities/Social Science requirement (4)

junior year, first semester (16-17 credits)

CHM 201	Technical Writing (2) or approved writing-intensive course (3)
CHM 332	Analytical Chemistry (3)
CHM 334	Advanced Chem. Lab 1 (3)
CHM 341	Molecular Structure, Bonding and Dynamics (3)
	Distribution requirement/elective (4)
	modern foreign language requirement (4) (See details in introduction)

junior year, second semester (15 credits)

CHM 307	Advanced Inorganic Chem. (3)
CHM 335	Advanced Chem. Lab II (3)
CHM 342	Thermodynamics and Kinetics (3)
CHM 343	Physical Chemistry Laboratory (2)
	modern foreign language requirement (4)
	free electives (4)

senior year, first semester (14 credits)

CHM 301	Chemistry Seminar (1)
CHM 371	Elements of Biochemistry I (3)
	Advanced chemistry elective (3)
	Distribution requirement (7)

senior year, second semester (14 credits)

	Advanced chemistry elective (3)*,**
	free electives (11)

**See list of choices for the advanced chemistry elective requirement under the B.S. degree in chemistry/College of Arts and Sciences.*

***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 for details of the major.

Minor in Chemistry

A minor in chemistry may be achieved by completing the following requirements:

CHM 31	Chemical Equilibria in Aqueous Systems (4) or
CHM 41	Concepts Models, Exper. II (4)
CHM 110	Organic Chemistry I (3)
CHM 111	Organic Chemistry Laboratory I (1)
CHM 332	Analytical Chemistry (3)
CHM 341	Molecular Structure, Bonding and Dynamics (3) or
CHM 342	Thermodynamics and Kinetics (3)
CHM 343	Physical Chemistry Lab (2)
Total Credits	(16 credits)

Necessary pre- or co-requisites for the above would be CHM 30 or 40 and MATH 21.

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.

Undergraduate Courses in Chemistry

CHM 5. Chemistry and National Issues (3)
For majors other than science and engineering. Chemistry and current controversies. The atmosphere: global warming, ozone depletion, pollution. Water pollution and treatment. Energy generation and side effects. Health: chemicals of life, drugs, carcinogens, personal care. Materials: natural and synthetic. Food: production and preservation. Chemistry: benefits and liabilities. (NS)

CHM 30. Introduction to Chemical Principles (4) fall-spring
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. (NS)

CHM 31. Chemical Equilibria in Aqueous Systems (4) fall-spring
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. Prerequisite: CHM 30, MATH 21, 31 or 51. Three lectures and one three-hour laboratory period. (NS)

CHM 40. Concepts, Models and Experiments I (4) fall
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. (NS)

CHM 41. Concepts, Models and Experiments II (4) spring
Continuation of Chemistry 40. Three lectures, one laboratory. Prerequisite: CHM 40 and Math 21, 31 or 51 or departmental consent. (NS)

CHM 110. Organic Chemistry I (3) fall
Systematic survey of the typical compounds of carbon, their classification, and general relations; study of synthetic reactions. Prerequisite: CHM 30 or 40. (NS)

CHM 111. Organic Chemistry Laboratory I (1) fall
Preparation of pure organic compounds. Modern techniques of characterization. Prerequisite: CHM 110 previously or concurrently. (NS)

CHM 112. Organic Chemistry II (3) spring
Continuation of CHM 110. Prerequisite: CHM 110. (NS)

CHM 113. Organic Chemistry Laboratory II (1) spring
Continuation of Organic Chemistry Laboratory I. Prerequisite: CHM 111 previously; CHM 112 previously or concurrently. (NS)

CHM 177. Introduction to Research (1-2) fall-spring
For advanced freshmen and sophomore chemistry majors. May be repeated for credit. Prerequisite: Consent of department chair. (NS)

CHM 194. Physical Chemistry for Biological Sciences (3) spring
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. Prerequisite: CHM 31 or 41. (NS)

CHM 201. Technical Writing (2)
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. Prerequisite: junior standing in chemistry major or consent of the department chair. (ND)

CHM 250. Special Topics (1-3)
Selected topics in chemistry. May be repeated for credit when different topics are offered. (NS)

CHM 301. Chemistry Seminar (1)
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. Prerequisite: Senior standing. (NS)

CHM 307. Advanced Inorganic Chemistry (3) spring
Introduction to transition metal complexes; theories of bonding; kinetics and mechanisms of transition metal complex reactions; selected aspects of organometallic chemistry; bioinorganic chemistry. Prerequisite: CHM 194 or 341. (NS)

CHM 312. (CHE 312, MAT 312) Fundamentals of Corrosion (3) fall
Corrosion phenomena and definitions. Electrochemical aspects including reaction mechanisms, thermodynamics, Pourbaix diagrams, kinetics of corrosion processes, polarization and passivity. Non-electrochemical corrosion including mechanisms, theories and quantitative descriptions of atmospheric corrosion. Corrosion of metals under stress. Cathodic and anodic protection, coatings alloys, inhibitors, and passivators. Prerequisite: MAT 205 or CHM 342. (NS)

CHM 332. Analytical Chemistry (3) fall
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: CHM 31 and 110. (NS)

CHM 334. Advanced Chemistry Laboratory I (3) fall
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: one year of organic chemistry. Prerequisite: CHM 110, 111, 112, 113 and pre- or co-requisite: CHM 332 (NS)

CHM 335. Advanced Chemistry Laboratory II (3) spring
Content related to CHM 334. Prerequisite: CHM 110, 111, 112, 113, 332 and 334.

CHM 336. Clinical Chemistry (3) spring
Applications of analytical chemistry to clinical problems. Discussion of methods in common use and the biochemicalmedical significance of the results. Prerequisites: CHM 332 and 112. (NS)

CHM 337. (MAT 333), (EES 337) Crystallography and Diffraction (3)
Introduction to crystal symmetry, point groups, and space groups. Emphasis on materials characterization by Xray 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. Prerequisite: MAT 203 or EES 131 or senior standing in chemistry. (NS)

CHM 341. Molecular Structure, Bonding and Dynamics (3)
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 selections rules. Interpretation of electronic, vibrational and rotational spectra. Prerequisites: CHM 31 or 41, Phy 13 or 21, Math 22 or 32. (NS)

CHM 342. Thermodynamics and Kinetics (3)
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. Prerequisite: CHM 31 or 41, Phy 13 or 21, Math 22 or 32. (NS)

CHM 343. Physical Chemistry Laboratory (2)
Laboratory studies that illustrate and extend the various fields of study in experimental physical chemistry as discussed in CHM 341 and CHM 342. Prerequisite: CHM 194 or CHE 210 or prerequisite CHM 341 and co-requisite CHM 342. This course fulfills the junior year writing course requirement in CAS. (NS).

CHM 350. Special Topics (1-3)
Selected advanced topics in chemistry. May be repeated for credit when different topics are offered. (NS)

CHM 358. Advanced Organic Chemistry (3) fall
Reaction mechanism types and supporting physical-chemical data. Classes of mechanisms include elimination, substitution, rearrangement, oxidation-reduction, enolate alkylations, and others. Prerequisite: one year of organic chemistry. (NS)

CHM 371. (BIOS 371) Elements of Biochemistry I (3) fall
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. Prerequisite: one year of organic chemistry. (NS)

CHM 372. (BIOS 372) Elements of Biochemistry II (3) spring
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. Prerequisite: CHM 371 and BIOS 41 or consent of the instructor. (NS)

CHM 375. Research Chemistry Laboratory (1-3) fall-spring
An introduction to independent study or laboratory investigation under faculty guidance. Prerequisite: consent of faculty research supervisor. (NS)

CHM 376. Advanced Research Chemistry Laboratory (1-6) fall-spring
Advanced independent study or laboratory investigation under faculty guidance. Prerequisite: 3 credits of CHM 375. Consent of faculty research supervisor. May be repeated for credit. (NS)

CHM 377. (BIOS 377) Biochemistry Laboratory (3) fall
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. Prerequisite: CHM 371, previously or concurrently, and BIOS 41 or consent of the instructor. (NS)

CHM 378. (BIOS 378) Biochemical Preparations (1-3) spring
A laboratory course involving the preparation or isolation, purification and identification of chemicals of biological origin. Prerequisites: CHM 377 and 372, previously or concurrently. (NS)

CHM 388. (CHE 388, MAT 388) Polymer Synthesis and Characterization Laboratory (3)
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: CHM 342 and 110. (NS)

CHM 391. (CHE 391) Colloid and Surface Chemistry (3)
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. Prerequisite: CHM 342 or equivalent. Chaudhury. (NS)

CHM 392. (CHE 392) Introduction to Polymer Science (3) spring
Introduction to concepts of polymer science. Kinetics and mechanisms of polymerization; synthesis and processing of polymers, characterization. Relationship of molecular conformation, structure and morphology to physical and mechanical properties. Prerequisite: CHM 342 or equivalent. (NS)

CHM 393. (CHE 393, MAT 393) Physical Polymer Science (3) fall
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. Prerequisite: one year of physical chemistry. (NS)

CHM 394. (CHE 394) Organic Polymer Science I (3) spring
Organic chemistry of synthetic high polymers. Polymer nomenclature, properties, and applications. Functionality and reactivity or 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. Prerequisites: one year of physical chemistry and one year of organic chemistry. (NS)

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 though 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.

The Master of Science in Chemistry degree requires a total of 30 credits, and may be obtained by one of three options: 1) a minimum of 30 course credits, 2) a minimum of 27 course credits and a 3 credit literature review paper (taken under CHM 421, Chemistry Research), or 3) a minimum of 24 course credits and 6 credits of experimental research (CHM 421). Each option requires a minimum of 18 credits at the 400 level (15 of which must be in chemistry) and one credit of CHM 481 (Seminar). 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.

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.

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 polmer 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), photocorrelation spectroscopy 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).

Graduate Courses in Chemistry

CHM 400. First Year Graduate Student Seminar (0) fall
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 403. Advanced Topics in Inorganic Chemistry (1-3)
Topics of contemporary interest in inorganic chemistry. This course may be repeated when a different topic is offered. Prerequisite: CHM 307 or equivalent.

CHM 405. Organometallic Chemistry (3)
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) spring
Introduction to transition metal complexes; theories of bonding; kinetics and mechanisms of transition metal complex reactions; selected aspects of organometallic chemistry; bio-inorganic chemistry. Prerequisite: one semester of physical chemistry, CAS graduate student status.

CHM 421. Chemistry Research (1-6)
Research in one of the following fields of chemistry: analytical, inorganic, organic, physical, polymer, biochemistry.

CHM 423. Bio-organic Chemistry (3)
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. Prerequisite: CHM 358 or equivalent.

CHM 424. Medicinal and Pharmaceutical Chemistry (3)
Principles of drug design, structureactivity relationships in antibacterial, antimalarial, antiinflammatory and psychoactive drugs; synthesis and modes of action of pharmacologically active agents radioactive pharmaceuticals. Prerequisite: CHM 358 or equivalent.

CHM 425. Pharmaceutical Regulatory Affairs 1: Drug Discovery to Approval (3)
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.

CHM 428. Pharmaceutical Regulatory Affairs 2: Biomarkers for Pharmaceutics and Diagnostics: Laws and Regulations (3)
Regulations have set in motion the use of Biomarkers as a key element for pharmaceutical development. Biomarkers 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/regulations in the United States. It will also define the current scientific requirements for Biomarkers to meet new regulations. Case studies will provide examples for the use of Biomarkers in pharmaceutical development as well as Design Controls, Quality System Regulations, Manufacturing Requirements for Diagnostic testing technologies.

CHM 430. Chemical and Biochemical Separations (3)
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)
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)
Mathematical and statistical methods for experimental design, calibration, signal resolution, and instrument control and optimization.

CHM 434. Advanced Topics in Spectroscopy (3)
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)
Topics of contemporary interest in analytical chemistry. May be repeated for credit when a different topic is offered.

CHM 437. (BIOS 437) Pathophysiological Chemistry (3)
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. Prerequisite: One semester of biochemistry.

CHM 438. Analytical Chemistry (3) fall
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. Prerequisite: CAS graduate student status.

CHM 441. Chemical Kinetics (3) alternate years
A study of kinetic processes. Phenomenological chemical kinetics; order, mechanism effect of external variables on rate. Theories of the rate constant. Relation between thermodynamics and kinetics. Applications to selected systems such as unimolecular decompositions, molecular

beams and diffusion-limited processes. Prerequisite: one year of physical chemistry.

CHM 442. Pharmaceutical Regulatory Affairs 3: Analytical Methods, Validation, and Data Manipulation (3)
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. (MAT 443) Solid-State Chemistry (3)
Crystal structure, diffraction in crystals and on surfaces, bonding and energy spectra in solids dielectrics, surface states and surface fields in crystals. Prerequisite: one course in linear algebra and one course in quantum mechanics.

CHM 444. Molecular Structure, Bonding and Dynamics (3)
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 selections rules. Interpretation of electronic, vibrational and rotational spectra. Prerequisites: CAS graduate student status.

CHM 451. Physical Organic Chemistry (3)
An introduction to quantitative organic chemistry including relationships between structure and reactivity, medium effects on reactions, introduction to orbital symmetry effects in organic reactions, and reaction mechanisms. Prerequisite: CHM 358 or equivalent.

CHM 452. Advanced Organic Chemistry (3) fall
Reaction mechanism types and supporting physical chemical data. Classes of mechanisms include elimination, substitution, rearrangement, oxidation reduction, enolate alkylations, and others. Prerequisites: one year of organic chemistry and CAS graduate student status.

CHM 453. Heterocyclic Compounds (3)
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. Prerequisite: CHM 358 or equivalent.

CHM 455. Organic Reactions (3)
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. Prerequisite: CHM 358 or equivalent.

CHM 456. Spectral Analysis (3) spring
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)
Intensive inclass 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. Prerequisite: CHM 358 or equivalent.

CHM 458. Topics in Organic Chemistry (1-3)
An intensive study of limited areas in organic chemistry. May be repeated when a different topic is offered.

CHM 463. Pharmaceutical Regulatory Affairs 4: Commercial Production, Validation, and Process Qualification (3)
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 466. Advanced Organic Preparations (2-3)
A laboratory course of instruction in advanced techniques of the preparation of organic compounds.

CHM 467. (BIOS 467) Principles of Nucleic Acid Structure (3)
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. Prerequisite: one year of biochemistry and one year of physical chemistry or permission of the department chair.

CHM 468. (BIOS 468) Principles of Protein Structure (3)
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. Prerequisites: one year of biochemistry and one year of physical chemistry or permission of the department chair.

CHM 469. (BIOS 469) Biochemical Problem Solving I (1) fall
Applications of material covered in BIOS/CHM 371 including techniques used in research. Prerequisite: BIOS/CHM 371 previously or concurrently.

CHM 470. (BIOS 470) Biochemical Problem Solving II (1) spring
Applications of concepts covered in BIOS/CHM 372 including techniques used in research. Prerequisite: BIOS/CHM 372 previously or concurrently.

CHM 471. (BIOS 471) Eucaryotic Biochemistry (3)
Biochemistry of selected eucaryotic processes including hormone chemistry, blood clotting, immunochemistry, vision chemistry, muscle chemistry and photosynthesis. The second part of the course will involve presentation and discussion of the current literature by class participants. Prerequisite: BIOS/CHM 372 or consent of department chair.

CHM 472. (BIOS 472) Lipids and Membranes (3)
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. Prerequisite: BIOS/CHM 372 or consent of department chair.

CHM 474. Pharmaceutical Regulatory Affairs 5: Pharmaceutics (3)
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. (NS)

CHM 475. Advanced Topics in Chemistry (1)
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)
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. Prerequisite: One semester of biochemistry.

CHM 479. (BIOS 479) Biochemical Techniques (3)
Laboratory studies of the techniques and principles involved in the isolation, identification, and biochemical transformation of carbohydrates, lipids, nucleic acids and proteins. Prerequisite: CHM 371 or its equivalent previously or concurrently.

CHM 480. (BIOS 480) Advanced Biochemical Preparations (1-3)
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. Prerequisite: Two semesters of biochemistry.

CHM 481. Chemistry Seminar (1)
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.

CHM 487. Topics in Colloid and Surface Chemistry (3)
Applications of colloid chemistry; special topics in surface chemistry. Lectures and seminar. May be repeated for credit as different topics are covered. Prerequisite: CHM 391.

CHM 488. Advanced Topics in Physical Chemistry (1-3)
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.

CHM 489. Organic Polymer Science II (3)
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. Prerequisite: CHM 394 or equivalent.

CHM 494. Quantum Chemistry (3)
Principles and applications of quantum mechanics to chemical problems. Applications to chemical bonding, molecular structure, reactivity and spectroscopy. Prerequisite: CHM 444 or equivalent.

CHM 495. Statistical Thermodynamics (3)
Principles and applications of statistical mechanics to chemical problems. A study of the techniques for evaluating the properties of matter in bulk from the properties of molecules and their interactions. Prerequisite: CHM 444 or equivalent.

Civil and Environmental Engineering

Professors. Stephen P. Pessiki (Cornell), chair and P.C. Rossin Professor; Sibel Pamukcu, Ph.D. (L.S.U.), associate chair; John L. Wilson, Ph.D. (Pittsburgh), director of graduate studies and research; Dan M. Frangopol, Sc. D. (U. Liàge, Belgium), Fazlur R. Khan Endowed Chair of Structural Engineering and Architecture; Gerard P. Lennon, Ph.D. (Cornell), Deputy Provost for Academic Affairs; James Ricles, Ph.D. (U.C. Berkeley), director of RealTime Multidirectional Earthquake Simulation Facility, and Bruce G. Johnston Professor; Richard Sause, Ph.D. (U.C. Berkeley), director of Center for Advanced Technology for Large Structural Systems and Joseph T. Stuart Professor; Arup K. SenGupta, Ph.D. (Houston), P.C. Rossin Professor; Richard N. Weisman, Ph.D. (Cornell).

Associate professors. Derick Brown, Ph.D. (Princeton); Kristen L. Jellison, Ph.D. (M.I.T.); Peter Mueller, Dr. sc. techn. (ETH, Zurich); Clay Naito, Ph.D. (U.C. Berkeley);.

Assistant professors. Shamim N. Pakzad, Ph.D. (U.C. Berkeley); Muhannad T. Suleiman, Ph.D. (Iowa State).

Professor of Practice. Jennifer H. Gross, M.S. (U. of Texas - Austin).

Active emeriti. John W. Fisher, Ph.D. (Lehigh); Le Wu Lu, Ph.D. (Lehigh); Alexis Ostapenko, Sc.D. (M.I.T.); Robert M. Sorensen, Ph.D. (U.C. Berkeley); David A. VanHorn, Ph.D. (Iowa State); Ben-Tseng Yen, Ph.D. (Lehigh).

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 accredited Civil Engineering Bachelor of Science degree **Program Educational Objectives** are, Civil Engineering: (1) graduates will develop careers in civil engineering and other professionally related fields. (2) graduates will recognize the need for life-long learning and will seek additional professional training and personal development. (3) graduates will be productive members of multi-disciplinary teams and will apply their skills to develop innovative solutions and technologies. (4) graduates will pursue professional licensure. (5) graduates will advance in position to be leaders in their profession and will become members of professional societies.

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 ABET accredited Environmental Engineering Bachelor of Science program are: (1) graduates will develop careers in environmental engineering and other professionally related fields. (2) graduates will recognize the need for life-long learning and will seek additional professional training and personal development. (3) graduates will be productive members of multi-disciplinary teams and will apply their skills to develop innovative solutions and technologies. (4) graduates will pursue professional licensure. (5) graduates will advance in position to be leaders in their profession and will become members of professional societies.

A technical minor in Environmental Engineering, available for students outside the department, consists of a prerequisite (CHM 31), three courses chosen from CEE 170, CEE 274, CEE 373 (CHE 373), and CEE 375 (CHE 375), and one additional course from the required list or from CEE 222, CEE 323 (EES 323), CEE 327 (EES 327), CEE 345, CEE 371, CHE 331, CHE 370, EES 353, and EES 376. At least two of the courses must be from the CEE department.

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; Civil Engineering and Earth and Environmental Sciences).

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.

Recommended Sequence of Courses, B.S. in Civil Engineering

The normal freshman engineering year is 29 credits (see Section III). The HSS Advanced Requirement of 13 credits is shown below as three 3-credit courses and one 4-credit course. Other options are possible.

sophomore year, first semester (17 credit hours)

MATH 23	Calculus III (4)
MECH 3	Fundamentals of Engineering Mechanics (3)
CEE 10	Engineering/Architectural Graphics and Design (3)
CEE 11	Surveying (1)
CEE 12	Civil Engineering Statistics (2)
HSS	Elective or ECO 1 Principles of Economics (4)

sophomore year, second semester (18 credit hours)

MATH 205	Linear Methods (3)
MECH 12	Strength of Materials (3)
CEE 170	Introduction to Environmental Engineering (4)
PHY 21	Introductory Physics II (4)
PHY 22	Introductory Physics Lab II (1)
HSS	Humanities/Social Sciences Elec.

(3)

junior year, first semester (17 credit hours)

MAT 33	Engineering Materials and Processes (3)
CEE 121	Mechanics of Fluids (3)
CEE 123	Civil Engineering Materials (1)
CEE 142	Soil Mechanics (3)
CEE 159	Structural Analysis I (4)
	*Engineering Science Elective (3)

junior year, second semester (17 credit hours)

CEE 117	Numerical Methods in Civil Engineering (2)
CEE 202	CEE Planning and Engineering Economics (3)
CEE 262	Fund. of Structural Steel Design (3) or
CEE 264	Fund. of Structural Concrete Design (3)
CEE 222	Hydraulic Engineering (3)
CEE 242	Geotechnical Engineering (3)
CEE	**Approved Elective (3)

senior year, first semester (18 credit hours)

CEE 203	Professional Development (2)
HSS	Humanities/Social Sciences Elec. (7)
CEE	**Approved Electives (6)
	Free Elective (3)

senior year, second semester (17 credit hours)

CEE 290	*** Capstone Design (3)
HSS	Humanities/Social Science Elective (3)
CEE	**Approved Electives (8)
	Free Elective (3)

**MECH 102, ME 104, or ECE 83/81.*

***Seventeen CEE elective credits approved by the CEE department chairperson; list available from department.*

****Students must have completed successfully at least one CE approved elective related to the design project topic area.*

Elective opportunities total 36 credit hours. The selection of elective courses is to be in consultation with student's academic adviser in the Department of Civil and Environmental Engineering. A total of 133 credit hours are required for the bachelor's degree in civil engineering.

Recommended Sequence of Courses, B.S. in Environmental Engineering

The normal freshman engineering year is 29 credits (see Section III). The HSS Advanced Requirement of 13 credits is shown below as three 3-credit courses and one 4-credit course. Other options are possible.

sophomore year, first semester (17 credit hours)

MATH 23	Calculus III (4)
CHM 110	Organic Chemistry I (3)
CHM 111	Organic Chem Lab (1)
MECH 2 or 3	Elementary Engineering Mechanics (3)
CEE 12	Civil Engineering Statistics (2)
ECO 1	Principles of Economics (4)

sophomore year, second semester (18 credit hours)

MATH 205	Linear Methods (3)
PHY 21	Intro Physics II (4)
PHY 22	Intro Physics II Laboratory (1)
CEE 170	Intro. Environmental Engr. (4)
CEE 272	Environmental Risk Assessment (2)
HSS	*Humanities/Social Sciences Elective (4)

junior year, first semester (16 credit hours)

CEE 121	Mechanics of Fluids (3)
CEE 142	Soil Mechanics (3)
CEE 375	Env. Engineering Processes (3)
CHE 31	Matl. & Energy Bal. of CHE Process (3)
ESR	***Earth Science Requirement (3)
EES 22	Exploring Earth (1)

junior year, second semester (17 credit hours)

CEE 202	CEE Planning and Engineering Economics (3)
CEE 222	Hydraulic Engineering (3)
CEE 274	Environmental Water Chemistry (3)
CHE 60	Unit Ops Survey (3)
CEE 275	Enviro-Geo-Hydraulics Lab (2)
EBR	****Environmental Biology Requirement (3)

senior year, first semester (17 credit hours)

CEE 203	Professional Development (2)
CEE 378	Solid & Haz. Waste Management (3)
CEE 379	Environmental Case Studies (3)
AE	**Approved Elective (3)
HSS	*Humanities/Soc. Sciences Elective (3)
FE	Free Elective (3)

senior year, second semester (18 credit hours)

CEE 377**	Environmental Engineering

	Project (3)
AE	**Approved Electives (6)
HSS	*Humanities/Social Sci. Elective (6)
FE	Free Elective (3)

**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.*

***9 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.*

A total of 132 credits are required for the bachelor's degree in Environmental Engineering.

Undergraduate Courses

CEE 10. (ARCH 10) Engineering/Architectural Graphics and Design (3) fall
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 10.

CEE 11. Surveying (1) fall
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 12. Civil Engineering Statistics (2) fall
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 104. Readings in Civil Engineering (1-4)
Study of selected technical papers, with abstracts and reports. May be repeated for credit. Prerequisite: consent of the department chair.

CEE 117. Numerical Methods in Civil Engineering (2) spring
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: Engineering 1, MATH 205.

CEE 121. Mechanics of Fluids (3) fall
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. Prerequisite: MECH 2 or 3.

CEE 123. Civil Engineering Materials (1) spring
Properties of commonly used civil engineering materials focusing on concrete. Concrete coverage includes cement chemistry and manufacture; cement hydration and microstructure; mixture design; mechanical properties; admixtures; in-service performance and deterioration mechanisms. Includes some laboratory work. (ES 1)

CEE 142. Soil Mechanics (3) Fall
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. Prerequisite: MECH 3 or 2.

CEE 159. Structural Analysis I (4) fall
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. Prerequisite: MECH 12.

CEE 170. Introduction to Environmental Engineering (4) spring
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: CHM 30.

CEE 171. (CHE 171, ES 171) Fundamentals of Environmental Technology (4)
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. Prerequisites: EES (ES) 002, or one advanced science course, or permission of instructor. Not available to students in RCEAS.

CEE 202. CEE Planning and Engineering Economics (3) spring
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) fall
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)
Supervised individual design problems, with report. Prerequisite: consent of the department chair.

CEE 207. Transportation Engineering (3) spring
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: CEE 11.

CEE 211. Research Problems (1-6)
Supervised individual research problems, with report. Prerequisite: consent of the department chair.

CEE 222. Hydraulic Engineering (3) spring
Pipe and pump hydraulics, engineering hydrology, ground water hydraulics, and open channel hydraulics. Laboratory experiments in applied hydraulics. Prerequisite CEE 121, ME 231, or equivalent.

CEE 242. Geotechnical Engineering (3) spring
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. Prerequisite: CEE 142.

CEE 244. Foundation Engineering (3) fall
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. Prerequisite: CEE 242.

CEE 258. Structural Laboratory (3)
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. Prerequisite: CEE 262 and CEE 264.

CEE 259. Structural Analysis II (3) fall
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. Prerequisite: CEE 159.

CEE 262. Fundamentals of Structural Steel Design (3) spring
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. Prerequisite: CEE 159.

CEE 264. Fundamentals of Structural Concrete Design (3) spring
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. Prerequisite: CEE 159.

CEE 266. Construction Management (3) spring
An overview of mangement 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 CEE 159 and CEE 202, or instructor's approval.

CEE 272. Environmental Risk Assessment (2) spring
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) spring
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. Prerequisite: CHM 31 or CEE 170.

CEE 275. Environmental, Geotechnics and Hydraulics Laboratory (2) Spring
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. Prerequisite: CEE 170, previously or concurrently.

CEE 279. (EES 358) Microbial Ecology (4)
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. Prerequisite: EES 152, or consent of instructor.

CEE 281. Special Topics (1-6)
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. Prerequisite: consent of the department chair.

CEE 290. CEE Design Project (3) spring
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. Prerequisite: Senior standing in CEE department or permission of instructors.

CEE 316. (EES 316) Hydrogeology (4)
Interrelationships of geologic materials and processes with water; entry, storage, interaction, and flow of water through permeable earth materials; evaluation, development, and management of ground-water resources. Lectures and recitation/laboratory. Prerequisites: EES 21 or EES 101.

CEE 320. (EES 320) Engineering Hydrology (3) fall
Rainfall-runoff analysis, overland flow, hydrograph theories, modeling. Frequency analysis of extreme events. Flood routing. Design storms. Floodplain hydraulics, floodplain delineation. Prerequisite: CEE 222.

CEE 321. Open Channel Hydraulics (3) fall
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. Prerequisite: CEE 222.

CEE 323. (EES 323) Environmental Groundwater Hydrology (3) spring
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: CEE 121 or CHE 44 or ME 231 or CEE/EES 316 or permission of instructor.

CEE 327. (EES 327) Surface Water Quality Modeling (3) spring
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: CEE 121 or CHE 44 or ME 231, CEE 222 and CEE 170 or permission of instructor.

CEE 335. Coastal Engineering (3) fall
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. Prerequisite: CEE 121 or CHE 44 or ME 231.

CEE 341. Ground Improvement and Site Development (3)
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. Prerequisite: CEE 242.

CEE 342. Experimental Geotechnical Engineering (3)
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. Prerequisites: CEE 242 and senior standing.

CEE 344. Behavior of Soils as Engineering Materials (3)
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. Prerequisite: CEE 242.

CEE 345. Geo-Environmental Engineering (3)
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. Prerequisite: CEE 242 or consent of the instructor.

CEE 346. Fundamentals of Designing with Geosynthetics (3) spring
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. Prerequisite: CEE 242.

CEE 352. Structural Dynamics (3) fall
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: MATH 205, CEE 159, and MECH 102.

CEE 361. Bridge Systems Design (3)
Introduction to bridge structural systems in steel and concrete. Loads and specifications. Design and analysis of bridge structural components. Prerequisites or co-requisites: CEE 259, CEE 262, CEE 264.

CEE 363. Building Systems Design (3) spring
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 or co-requisites: CEE 259, CEE 262, and CEE 264.

CEE 364. Advanced Project Management (3) spring
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. Prerequisite: CEE 266 or consent of instructor.

CEE 365. Prestressed Concrete (3) fall
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. Prerequisite: CEE 264 or consent of the department chair.

CEE 366. Finite Element Method in Structural Engineering (3) spring
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: CEE 259.

CEE 371. Reaction Kinetics in Environmental Engineering (3)
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. Prerequisite: CEE 375 (CHE 375).

CEE 373. (CHE 373) Fundamentals of Air Pollution (3)
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. Prerequisite senior standing in the College of Engineering and Applied Science.

CEE 375. (CHE 375) Environmental Engineering Processes (3) fall
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. Prerequisite: CEE 170 or equivalent.

CEE 376. Environmental Biotechnology (3)
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: CEE 375 (CHE 375) or consent of instructor (ES 2, ED 1)

CEE 377. Environmental Engineering Design (3) spring
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. Prerequisite: CEE 170 and CEE 375 (CHE 375) and senior standing in CEE department or permission of instructor.

CEE 378. Hazardous Waste Treatment and Management (3)
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. Prerequisite: CEE 375 (CHE 375).

CEE 379. (EES 379) Environmental Case Studies. (3 to 4)
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: EES 22 or CEE 375 (CHE 375) or permission of the instructor.

CEE 381. Special Topics (1-3)
A study of selected topics in civil engineering, not included in other formal courses. A report is required. Prerequisite: consent of the department chair.

CEE 385. Research Procedures Seminar (1) fall
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.

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, leading to the degrees of master of science, master of engineering, and doctor of philosophy in civil engineering or environmental engineering.

The programs educate students through coursework and independent study and research. Graduates of these programs will be “full service engineers” with the knowledge and analytical problem-solving capabilities needed to lead and innovate within multi-disciplinary teams in technologically-complex environments.

Graduate studies in 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, listed below), or alternatively, a report based on a research course of at least three credits (CEE 429, 439, 449, 479 or 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 courses may extend across the various specialty areas in civil engineering. Each candidate for the M.Eng. may choose to complete an individual engineering project representing three to six credits (CEE 480) in place of the thesis or research report required for the M.S. or to take a minimum of 30 course credits without a research or design project.

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 at the first opportunity following one semester in residence. After qualification, the candidate, the candidate’s departmental Ph.D. committee, and the department chair formulate the program of work.

The laboratories of the department are located in the Fritz Engineering Laboratory. The laboratory offers outstanding facilities for research and instruction in structural engineering, geotechnical engineering, water resources engineering, coastal engineering, environmental engineering, and related fields. In particular, the structural testing equipment includes dynamic testing machines, a five-million-pound universal hydraulic testing machine, and other special loading apparatus. Included in the latter are the facilities of the Center for Advanced Technology for Large Structural Systems (ATLSS center) located on the mountaintop section of the 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 and costal engineering 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-art, fully automated triaxial compression and permeability machines for multiple simultaneous tests. Brochures describing the research facilities and programs are available on request.

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 aid to students of outstanding promise. The half-time research or teaching activities required of holders of assistantships provides a valuable educational experience that supplements the formal course offerings. The graduate course offerings of the department are programmed to fit the schedule of half-time assistants, and to accommodate part-time students. A very limited number of scholarships and fellowships are available to provide financial aid for full-time study.

Graduate Courses in Civil Engineering

CEE 404 (Mech 404). Mechanics and Behavior of Structural Members (3) fall
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, bendings, shear, and torsion. Stability analysis of beam-columns. Beams on elastic foundations. Energy concepts and their use in structural analysis. Prerequisites: CEE 259 or equivalent.

CEE 405. Analytical and Numerical Methods I (3)
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. Prerequisite: MATH 205 or equivalent.

CEE 406. Structural Reliability of Components and Systems (3)
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: MATH 21, MATH 205, and CEE 259.

CEE 409. Finite Element Method in Structural Mechanics (3) spring
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: CEE 405 and CEE 413 or equivalent.

CEE 412. Methodologies of Structural Design (2)
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)
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)
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: CEE 261 or equivalent.

CEE 416. Design Project I (3) summer
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. Prerequisite: Enrollment limited to students in M.Eng. program.

CEE 417. Design Project II (3) fall
Task-specific teams will be organized to perform preliminary designs of different design options for the ocerall 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. Prerequisite: CEE 416.

CEE 418. Design Project III (3) spring
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. Prerequisite: CEE 417.

CEE 419 Structural Behavior Laboratory (3) summer
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. Prerequisite: CEE 262 and CEE 264 or consent of instructor.

CEE 420. Surface Wave Mechanics (3)
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. Prerequisite: consent of instructor.

CEE 424. Surface Water Hydrology (3)
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. Prerequisite: CEE 320 (EES 320) or equivalent.

CEE 425. Hydraulics of Sediment Transport (3)
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. Prerequisite: CEE 321 or equivalent.

CEE 427. Transport of Contaminants in Groundwater (3)
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. Prerequisite: CEE 323 (EES 323) or permission of instructor.

CEE 428. Advanced Topics in Hydraulics (1-3)
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. Prerequisites: CEE 321 and consent of the department chair. May be repeated for credit.

CEE 429. Hydraulic Research (1-6)
Individual research problems with reports. May be repeated for credit.

CEE 431. Life-Cycle of Structural Systems (3)
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: MATH 205, CEE 259, a course in structural design, or consent of instructor.

CEE 432. Structural Safety and Risk (3)
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: MATH 205, CEE 259, a course in structural design, or consent of instructor.

CEE 433. Structural Optimization (3)
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: MATH 205, CEE 259, a course in structural design, or consent of instructor.

CEE 436. Advanced Topics in Coastal Engineering (1-3)
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. Prerequisite: CEE 335. May be repeated for credit.

CEE 439. Coastal Engineering Research (1-6)
Individual research problems with reports. May be repeated for credit.

CEE 441. Dynamic Analysis in Geotechnical Engineering (3)
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. Prerequisite: CEE 244 or consent of the department chair.

CEE 443. Advanced Soil Mechanics (3) fall
Characterization of particulate media; particle-fluid interaction; load deformation, thermoelastic and viscoelastic behavior; elastic waves in particulate media; electromagnetic properties; empirical and analytical models. Prerequisite: a course in soil mechanics.

CEE 445. Advanced Foundation Engineering (3) fall
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. Prerequisite: a course in soil mechanics.

CEE 447. Advanced Topics in Geotechnical Engineering (1-3)
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. Prerequisite: consent of the department chair. May be repeated for credit.

CEE 448. Constitutive Laws in Soil Mechanics (3)
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. Prerequisite: consent of the instructor.

CEE 449. Geotechnical Research (1-6)
Individual research problems relating to soil engineering, with report. Prerequisite: a course in soil mechanics.

CEE 450. Advanced Structural Analysis I (3)
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. Prerequisite: CEE 259 or equivalent.

CEE 452. Fatigue and Fracture of Structures - An Interdisciplinary View (3)
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)
Nonlinear analysis of structural components and systems, considering the effects of material and geometric nonlinearities. Solution strategies; material constitutive models; nonlinear membersection analysis; computational plasticity; nonlinear beam-column element formulations; second order analysis; structural stability; and nonlinear time history analysis of structural dynamic systems. Prerequisites: CEE 352, CEE 413, CEE 450.

CEE 455. Advanced Structural Dynamics (3)
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: CEE 352 or MECH 406, CEE 405 and CEE 450 or equivalent.

CEE 456. Behavior and Design of Earthquake Resistant Structures (3)
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. Prerequisite: CEE 352 or equivalent.

CEE 459. Advanced Topics in Plastic Theory (3) fall
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. Prerequisite: CEE 413.

CEE 461. Advanced Bridge Engineering (3)
Students in CEE 461 cover the same topics described under CEE 360, 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: CEE 262 and CEE 264.

CEE 462. Stability of Structural Systems (3)
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: CEE 413/404 or equivalent.

CEE 463. Advanced Mechanics of Reinforced Concrete (3)
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: CEE 413 or equivalent.

CEE 467. Advanced Topics in Structural Engineering (1-3)
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. Prerequisite: consent of the department chair. May be repeated for credit.

CEE 468. (MECH 415) Stability of Elastic Structures (3)
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. Prerequisite: MATH 205.

CEE 470. Reaction Kinetics in Environmental Engineering (3)
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)
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)
Theory and design of water and wastewater treatment facilities. Physical, chemical, and biological treatment processes for water and wastewater treatment. Prerequisite: CEE 375 (CHE 375) or equivalent.

CEE 473. (CHE 473) Environmental Separation and Control
Theory and application of adsorption, ion exchange, reverse osmosis, air stripping and chemical oxidation in water and wastewater treatment. Modeling engineered treatment processes. Prerequisite: CEE 470 or consent of the instructor.

CEE 474. Aquatic Chemistry (3)
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. Prerequisite: CEE 274.

CEE 475. Advanced Topics in Environmental Engineering (1-3)
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. Prerequisite: Department chair approval.

CEE 476. Environmental Engineering Microbiology (3)
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. Prerequisite: CEE 375 (CHE 375) or consent of instructor.

CEE 477. Environmental Engineering Processes (3)
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. Prerequisite: CEE 170 or consent of instructor.

CEE 478. Toxic and Hazardous Wastes (3)
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. Prerequisite: CEE 274 or CEE 375 (CHE 375).

CEE 479. Environmental Engineering Research (1-6)
Individual research problems in environmental engineering with report. May be repeated for credit.

CEE 480. Civil Engineering Project (1-6)
An intensive study of one or more areas of civil engineering, with emphasis on engineering design and applications. A written report is required. May be repeated for credit.

CEE 481. Special Problems (1-6)
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. May be repeated for credit.

CEE 483. Graduate Seminar (1-3)
Study of current topics in civil engineering.

CEE 491. Thesis (1-6)
CEE 499. Dissertation (1-15)

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 (*www3.lehigh.edu/engineering/cee/* and *www.ees.lehigh.edu*).

Suggested outline of courses for B.S. in Environmental Science and B.S. in Civil Engineering

The freshman engineering year (see Section III) is often 29 credits. 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 160-175 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**.

second year, first semester (18 credit hours)

MATH 23	Calculus III (4)
MECH 3	Fundamentals of Engineering Mechanics (3)
CHM 31	**Chemical Equilibria in Aqueous Systems (3)
EES Gateway	Gateway Elective (3)
EES 22	Exploring Earth (1)
CEE 11	Surveying (1)
CEE 12	Civil Engineering Statistics (2)

second year, second semester (18 credit hours)

PHY 21	Introductory Physics II (4)
PHY 22	Introductory Physics Laboratory II (1)
MECH 12	Strength of Materials (3)
EES 100	Earth System Science (4)
MATH 205	Linear Methods (3)
MAT 33	Engineering Materials and Processes (3)

third year, first semester (18 credit hours)

CEE 121	Mechanics of Fluids (3)
CEE 123	Civil Engineering Materials (1)
CEE 142	Soil Mechanics (3)
EES	Course suggested as only 100 and 300 level (4)
EES	Course suggested as only100 and 200 level (4)
CEE 10	Architectural/Engineering Graphics and Design (3)

third year, second semester (18 credit hours)

CEE 242	Geotechnical Engineering (3)
CEE 222	Hydraulic Engineering (3)
CEE 170	Introduction to Environmental Engineering (4)
EES 200	Earth History (4)
ECO 1	Principles of Economics (4)

fourth year, first semester (18 credit hours)

CEE 117	Numerical Methods in Civil Engineering (2)
CEE 159	Structural Analysis I (4)
EES	Course 100 to 300 levels (4)
EES	Course 100 to 300 levels (4)
EES	Course 100 to 300 levels (4)

fourth year, second semester (16 credit hours)

CEE 202	Civil Engineering Planning and Engineering Economics (3)

CEE 262	Fundamentals of Structural Steel Design (3)
or CEE 264	Fundamentals of Structural Concrete Design (3)
CEE	**Civil Engineering Approved Elective (3)
	*Engineering Science Elective (3)
EES	100 to 300 levels (4)

year 4/5 summer (0-6 credit hours)

Optional 1 field course

EES 341	Field Camp in Earth and Environmental Sciences (1-6)

fifth year, first semester (15-19 credit hours)

CEE 203	Professional Development (2)
CEE	**Civil Engineering Approved Elective (3)
HSS	Humanities/Social Sciences AR Elective (7)

Select 1, or 2 courses from below so the total here and year 4/5 summer is 8 credits of Tier 3 courses:

EES	Course 100 to 300 levels (4)
EES	Course 100 to 300 levels, possibly EES 380 Senior Seminar (4)

fifth year, second semester (18 credit hours)

CEE	**Civil Engineering Approved Electives (7)
CEE 290	***Civil Engineering Capstone Design Project (3)
H/SS	Humanities/Social Sciences AR Electives (4)
EES	Course 100 to 300 levels (4)

**MECH 102, ME 104, or ECE 83/81.*

***CHM 31 plus thirteen additional credits of CEE Approved Electives are required; see list on CEE web-site 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.*

Suggested outline of courses for B.S. in Environmental Science and B.S. in Environmental Engineering

The freshman engineering year (see Section III) is often 29 credits. 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 158-167 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.

second year, first semester (18 credit hours)

MATH 23	Calculus III (4)
MECH 2 or 3	Elementary Engineering Mechanics (3)
CHM 110	Organic CHEM I (3)
CHM 111	Organic Chem Lab I (1)
ESR	***Earth Science Requirement (3)
EES 22	Exploring Earth (1)
HSS	Humanities/Social Sciences AR Elective (3)

second year, second semester (15 credit hours)

MATH 205	Linear Methods (3)
PHY 21	Introductory Physics II (4)
PHY 22	Introductory Physics Lab II (1)
CEE 170	Introduction to Environmental Engineering (4)
EBR	****Environmental Biology Requirement (3)

third year, first semester (19 credit hours)

CEE 12	Civil Engineering Statistics (2)
CEE 375	Env. Engineering Processes (3)
EES	Course suggested as only 100 and 200 level (4)
EES	Course suggested as only 100 and 200 level (4)
HSS	Humanities/Social Science Elective (3)
CHE 31	MAT. & Energy Bal. Of CHE Process (3)

third year, second semester (18 credit hours)

CEE 274	Environmental Water Chemistry (3)
CHE 60	Unit Ops Survey (3)
ECO 1	Principles of Economics (4)
EES	Course 100 to 200 level (4)
EES	Course 100 to 300 levels (4)

fourth year, first semester (17 credit hours)

CEE 121	Mechanics of Fluids (3)
CEE 142	Fundamentals of Soil Mechanics (3)
CEE 378	Solid & Haz. Waste Management (3)
EES Course	100 to 300 levels (4)
EES Course	100 to 300 levels (4)

fourth year, second semester (18 credit hours)

CEE 202	CEE Planning and Engineering Economics (3)
CEE 222	Hydraulic Engineering (3)
CEE 272	Env. Risk Assessment (2)
CEE 275	Enviro-Geo-Hydraulics Lab (2)
EES Course	100 to 300 levels (4)
EES Course	100 to 300 levels, possibly senior seminar (4)

year 4/5 summer (0-6 credit hours)

Optional field 1 course

EES 341	Field Camp in Earth and Environmental Sciences (1-6)

fifth year, first semester (16 credit hours)

CEE 203	Professional Development (2)
CEE 379	(EES 379) Env. Case Studies (4)
EES Course	100 to 300 levels, possibly senior seminar (4)
	*Approved electives (2)
HSS	Humanities/Social Sciences AR Electives (4)

fifth year, second semester (16 credit hours)

CEE 377	Environmental Engineering Design (3)
HSS	Humanities/Social Sciences AR Electives (3)
	*Approved electives (7)
FE	Free Elective (3)

**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.*

Classical Studies

Program Director: Barbara Pavlock

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Classical Studies Faculty. Professors Barbara Pavlock, Ph.D. (Cornell); Charles Robert Phillips, III, Ph.D. (Brown); David B. Small, Ph.D. (Cambridge),

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 15 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 at Athens and Rome.

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 34 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.

Any four of the following:

CLSS 52 (ENGL 52)	Classical Epic (3)
CLSS 54 (ENGL 54, THTR 54)	Greek Tragedy (3)
CLSS 56 (ENGL 56)	Topics in Greek and Roman Literature (3)
CLSS 58 (ENGL 58, THTR 58)	Greek and Roman Comedy (3)
CLSS 174 (ANTH 174, ART 174, ARCH 174).	Greek Archaeology (3)
CLSS 176 (ANTH 176, ART 176, ARCH 176).	Roman Archaeology (3)

Any two courses in ancient history

At least two electives from the remaining program offerings

One course in either Latin or Greek on the intermediate level (or LAT/GRK 1, 2, 11, or 12, depending on previous background)

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 34 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

Latin 1 and 2 or Greek 1 and 2, depending on prior preparation

Latin 11 and 12, or Greek 11 and 12, depending on prior preparation

Three advanced courses in the major language minimum, depending on prior preparation. 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.

Any two ancient history courses

At least two electives from the remaining program offerings

Courses in Classical Civilization (CLSS)

CLSS 21. (HIST 21) Greek History (4) fall
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. Phillips (SS)

CLSS 22. (HIST 22) Roman History (4) spring
Rome from its origins to A.D. 476. Political, social and religious developments. Transformation of the late Roman Empire to the early medieval period. Phillips (SS)

CLSS 50. Mythology (3) fall
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. (SS)

CLSS 52. (ENGL 52) Classical Epic (3)
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*. Pavlock (HU)

CLSS 54. (ENGL 54, THTR 54) Greek Tragedy (3)
Aspects of Greek theater and plays of Aeschylus, Sophocles, and Euripides in their social and intellectual contexts. Pavlock (HU)

CLSS 56. (ENGL 56) Topics in Greek and Roman Literature (3)
Classical literature in translation, including themes or specific periods in Greek or Roman literature. May be repeated for credit, as topics vary. Pavlock (HU)

CLSS 58. (ENGL 58, THTR 58) Greek and Roman Comedy (3)
Study of comedy as a social form through plays of Aristophanes, Menander, Plautus, and Terence. Pavlock (HU)

CLSS 91. Independent Study (1-4) (ND)

CLSS 112. (ANTH 112) Doing Archaeology (4)
Principles of archaeological method and theory. Excavation and survey methods, artifact analysis, dating techniques, and cultural reconstruction. Course includes field project. Small (SS)

CLSS 114 (REL 114) Christian Origins: New Testament and the Beginnings of Christianity (4)
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. Wright (HU)

CLSS 127. (ANTH 127) Early Civilizations (4)
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. Small (SS)

CLSS 131. (PHIL 131) Ancient Philosophy (4) fall
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. (HU)

CLSS 132. (PHIL 132) Hellenistic Philosophy (4)
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. (HU)

CLSS 161. (HIST 161) Roman Law (4)
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. Phillips (SS)

CLSS 171. Independent Study (1-4)

CLSS 174. (ANTH 174, ART 174, ARCH 174) Greek Archaeology (3)
Ancient Greek culture from the neolithic to Hellenistic periods. Reconstructions of Greek social dynamics from the study of artifacts. Small (SS)

CLSS 176. (ANTH 176, ART 176, ARCH 176) Roman Archaeology (3)
Cultures of the Roman Empire. Reconstructions of social, political, and economic dynamics of the imperial system from the study of artifacts. Small (SS)

CLSS 191 (1-4) Special Topics (ND)

CLSS 213. (HIST 213, REL 213) Ancient Roman Religion (4)
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. Phillips (SS)

CLSS 231. (PHIL 231) Figures/Themes in Ancient Philosophy (4)
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. Prerequisite: One HU designated course in Philosophy. (HU)

CLSS 232. (PHIL 232) Figures/Themes in Hellenistic Philosophy (4)
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. Prerequisite: One HU designated course in Philosophy. Mendelson. (HU)

CLSS 251. (REL 251) Classical Mythology (3)
Myth, religion, and ritual in ancient Greece and Rome. Emphasis on primary sources; introduction to ancient and modern theories of religion. Cross-cultural material. (SS)

CLSS 281. Readings (3) fall
Advanced study of a historical period or theme. Emphasis on primary sources. Prerequisites: CLSS 21 or 22 and consent of the program head. (ND)

CLSS 282. Readings (3) spring
Advanced study of a historical period or theme. Emphasis on primary sources. Prerequisites: CLSS 21 or 22 and consent of the program head. (ND)

CLSS 291. Independent Study (1-4)

CLSS 311 (HIST 311) Twins and Sins: The Rise of Rome (3-4)
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. Phillips (SS)

CLSS 312. (HIST 312) Decline and Fall of the Roman Empire (3-4)
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. Phillips (SS)

CLSS 313. (HIST 313) Golden Age of Greek Democracy (3-4)
Greek history of the seventh through fifth centuries B.C. Emphasis on the contrasting political and social systems of Athens and Sparta with consideration of related economic and military history. Attention to art, gender, literature, religion. Discussion and lectures; papers. Phillips (SS)

CLSS 314. (HIST 314) Age of Caesar and Christ (3-4) spring
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. Phillips (SS)

CLSS 345. (ANTH 345) Evolution of the State (4)
Theories of state formation. Comparison of evolutionary trajectories of early states in the Near East, Mediterranean, and the New World. Small (SS)

Courses in Ancient Greek

GRK 1. Elementary Ancient Greek I (4) fall
Fundamentals of the Greek language. Grammatical exercises and short passages of easy prose. Staff (HU)

GRK 2. Elementary Ancient Greek II (4) spring
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. Staff (HU)

GRK 11. Intermediate Ancient Greek (3) fall
Readings in Herodotus, Homer, or Xenophon. Grammar review. Students should have completed two semesters of elementary ancient Greek or the equivalent. (HU)

GRK 12. Intermediate Ancient Greek (3) spring
May include Plato: *Euthyphro*, *Apology* and *Crito*, or other dialogues. Students should have completed two semesters of elementary Greek or the equivalent. (HU)

GRK 91. Independent Study (1-4) (HU)

GRK 111. Greek Drama (3)
Representative plays of Sophocles, Euripides and Aristophanes. Literary study of the drama. Students should have completed four semesters of ancient Greek or the equivalent. (HU)

GRK 112. Readings in Ancient Greek (3)
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. (HU)

GRK 113. Greek Historians (3)
Selections from Herodotus, Thucydides or Xenophon. Study of Greek historiography. Students should have completed four semesters of ancient Greek or the equivalent. (HU)

GRK 171. Independent Study (1-4) (HU)

GRK 271. Readings (3) fall
Intensive readings in one author or in a selected genre. Prerequisites: six credit hours at the 100 level and consent of the program head. (HU)

GRK 272. Readings (3) spring
Intensive readings in one author or in a selected genre. Prerequisites: six credit hours of courses at the 100 level and consent of the program head. (HU)

GRK 291. Independent Study (1-4)

Courses in Latin

LAT 1. Elementary Latin I (4) fall
Fundamentals of grammar and syntax. Emphasis on language structure and vocabulary building. Pavlock (HU)

LAT 2. Elementary Latin II (4) spring
Continuation of grammar, easy Latin prose and poetry. Students should have completed one semester of elementary Latin or the equivalent. (HU)

LAT 11. Intermediate Latin (3) fall
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. Pavlock (HU)

LAT 12. Intermediate Latin (3) spring
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. Pavlock (HU)

LAT 91. Independent Study (1-4)

LAT 111. Catullus and Horace (3)
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. Pavlock (HU)

LAT 112. Latin Prose (3)
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. Pavlock (HU)

LAT 113. Vergil (3)

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. Pavlock (HU)

LAT 114. Livy (3)
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. Pavlock (HU)

LAT 115. Ovid (3)
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. Pavlock (HU)

LAT 116. Petronius (3)
Selections from the *Satyricon,* focusing on language usage and epic parody. Students should have completed four semesters of Latin or the equivalent. Pavlock (HU)

LAT. 171. Independent Study (1-4) (HU)

LAT 211. Readings (3) fall
Intensive readings in one author or in a selected genre. Prerequisites: six hours of courses at the 100 level and consent of the program head. (HU)

LAT 212. Readings (3) spring
Intensive reading in one author or in a selected genre. Prerequisites: six hours of courses at the 100 level and consent of the program head. (HU)

LAT 291. Independent Study (1-4) (HU)

Cognitive Science

Program Director: Padraig G. O'Seaghdha, Ph.D.

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Cognitive Science Faculty

Biological Sciences: Michael Burger, Ph.D. (Texas at Austin); John Nyby, Ph.D. (Texas); Colin J. Saldanha, Ph.D. (Columbia); Jill Schneider, Ph.D. (Wesleyan); Neal Simon, Ph.D. (Rutgers); Jennifer M. Swann, Ph.D. (Northwestern)

Computer Science and Engineering: Henry S. Baird, Ph.D. (Princeton); Glenn D. Blank, Ph.D. (Wisconsin); Jeffrey D. Heflin, Ph.D. (Maryland); Edwin J. Kay, Ph.D. (Lehigh); Hector MunozAvila, Ph.D. (U. Kaiserslautern, Germany); Daniel Lopresti Ph.D. (Princeton); Roger N. Nagel, Ph.D. (Maryland); John R. Spletzer, Ph.D. (Pennsylvania)

Modern Languages and Literature: Kiri Lee, Ph.D. (Harvard)

Philosophy: Gordon Bearn, Ph.D. (Yale); Mark H. Bickhard, Ph.D. (Chicago); Steven L. Goldman, Ph.D. (Boston); Aladdin M. Yaqub, Ph.D. (Wisconsin)

Psychology: Catherine M. Arrington, Ph.D. (Michigan State); Susan Barrett, Ph.D. (Brown); Amanda Brandone, Ph.D. (Michigan); Christopher T. Burke, Ph.D. (NYU); Michael J.

Gill, Ph.D. (Texas-Austin); Almut Hupbach, Ph.D. (University of Trier); Barbara C. Malt, Ph.D. (Stanford); Gordon B. Moskowitz, Ph.D. (NYU); Ageliki Nicolopoulou, Ph.D. (UCBerkeley); Padraig G. O'Seaghdha, Ph.D. (Toronto); Dominic J. Packer, Ph.D. (Toronto).

Sociology and Anthropology: John B. Gatewood, Ph.D.(Illinois); Robert E. Rosenwein, Ph.D. (Michigan)

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.

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.

B.A. in Cognitive Science

Collateral Requirements (8 credits)

The collateral course requirements are: CSE 15 and either MATH 21 (preferred) or MATH 51. Additional coursework in mathematics is strongly recommended (particularly CSE/MATH 261). We also recommend PSYC 1, ANTH 1 and COGS 140 (Introduction to Linguistics) as providing valuable background. Students who are particularly interested in cognition and neuroscience should also take CHEM 30 or 40, and BIOS 41, BIOS 115, and BIOS 116, with their associated laboratory courses, by the end of their sophomore year.

CSE 15	Introduction to Computer Science (4)
And	
MATH 21	Calculus I (4), or
MATH 51	Survey of Calculus I (4)

Introductory Course (4 credits)

COGS 7	Introduction to Cognitive Science (4)

Disciplinary Core Courses (15 credits)

COGS 117 (PSYC 117)	Cognitive Psychology (4)
COGS 176 (PSYC 176)	Mind and Brain (4)
COGS 250 (PHIL 250)	Philosophy of Mind (4)
COGS 327 (CSE 327)	Artificial Intelligence Theory and Practice (3)

Major Electives (minimum of 16 credits)

Students must complete a minimum of five major electives chosen from among the courses listed below, with at least one course from each of the three tracks.

Artificial Intelligence and Formal Models:

CSE 17	Programming and Data Structures (3)
CSE 261 (MATH 261)	Discrete Structures (3)
CSE 262	Programming Languages (3)
CSE 318.	Automata and Formal Grammars (3)
CSE 326	Pattern Recognition (3)
CSE 335	Topics in Intelligent Decision Support Systems (3)
CSE 337	Reinforcement Learning (3)
CSE 348	AI Game Programming (3)
CSE 360	Introduction to Mobile Robotics (3)
CSE 431	Intelligent Agents *(for undergraduate students who qualify)*
PHIL 114	Symbolic Logic (4)
PHIL 115 (MATH 115)	Topics in Philosophical Logic (4)

PHIL 265	Philosophy of Mathematics (4)
MATH 303 (PHIL 303)	Mathematical Logic (3,4)
MATH 304 (PHIL 304)	Axiomatic Set Theory (3,4)
MATH 329	Computability Theory (4)

Language, Culture, and Meaning:

COGS 140 (ANTH 140, PSYC 140, MLL 140)	Introduction to Linguistics (4)
ANTH 376	Culture and the Individual (4)
PHIL 139	Contemporary Philosophy (4)
PHIL 220	Theory of Knowledge (4)
PHIL 260	Philosophy of Language (4)
PSYC 307	Higher Order Cognition (4
PSYC 313	Person Perception (4)
PSYC 314 (SSP 314)	Social Cognition (4)
PSYC 320	Psychology of Language (4)
PSYC 321	Language Development (4)
PSYC 351	Cognitive Development (4)
PSYC 358	Inside the Infant Mind (4)
PSYC 362	Cognition in Practice and Policy (4)
PSYC 365	Human Development in Cross-Cultural Perspective (4)
PSYC 384	Self and Identity (4)
SSP 135 (JOUR 135, PSYC 135)	Human Communication (4)
SSP 302	The Sociology of Cyberspace (4)

Cognition and Neuroscience:

ANTH 145	Human Evolution (4)
BIOS 121	Comparative/Integrative Biology for BIOS Minors (3)
BIOS 276	Central Nervous System and Behavior (3)
BIOS 277	Experimental Neuroscience Lab (2)
BIOS 382	Endocrinology of Behavior (3)
BIOS 365	Neurobiology of Sensory Systems (3)
PSYC 304	Memory Development from Infancy to Old Age (4)
PSYC 369	Memory Under Construction (4)
PSYC 377	Attention and Attentional Failure (4)

Senior Thesis (6 credits)
After completing the introductory and the core courses, students pursue their individual interests in their selections of major electives. The required senior thesis (COGS 301 and 399) provides a capstone integration through an individual research project spanning at least two cognitive science sub-disciplines.

Recommended Timing of Courses

Freshman	*Sophomore*
COGS 7, spring	COGS 117
CSE 15	COGS 176
MATH 21 or 51	1 major elective

[also, CHEM 30 or 40 and BIOS 41 by end of sophomore year for students especially interested in neuroscience]

Junior	*Senior*
COGS 250	2 major electives
COGS 327	COGS 399 (thesis)
2 major electives	

Minor in Cognitive Science

The undergraduate minor in Cognitive Science requires five courses: COGS 7 and four additional courses selected from among the major's core courses and major electives, with at least two of these being Disciplinary Core Courses.

Course Descriptions

COGS 7. Introduction to Cognitive Science (4) spring
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. (SS)

COGS 117 (PSYC 117). Cognitive Psychology (4)
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. Prerequisite: PSYC 1 or COGS 7. May not be taken pass/fail. (SS)

COGS 140 (ANTH 140, PSYC 140, MLL 140). Introduction to Linguistics (4)
Relationship between language and mind; formal properties of language; language and society; how languages change over time. May not be taken pass/fail. (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. Prerequisite: consent of the program director.

COGS 176 (PSYC 176). Mind and Brain (4)
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. Prerequisite: PSYC 1 or COGS 7. May not be taken pass/fail. (NS)

COGS 250 (PHIL 250). Philosophy of Mind (4)
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. Prerequisite: One HU course in Philosophy. (HU)

COGS 301. Senior Project in Cognitive Science: Proposal (3)
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. Prerequisite: consent of program director.

COGS 327 (CSE 327). Artificial Intelligence Theory and Practice (3)
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. Prerequisite: CSE 15,17 or 18

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. Prerequisite: consent of the program director.

COGS 399. Senior Project in Cognitive Science: Thesis (3)
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. Prerequisite: COGS 301 and consent of the program director.

COGS 405 Individual Study in Cognitive Science (1-6)
Study of a topic not covered in regular course offerings. By arrangement with a consulting faculty member. May be repeated for credit. Prerequisite: Consent of the program director.

COGS 423 (PSYC 423). Foundations of Cognitive Science (3)
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 (PSYC 478). Ontological Psychology (3)
Principles and constraints for modeling psychological phenomena. Representation; perception; memory; knowing; learning; emotions; consciousness; language; rationality.

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 423, a graduate seminar, plus four electives from the list below (or approved substitutions). 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.

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, a graduate seminar, plus three electives from the list below. 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.

Required Course

COGS 423 (PSYC 423) Foundations of Cognitive Science

Approved Electives (for both concentrations)

Computer Science:

CSE 416	Advanced Issues in Knowledge-based Systems
CSE 417	Topics in Information Retrieval
CSE 426	Pattern Recognition
CSE 428	Semantic Web Topics
CSE 429	Virtual Environments
CSE 430	Textual Data Mining
CSE 431	Intelligent Agents
CSE 435	Topics on Intelligent Decision Support Systems
CSE 447	Data Mining
CSE 448	AI Game Programming
CSE 460	Mobile Robotics

Psychology:

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 Judgment
PSYC 476	Seminar in Cognition
PSYC 478 (COGS 478)	Ontological Psychology
PSYC 480	Seminar in Cognitive Development

Philosophy:
(Note: 200-level courses may be taken by graduate students if the courses are not in the student's major.)

PHIL 250 (COGS 250)	Philosophy of Mind
PHIL 260	Philosophy of Language

Sociology and Anthropology:

SSP 403	The Sociology of Cyberspace
ANTH 376	Culture and the Individual

Additional Electives (Graduate Certificate only)

Computer Science:

CSE 326	Pattern Recognition
CSE 327 (COGS 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 in Intelligent Decision Support Systems
CSE 347	Data Mining
CSE 348	AI Game Programming
CSE 360	Introduction to Mobile Robotics

Psychology:

PSYC 304	Memory Development from Infancy to Old Age
PSYC 307	Higher Order Cognition
PSYC 313	Person Perception
PSYC 314 (SSP 314)	Social Cognition
PSYC 317	Psychology of Emotion
PSYC 320	Psychology of Language
PSYC 321	Language Development
PSYC 351	Cognitive Development
PSYC 358	Inside the Infant Mind
PSYC 362	Cognition in Practice and Policy
PSYC 365	Human Development in Cross Cultural Perspective
PSYC 369	Memory Under Construction
PSYC 377	Attention and Attentional Failure

Communication

See listings under Minor Programs in the College of Arts and Sciences and under Journalism and Communication.

Computer Engineering

Professors. Henry Baird, Ph.D. (Princeton); Filbert J. Bartoli, Ph.D. (Catholic University of America); Rick Blum, Ph.D. (Pennsylvania); D. Richard Decker, Ph.D. (Lehigh); Edwin J. Kay, Ph.D. (Lehigh); Henry F. Korth, Ph.D. (Princeton); Daniel D. Lopresti, Ph.D. (Princeton); Alastair D. McAulay, Ph.D. (Carnegie Mellon).

Associate Professors. Liang Cheng, Ph.D. (Rutgers); Mooi Choo Chuah. Ph.D. (U. of California); Brian Davison, Ph.D. (Rutgers); Tiffany Jing Li, Ph.D. (Texas A&M); John R. Spletzer. Ph.D. (U. of Pennsylvania); Meghanad D. Wagh, Ph.D. (I.I.T., Bombay).

Assistant Professors. Shalinee Kishore, Ph.D. (Princeton); Michael Spear (Rochester); Zhiyuan Yan, Ph.D. (Illinois Urbana-Champain).

Undergraduate Programs

Mission Statement for the Engineering Program

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.

Program Educational Objectives in Computer Engineering

The graduates of the Computer Engineering program will:

1. Solve technologically challenging problems in computer engineering using their critical thinking skills, and fundamental knowledge of mathematics, science and engineering.
2. Attain positions of responsibility in their chosen careers, including industry, government, medicine, business, law and academia by applying their computer engineering skills, professional attitudes and ethics.
3. Have the ability to pursue diverse career paths, adapt to dynamic changes in their chosen profession and engage in life-long learning.
4. Apply their knowledge of global, societal and environmental issues in solving engineering problems.
5. Function effectively on multidisciplinary teams using their technical knowledge and effective communication skills.

Bachelor of Science in Computer Engineering

The required courses for this degree contain the fundamentals of electronic circuits, signal theory, logic design, computer architecture, structured programming, data structures, software engineering, 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 135 credit hours and is offered jointly by the CSE and ECE departments. The Computer Engineering program is accredited by the Engineering Accreditation

Commission of ABET, 111 Market Place, Suite 1050, Baltimore, MD 21202-4012 - telephone (410) 347-7700.

The recommended sequence of courses follows:

See Freshman Year Requirements, Section III.

Sophomore year, first semester (17 credit hours)

ECE 81	Introduction to Electrical Engineering (4)
ECE 33	Introduction to Computer Engineering (4)
PHY 21, 22	Introductory Physics II and Laboratory II (5)
MATH 23	Analytic Geometry and Calculus III (4)

Sophomore year, second semester (18 credit hours)

CSE 18	Data Structures and Programming (3)
ECE 121	Electronic Circuits Laboratory (2)
ECE 123	Electronic Circuits (3)
ECO 1	Principles of Economics (4)
MATH 205	Linear Methods (3)
HSS	Elective (3)

Junior year, first semester (18 credit hours)

ECE 82	Junior Lab (1)
ECE 108	Signals and Systems (4)
CSE 109	Systems Programming (4)
MATH 231	Probability and Statistics (3) OR
MATH 309	Theory of Probability (3)
	approved technical elective * (3)
	free elective (3)

Junior year, second semester (17-18 credit hours)

CSE 216	Software Engineering (3)
ECE 138	Digital Systems Laboratory (2)
ECE 201	Computer Architecture (3)
CSE 261	Discrete Structures (3)
	free elective (3)
	HSS elective (3-4)

Senior year, first semester (18 credit hours)

CREG 257	Senior Lab Project I (3)
ECE 319	Digital System Design (3)
CSE 303	Operating System Design (3)
	HSS elective (6)
	approved technical elective (3)

Senior year, second semester (17-18 credit hours)

CREG 258	Senior Lab Project II (2)
	approved technical electives* (9)
	HSS elective (3-4)
	free elective (3)

**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 another department.CSE 42, CSE 130, and CSE 252 are not approved technical electives.*

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-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 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.eecs.lehigh.edu/compe* 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.

Undergraduate Courses

Most courses in the Computer Engineering curriculum are listed in the CSE (Computer Science and Engineering) and ECE (Electrical and Computer Engineering) departments.

CREG 257. Senior Lab Project I (3)
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)
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-requisite: CREG 257 or department approval.

Computer Science and Business Program

Program Directors. James A. Hall, Ph.D. (Oklahoma State University) associate professor of accounting and information systems; Edwin Kay, Ph.D. (Lehigh University) professor of computer science and engineering.

The computer science and business (CSB) program is offered jointly by the College of Business and Economics and the Computer Science and Engineering department in the P.C. Rossin College of Engineering and Applied Science. This carefully crafted 136 credit hour program 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.

Students enrolled in the CSB program obtain the skills and training needed to understand business functions and business related problems, to analyze business-user information needs, to design computer based information systems, and to implement systems solutions within business organizations. Graduates of the program are ideal candidates for placement within public accounting firms, large consulting companies, and startup companies. This program also prepares students to become the Chief Information Officers, decision makers, and general managers of information age corporations.

The four year program constitutes 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. The CSB major is accredited in Business (AACSB International) and is accredited by the Computer Accreditation Commission of ABET, 111 Market Place, Suite 1050, Baltimore, MD 21202-4012 - telephone (410) 347-7700.

Mission for Program

The CSE department's mission for its Computer Science and Business program 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 www.cse.lehigh.edu/CSBSEQUENCE.

Total required credit hours: 136

Required Computer Science courses (39-40 credit hours):

CSE 15	Introduction to Computer Science (4)
CSE 17	Programming and Data Structures (3)
CSE 33	Introduction to Computer Engineering (4)
CSE 109	Systems Programming (4)
CSE 201	Computer Architecture (3)
CSE 216	Software Engineering (3)
CSE 241	Database Systems and Applications (3) OR
CSE 341	Database Systems, Algorithms, and

	Applications (3)
CSE 261	Discrete Structures and Applications (3)
CSE 262	Programming Languages (3)
CSE 303	Operating System Design (3)
CSE 340	Design and Analysis of Algorithms (3)

One 300-level course drawn from the list at *www.cse.lehigh.edu/CSBCHOICE*

Required Business courses (34 credit hours):

BUS 1	Introduction to Business (3)
ACCT 151	Introduction to Financial Accounting (3)
ACCT 152	Introduction to Managerial Accounting (3)
ECO 1	Principles of Economics (4)
ECO 29	Money, Banking, and Financial Markets (3)
ECO 146	Applied Microeconomic Analysis (3)
FIN 125	Business Finance (3)
LAW 201	Legal Environment of Business (3)
SCM 186	Supply Chain Operations Management (3)
MGT 301	Strategic Management (3)
MKT 111	Principles of Marketing (3)

Required Math and Science courses (26 credit hours):

MATH 21	Calculus I (4)
MATH 22	Calculus II (4)
MATH 205	Linear Methods (3)
MATH 231	Probability & Statistics (3) OR
ECO 45	Statistical Methods (3)

Twelve credits 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. Suggested sequences can be found at www.cse.lehigh.edu/SCISEQ

Required CSB courses (9 credit hours):

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 (9 credit hours):

Courses approved by the student's advisor. See "CSB TRACKS" below

Humanities and Social Science requirements (18 credit hours):

ENGL 1	Composition and Literature (3)
ENGL 2	Composition and Literature II (3)
CSE 252	Computers, Internet and Society (3)

An additional 6 credit hours in the humanities (HU).

An additional 3 credit hours in the social sciences (SS).

CSB Tracks

Students can 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 student's advisor may also approve courses from other departments. Some examples of CSB tracks are presented at www.cse.lehigh.edu/CSBSEQUENCE

Course Descriptions

CSB 311. Computer Applications in Business (3) fall
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 systems development techniques. Application of CASE technology to a hypothetical business project. Prerequisites: ACCT 152 or ACCT 108, and CSE 17 or equivalent. Not available to students who have credit for ACCT 311.

CSB 312. Design of Integrated Business Applications I (3) spring
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. Prerequisite: CSB 311.

CSB 313. Design of Integrated Business Applications II (3) fall
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. Prerequisite: CSB 312

CSB 314. International Practicum (1-3)
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: ACCT 311, or CSB 311, or permission of the instructor.

Computer Science and Engineering

Professors. Daniel P. Lopresti, Ph.D. (Princeton), Chair; Edwin J. Kay, Ph.D. (Lehigh), Associate chair; Henry Baird, Ph.D. (Princeton); Donald J. Hillman, Ph.D. (Cambridge, England); Henry F. Korth, Ph.D. (Princeton), Weiseman Professor of Computer Science and Engineering; Roger N. Nagel, Ph.D. (U. of Maryland), Harvey E. Wagner professor of manufacturing systems engineering.

Associate Professors Liang Cheng, Ph.D. (Rutgers); Mooi Choo Chuah, Ph.D. (UC San Diego); Brian D. Davison, Ph.D. (Rutgers); Jeff Heflin, Ph.D. (U. of Maryland); Hector Munoz-Avila, Ph.D. (U. of Kaiserslautern, Germany): John R. Spletzer, Ph.D. (U. of Pennsylvania).

Assistant Professors. Brian Chen, Ph.D. (Rice); Xiaolei Huang, Ph.D. (Rutgers); Michael Spear, Ph.D. (U. of Rochester); Gang Tan, Ph.D. (Princeton)

Professor of Practice. Sharon Kalafut M.S. (Pennsylvania State Univ.)

Adjunct Professor. Brad Askins M.S (University of Southern California); James Femister, Ph.D. (Lehigh)

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*.

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. 111 Market Place, Suite 1050, Baltimore, MD 21202-4012 and telephone (410) 347-7700.

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. 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 soft ware, 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). 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.

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.

Bachelor of Science in Computer Science and Business

See catalog entry for Computer Science and Business.

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, 111 Market Place, Suite 1050, Baltimore, MD 21202-4012 – telephone (410) 347-7700. 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 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 (36 credit hours):

CSE 18	Data Structures and Programming (3)
CSE 33	Introduction to Computer Engineering (4)
CSE 109	Systems Programming (4)
CSE 130	Technical Presentation (1)
CSE 201	Computer 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 (38 credit hours):

CHM 30	Introductory Chemical Principles and Laboratory (4)
ENGR 1	Engineering Computations (3)
ENGR 5	Introduction to Engineering Practice (3)
MATH 21	Calculus I (4)
MATH 22	Calculus II (4)
MATH 23	Calculus III (4)
MATH 205	Linear Methods (3)

MATH 231	Probability & Statistics (3)
PHY 11, 12	Introductory Physics I and Laboratory I (5)
PHY 21, 22	Introductory Physics II and Laboratory II (5)

Required approved electives (18 credit hours):
Twelve credit hours of CSE courses, not including CSE 42, and an additional 6 credit hours in areas of science and technology, chosen by the student with the approval of the student's advisor. 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

Humanities and Social Science (HSS) requirements (30 credit hours):

ENGL 1	Composition and Literature (3)
ENGL 2	Composition and Literature II (3)
ECO 1	Principles of Economics (4)
CSE 252	Computers, Internet and Society (3)

An additional 17 credit hours of HSS courses that satisfy the Engineering College "breadth and depth" requirements.

Free Electives (6 credit hours)

College of Arts and Sciences:

Bachelor of Science in Computer Science

See the distribution requirements of the College of Arts and Sciences, section III.

Total required credit hours: 127

Required Computer Science courses (40 credit hours):

CSE 15	Introduction to Computer Science (4)
CSE 17	Programming and Data Structures (3)
CSE 33	Introduction to Computer Engineering (4)
CSE 109	Systems Programming (4)
CSE 130	Technical Presentation (1)
CSE 201	Computer 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 (30 credit hours):

MATH 21	Calculus I (4)
MATH 22	Calculus II (4)
MATH 23	Calculus III (4)
MATH 205	Linear Methods (3)
MATH 231	Probability & Statistics (3)

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.

Required approved electives (18 credit hours):
Twelve credit hours of CSE courses, not including CSE 42, and an additional 6 credit hours in areas of science and technology, chosen by the student with the approval of the student's advisor. 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

Humanities and Social Science (HSS) requirements (30 credit hours):

ENGL 1	Composition and Literature (3)
ENGL 2	Composition and Literature II (3)
CSE 252	Computers, Internet and Society (3)

An additional 21 credit hours of HSS courses that satisfy the Arts and Sciences College distribution requirements.

Free electives (9 credit hours)

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 of the College of Arts and Sciences, section III. 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

Total required credit hours: 120

Required Computer Science courses (36 credit hours):

CSE 15	Introduction to Computer Science (4)
CSE 17	Programming and Data Structures (3)
CSE 33	Introduction to Computer Engineering (4)
CSE 109	Systems Programming (4)
CSE 201	Computer Architecture (3)
CSE 216	Software Engineering (3)
CSE 261	Discrete Structures (3) OR MATH 243 Algebra (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 Math and Science courses (11 credit hours):

MATH 21	Calculus I (4)
MATH 22	Calculus II (4)
MATH 43	Survey of Linear Algebra (3)

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. Engineering students should note that ENGR 1 plus CSE 16 is a substitute for CSE 15. The minor requires 16 credit hours, consisting of the following:

CSE 15	Introduction to Computing (4)
CSE 17	Programming and Data Structures (3)

Plus any three CSE courses, EXCEPT CSE 42, Principles of Computer Game Design, CSE 130, Technical Presentation, and CSE 252, Computers, the Internet, and Society.

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.

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 project 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*.

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.

Departmental Courses

Departmental courses are listed under the prefix CSE. Students should also consult the ECE department listing because electives can be chosen from either department.

Computer Science (CSE)

For Undergraduate Students

CSE 12. Survey of Computer Science (3)
Topics in computer science, Java programming and web page design. Includes multimedia laboratory. Not available to students who have taken CSE 15, 16, or ENGR 1.

CSE 15. Introduction to Computer Science (4) fall and spring
Broad overview of computer science, computer systems, and computer applications. Programming in Java. Interactive Web page development. Includes laboratory. Not available to students who have taken CSE 12 or ENGR 1.

CSE 16. Multimedia laboratory of Computer Science (1)
An introduction to the breadth of computer science using multimedia: the history of the idea of computing, problem solving with computers, object-oriented programming and software engineering, computer architecture, operating systems, networks, user interface design, HTML, Flash, social and ethical issues of computing and artificial intelligence.

CSE 17. Programming and Data Structures (3) fall and spring
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 17 and CSE 18. Prerequisite: CSE 15.

CSE 18. Data Structures and Programming (3) fall and spring
Covers the same topics as CSE 17, except that no previous exposure to Java is assumed. Credit will not be given for both CSE 17 and CSE 18. Prerequisite: ENGR 1 or CSE 12.

CSE 33 (ECE 33). Introduction to Computer Engineering (4) fall
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. Prerequisite: Engr 1 or CSE 17, or CSE 18.

CSE 42. Principles of Computer Game Design (3)
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. Prerequisites: none.

CSE 109. Systems Software (4) fall and spring
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. Prerequisite: CSE 17 or CSE 18.

CSE 130. Technical Presentation (1)
Oral and written communication of information in computer science. Technical writing; structure, style, and delivery of oral presentations; use of visual aids. Presentation topics chosen from the content of CSE 109. Corequisite CSE 17 or CSE 18.

CSE 190. Special Topics (1-3)
Supervised reading and research. Prerequisite: consent of the department head.

CSE 201 (ECE 201). Computer Architecture (3)
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. Prerequisite: CSE/ECE 33.

CSE 209. Assembly Language Programming (3)
Design and development of assembly language programs for computer systems. Interactive input-output, handling interrupts, system architecture, hardware/software tradeoffs. Evaluation of program efficiency. Prerequisite: CSE 109.

CSE 216. Software Engineering (3)
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. Prerequisite: CSE 109.

CSE 241. Database Systems and Applications (3)
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. Prerequisite: CSE 17, or CSE 18 or consent of Instructor.

CSE 252 (EMC 252) (STS 252). Computers, the Internet, and Society (3)
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. (SS)

CSE 261. (MATH 261). Discrete Structures (3)
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. Prerequisite: MATH 21.

CSE 262. Programming Languages (3)
Use, structure and implementation of several programming languages. Prerequisite: CSE 17 or CSE 18.

CSE 265. System and Network Administration (3)
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. Prerequisite: CSE17 or CSE 18.

CSE 271. Programming in C and the Unix Environment (3)
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. Prerequisite: CSE 109.

CSE 302. Compiler Design (3) spring
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: CSE 109 and CSE 318.

CSE 303. Operating System Design (3) fall and spring
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: ECE 201 and CSE 109.

CSE 308. Bioinformatics: Issues and Algorithms (3)
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: CSE 17 or CSE 18 or permission of the instructor.

CSE 313. Computer Graphics (3)
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. Prerequisite: CSE 109 or consent of the instructor.

CSE 318. Introduction to the Theory of Computation (3)
Formal study of theoretical computational models: finite automata, pushdown automata, and Turing machines. Study of formal languages: regular, context-free, and decidable languages. Prerequisite: CSE 261 or MATH 243.

CSE 319. Image Analysis and Graphics (3)
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. Prerequisite: CSE 313 or consent of the instructor.

CSE 320. (BIOE 320) Biomedical Image Computing and Modeling (3)
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. Prerequisite: Math 205 and CSE 109, or consent of instructor.

CSE 326. Pattern Recognition (3)
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: CSE 109, CSE 340, Math 205, and Math 231, or consent of instructor.

CSE 327 (COGS 327). Artificial Intelligence Theory and Practice (3)
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. Prerequisite: CSE 15 or CSE 17 or CSE 18.

CSE 331. User Interface Systems and Techniques (3)
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. Prerequisite: CSE 17 or CSE 18 or consent of the instructor.

CSE 332. Multimedia Design and Development (3)
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, and software development using high level authoring tools. Prerequisite: CSE 12 or CSE 15 or ENGR 1 or consent of instructor.

CSE 334 Software System Security (3)
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. Prerequisite: CSE 109 and CSE 262

CSE 335. Topics on Intelligent Decision Support Systems (3)
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. Prerequisite: CSE 327 or CSE 109.

CSE 336 (ECE 336). Embedded Systems (3)
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. Prerequisite: CSE 17 or CSE 18.

CSE 337 Reinforcement Learning Fall (3)
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. Prerequisite: Math 231 and CSE 109

CSE 340 (MATH 340). Design and Analysis of Algorithms (3)
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: MATH 22 and CSE 261 (MATH 261).

CSE 341. Database Systems, Algorithms, and Applications (3)
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: CSE 17 or CSE 18 or consent of the instructor.

CSE 342. Fundamentals of Internetworking (4)
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. Prerequisite: CSE 109.

CSE 343. Network Security (3)
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. Prerequisite: CSE 342 or CSE 303 or CSE 265

CSE 345. WWW Search Engines (3)
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. Prerequisite: CSE 109.

CSE 347. Data Mining (3)
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: Either CSE 17 or CSE 18 and MATH 231, or BIS 15 and ECO 145.

CSE 348. AI Game Programming (3)
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: CSE 327 or CSE 109.

CSE 350. Special Topics (3)
Selected topics in the field of computer science not included in other courses. May be repeated for credit.

CSE 352. Information Technology for Commerce (3)
Digitization and information integration for business applications: enterprise resource planning, (ERP); customer relationship management (CRM) and supply chain management (SCM); information innovation strategies and their dependence on a common technology architecture; technical, logistical and cultural implications of building and operation information integration systems applications. Consent of instructor.

CSE 360. Introduction to Mobile Robotics (3)
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: Math 205 and CSE 109

CSE 363. Network Systems Design (3)
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. Prerequisite: CSE 342, or CSE 404, or instructor's permission.

CSE 366. Object-Oriented Programming (3)
The implementation of object orientation in languages such as Smalltalk and Java. Objects, classes, inheritance, graphical interfaces, applets, exception-handling, and multithreading. Prerequisite: CSE 17 or CSE 18.

CSE 375. Hardware & Software Topics in Parallel Computing (3)
Introduction to parallel computing, covering both hardware and software topics such as interconnection networks, SIMD, MIMD, and hybrid parallel architectures, parallel languages, parallelizing compiler techniques and operating systems for parallel computers. Prerequisites: ECE 201 and CSE 303 previously or concurrently, or consent of the instructor.

CSE 376. Parallel Algorithms (3)
Parallel algorithms for searching, sorting, matrix processing, network optimization, and selected graph problems. Implementation and efficiency measures of parallel algorithms also considered. Prerequisite: CSE 375 or CSE 340 or consent of instructor.

CSE 379. Senior Project (3)
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. Prerequisite: senior standing and CSE 130.

CSE 392. Independent Study (1-3)
An intensive study, with report, of a topic in computer science which is not treated in other courses. May be repeated for credit. Prerequisite: Consent of instructor.

For Graduate Students

CSE 401 (ECE 401). Advanced Computer Architecture (3)
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. Prerequisite: CSE 201 or equivalent.

CSE 403. Theory of Operating Systems (3)
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. Prerequisite: CSE 303 or equivalent.

CSE 404 (ECE 404). Computer Networks (3)
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 408. Bioinformatics: Issues and Algorithms (3)
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: CSE17 or CSE18 or by Permission of the instructor.

CSE 409. Theory of Automata and Formal Grammars (3)
Finite automata. Pushdown automata. Relationship to definition and parsing of formal grammars. Prerequisite: CSE 318.

CSE 411. Advanced Programming Techniques (3)
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. Prerequisite: CSE 17 or CSE 18 or consent of department head. Credit will not be given for both CSE 109 and CSE 411.

CSE 412. Object-Oriented Programming (3)
Objects, messages, classes and inheritance; the model-view-controller paradigm. Prototyping the user interface.

CSE 416. Advanced Issues in Knowledge-based Systems (3)
Advanced techniques and current applications of knowledge-based systems. Emphasis on knowledge engineering techniques through the development of a substantial system. Prerequisite: CSE 414.

CSE 417. Topics in Information Retrieval (3)
Selected topics in the design of advanced retrieval systems. Prerequisite: CSE 241 or equivalent.

CSE 419. Image Analysis and Graphics (3)
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. Prerequisite: CSE 313 or consent of the instructor.

CSE 420 (BIOE 420). Biomedical Image Computing and Modeling (3)
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. Prerequisite: Math 205 and CSE 109, or consent of instructor

CSE 424. Advanced Communication Networks (3)
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: CSE 342 or CSE 404, and Math 231, or permission of instructor.

CSE 426. Pattern Recognition (3)
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. Prerequisites: CSE 109, CSE 340, Math 205, Math 231, or consent of instructor.

CSE 428. Semantic Web Topics (3)
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 429. Virtual Environments (3)
Software and technology of virtual environment systems. Current research in virtual environments. User tracking, display, and view rendering hardware. VE application programming libraries, real-time rendering techniques, 3D model representations, networking systems for distributed and multiuser environments, 3D user interaction techniques.

CSE 430. Textual Data Mining (3)
Theory and algorithms for topics in textual data mining and statistical natural language processing (NLP). Fundamental mathematics and linguistics of statistical NLP; probability theory and information theory. Text mining algorithms and applications. Practical design, implementation, application and evaluation of statistical NLP and textual data mining techniques in class projects. Prerequisite: CSE 347

CSE 431. Intelligent Agents (3)
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. Prerequisite: CSE 327 or equivalent.

CSE 432. Object-Oriented Software Engineering (3)

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)
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. Prerequisite: Graduate Standing in Computer Science or Consent of Instructor

CSE 435. Topics on Intelligent Decision Support Systems (3)
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) fall
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. Prerequisite: Graduate Standing in Computer Science or Consent of Instructor

CSE 438. Software Architecture (3)
Design and description of software architecture for large systems. Current research topics in software architecture. Individual projects are a significant part of this course. Projects may include the design of a new architecture, reverse engineering the architecture of an existing system, or investigation of a research topic in software architecture. Prerequisite: CSE 216 or CSE 432 or consent of the instructor.

CSE 440. Graph Theory and Application (3)
Fundamental concepts of and algorithms for graphs, including: connectivity, planarity, network flows, matchings, colorings, traversals, duality, intractability and applications. Prerequisite: CSE 340 or consent of instructor.

CSE 441 (Math 441). Advanced Algorithms (3) spring
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 proximation 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)
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. Prerequisite: CSE 342 or CSE 303 or CSE 403 or CSE/ECE 404.

CSE 445. WWW Search Engines (3)
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)
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. Prerequisites: Math 231 or permission of the instructor

CSE 448. AI Game Programming (3)
Contemporary computer games: techniques for implementing the program controlling the computer opponent; using Artificial Intelligence in contemporary computer games to enhance the gaming experience: path-finding and navigation systems; group movement and tactics; adaptive games, game genres, machine scripting language for game designers, and player modeling. This course, a version of 348 for graduate students requires advanced assignments. Credit will not be given for both CSE 348 and CSE 448.

CSE 450. Special Topics (3)
Selected topics in computer science not included in other courses. May be repeated for credit.

CSE 460. Mobile Robotics (3)
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 205 and CSE 109 or their equivalents.

CSE 491. Research Seminar (1-3)
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. Prerequisite: Consent of instructor.

CSE 492. Independent Study (1-3)
An intensive study, with report of a topic in computer science that is not treated in other courses. May be repeated for credit. Prerequisite: Consent of instructor.

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) and through thesis/dissertation credits (see below).

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 and for thesis (490) or dissertation (499) credits, 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.

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.
- A further 6 credits for thesis/project/independent study can be part of the industrial experience.
- Minimum of 18 course credit hours, excluding ENGR 400 and Thesis (490) must be obtained through Lehigh University

Ph.D. program

- Beyond the master's program, ENGR 400 can be taken for a maximum of 9 credits, with at most 3 credits in any registration period.
- In addition to ENGR 400 credits, a maximum of 9 dissertation credits (499) can also be obtained as part of the co-op experience.

ENGR 400. Engineering Co-op for Graduate Students (3)
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 can be applied towards a master's degree and no more than an additional nine credits towards a Ph.D. The credits must be taken P/F.

ENGR 452. (CHE 461, ME 442) Mathematical Methods in Engineering (3) fall
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, eigenvectors, and eigenfunctions. First and higher-order linear differential equations with initial and boundary conditions; Sturm-Louiville 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 475. Research (1)
Projects conducted under the supervision of a faculty advisor. Includes analytical, computational or experimental work, literature searches, assigned readings. Regular meetings with the advisor to consider progress made and future direction are required. The course is open only to graduate students and may be repeated for credit. Prerequisite: Graduate standing and departmental approval.

Cooperative (Undergraduate) Education

See the P.C. Rossin College of Engineering and Applied Science entry in Section III.

Earth and Environmental Sciences

Professors. David J. Anastasio, Ph.D. (Johns Hopkins); Gray E. Bebout, Ph.D. (U.C., Los Angeles); Edward B. Evenson, Ph.D. (Michigan); Kenneth P. Kodama, Ph.D. (Stanford); Anne S. Meltzer, Ph.D. (Rice); Frank J. Pazzaglia, Ph.D. (Penn State); Dork L. Sahagian, Ph.D. (Chicago); Peter K. Zeitler, Ph.D. (Dartmouth).

Associate Professors. Robert K. Booth, Ph.D. (Wyoming); Bruce R. Hargreaves, Ph.D. (U.C., Berkeley); Donald P. Morris, Ph.D. (Colorado); Stephen C. Peters, Ph.D. (Michigan); Joan M. Ramage, Ph.D. (Cornell); Zicheng Yu, Ph.D. (Toronto).

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Emeritus Professors. Paul B. Myers, Jr., Ph.D. (Lehigh); Dale R. Simpson, Ph.D. (Caltech); Bobb Carson, Ph.D. (Washington).

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*.

Field Work and Experiential Learning

The EES department offers its students diverse and abundant field experiences. Supervised internships allow students at all levels to become engaged in projects involving cross-disciplinary research, assessment, and consulting work. The Department runs a nationally-recognized 4week long (6credit) summer field camp in the Rocky Mountains, which offers intense field training in hydrology, ecology, geology, and field methods including computer-based mapping. 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. 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. Most EES undergraduate-and graduate-level courses include field experiences in the form of one-day or weekend-long field trips, and the department sponsors an annual field trip, for all interested EES members (past destinations have included Puerto Rico, Iceland, Scotland, Newfoundland, Argentina, Virgin Islands, the Grand Canyon, and Hawaii).

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 (Dual B.S. Degrees Program)

Graduate Studies

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.

The Earth and Environmental Sciences minor program consists of 1-credit integrated introductory laboratory EES 22 (Exploring Earth), plus other EES courses to bring the total earned in EES to a minimum of 15 credits. At least 8 of the 15 credits must be satisfied by taking EES courses at the 100 or higher levels. Natural science (NS) designated EES College seminars (EES 90) 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 (at least 25 credits)

College Seminar (3)

English Composition (2 courses for 6 credits)

Distribution requirements (at least 2 humanities courses for at least 8 credits, and at least 2 social science courses for at least 8 credits)

Junior Writing Requirement:

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).

MATH and Collateral Science Requirements (at least 8 credits)

- 1 semester of math equivalent to MATH 12 or above for at least 4 credits.
- 1 additional course from Chemistry, Mathematics, or Physics, approved by advisor, for at least 4 credits. Courses cross-listed in EES (e.g., ASTR 105, PHY 105) do not fulfill this requirement.

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.

Required courses for the major (at least 32 credits)

- Gateway Sequence (at least 4 credits):
  - Any introductory course in EES (except EES 4 and EES 22)
  - Integrated introductory laboratory course (EES 22 – Exploring Earth)
- Core sequence in EES major (12 credits):
  - EES 100 – Earth Systems Science
  - EES 200 – Earth History
  - EES 380 – Senior Seminar in EES
- Writing-Intensive Requirement:
  - Completion of a designated writing-intensive during the Junior year, preferably within EES (one designated 200-level course will be offered each semester)
- Major electives (at least 4 courses for at least 16 credits):
  - Select from EES or cross-listed offerings at the 100 through 300 levels
  - Up to 8 credits of EES internship (EES 93, 293) and EES research (EES 393) may be used as major electives (no more than 4 of which can be EES 93/293).

Free electives

Courses chosen from anywhere in the University's curriculum, sufficient credits to bring the total to a minimum of 120 credits.

Degree Requirements for Bachelor of Sciences Degree in Earth and Environmental Sciences

University and College Requirements (at least 25 credits)

College Seminar (3)

English Composition (2 courses for 6 credits)

Distribution requirements (at least 2 humanities courses for at least 8 credits and at least 2 social science courses for at least 8 credits).

Junior Writing Requirement:

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).

MATH and Collateral Science Requirements (at least 21 credits)

- Two courses in Mathematics for at least 7 credits (one must be a course in Calculus)
- One specified course and lab in Chemistry: CHM 30 or CHM 40 (4 credits)
- One specified course and lab in Physics (PHY 10 or 11 and PHY 12) (4 credits)
- To bring total collateral credits to a minimum of 21, at least two additional courses in Biology (BIOS 41 or above), Chemistry (CHM 31 or above), or Physics (PHY 13 or above). Courses cross-listed in EES (e.g., ASTR 105, PHY 105) do not fulfill this requirement.

Required courses for the major (at least 48 credits)

- Gateway Sequence (at least 4 credits):
  - Any introductory course in EES (except EES 4 and EES 22, but including EES 105)
  - Integrated introductory laboratory course (EES 22 – Exploring Earth)
- Core sequence in EES major (12 credits):
  - EES 100 – Earth Systems Science
  - EES 200 – Earth History
  - EES 380 – Senior Seminar in EES
- Field Requirement:

    - Successful completion of EES 341, or other field experience approved by the student's advisor. 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.
- Writing-Intensive Requirement:
    - Completion of a designated writing-intensive during the Junior year, preferably within EES (one designated 200-level course will be offered each semester)
- Major electives (at least 8 courses for at least 32 credits):
    - Select from EES or cross-listed offerings at the 100 through 300 levels
    - At least four of the courses must be at the 300 level
    - Up to 8 credits of EES internship (EES 93, 293) and EES research (EES 393) may be used as major electives (no more than 4 of which can be EES 93/293).

Free Electives:

Courses chosen from anywhere in the University's curriculum, sufficient credits to bring the total to a minimum of 120.

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 (1) 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, 415, 426, or 484), (2) have completed a minimum of three credits of EES 393 (Supervised Research) as part of the baccalaureate program, and (3) 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. Additional useful information can be found on the web sites (*www.lehigh.edu/~incee/* and *www.ees.lehigh.edu*).

Suggested outline of courses for Dual B.S. in CEE & EES

The freshman engineering year (see Section III) is often 29 credits. The H/SS Advanced Requirement of 13 credits is shown below as two 3-credit courses and one 4-credit course. Other options are possible.

second year, first semester (18 credit hours)

MATH 23	Calculus III (4)
MECH 3	Fundamentals of Engineering Mechanics (3)
CHM 31	**Chemical Equilibria in Aqueous Systems (4)
EES Gateway	Gateway Elective (3)
EES 22	Exploring Earth (1)
CEE 11	Surveying (1)
CEE 12	Civil Engineering Statistics (2)

second year, second semester (18 credit hours)

PHY 21	Introductory Physics II (4)
PHY 22	Introductory Physics Laboratory II (1)
MECH 12	Strength of Materials (3)
EES 100	Earth System Science (4)
MATH 205	Linear Methods (3)
MAT 33	Engineering Materials and Processes (3)

third year, first semester (17 credit hours)

CEE 121	Mechanics of Fluids (3)
CEE 142	Fundamentals of Soil Mechanics (3)
EES	100-300 level elective (4)
EES	100 - 200 level elective (4)
CEE 10	Architectural/Engineering Graphics and Design (3)

third year, second semester (18 credit hours)

CEE 242	Principles and Practices of Geotechnical Engineering (3)
CEE 222	Hydraulic Engineering (3)
CEE 170	Introduction to Environmental Engineering (4)
EES 200	Earth History (4)
ECO 1	Principles of Economics (4)

fourth year, first semester (18 credit hours)

CEE 117	Numerical Methods in Civil Engineering (2)
CEE 159	Structural Analysis I (4)
EES	100 to 300 level elective (4)
EES	100 to 300 level elective (4)
EES	100 to 300 level elective (4)

fourth year, second semester (16 credit hours)

CEE 202	Civil Engineering Planning and Engineering Economics (3)
CEE 262	Fundamentals of Structural Steel Design (3) or
CEE 264	Fundamentals of Structural Concrete Design (3)
CEE	**Civil Engineering Approved Elective (4)

Engineering Course *Engineering Science Elective (3)

EES	100 to 300 level elective (4)

year 4/5 summer (0-6 credit hours)

Optional 1 field course

EES 341	Field Camp in Earth and Environmental Sciences (6)

fifth year, first semester (15-19 credit hours)

CEE 203	Professional Development (2)
CEE	**Civil Engineering Approved Electives (3)
H/SS	Humanities/Social Sciences AR Electives (7)

Select 1, or 2 courses from below so the total here and year 4/5 summer is at least 8 credits:

EES Course	EES 380 Senior Seminar in EES
EES Course	100 to 300 level elective (4)

fifth year, second semester (18 credit hours)

CEE	**Civil Engineering Approved Electives (8)
CEE	***Civil Engineering Capstone Design Project Elective (3)
H/SS	Humanities/Social Sciences AR Electives (3)

EES Course (4) 100 to 300 level elective, possibly EES 380 Senior Seminar in EES

**MECH 102, ME 104, or ECE 81.*

***CHEM 31 plus thirteen additional credits of CEE Approved Electives are required; see list on CEE web-site 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*

In addition to EES 100, EES 200, and EES 380, 8 additional EES courses, at least 4 at the 300-level are required for the BS EES degree, including a Field requirement and Writing-Intensive requirement. Please see elsewhere in the catalog for details.

A total of 159 to 174 credit hours is 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**.

Undergraduate Courses

EES 002 (ES 002, GCP 002). Introduction to Environmental Science (3)
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. Prerequisites: none. (NS)

EES 004. The Science of Environmental Issues (1)
Analysis of current environmental issues from a scientific perspective. The focus on the course will be weekly discussions based on assigned readings. Pre- or co-requisite: 3-credit introductory-level (000-level) course in EES (or the cross-listed EES 105/ASTR 105/PHY 105). Staff. (NS)

EES 11. Environmental Geology (3)
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. Prerequisites: none. Evenson (NS)

EES 012. Ice Age Earth (3)
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. Prerequisites: none. Evenson. (NS)

EES 014. Lands of the Midnight Sun (3)
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. Prerequisites: none. Ramage. (NS)

EES 015. Volcanoes and the Ring of Fire (3)
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. Prerequisites: none. Bebout. (NS)

EES 016. Geology of War (3)
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. Prerequisites: none. Pazzaglia. (NS)

EES 021. Introduction to Planet Earth (3)
Processes within the Earth and dynamic interactions between the solid earth, the atmosphere, and the oceans. Lectures. Prerequisites: none. Anastasio, Kodama. (NS)

EES 022. Exploring Earth (1)
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. Pre- or co-requisite: 3-credit introductory-level (000-level) course in EES (or the cross-listed EES 105/ASTR 105/PHY 105). Anastasio, Yu. (NS)

EES 023. Weather and Climate: Past, Present, and Future (3)
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. Prerequisites: none. May be combined with EES 022 or EES 004 for 4 credits. Felzer (NS)

EES 024. Climate Change (3)
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. Prerequisites: none. Yu. (NS)

EES 025. The Environment and Living Systems (3)
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. Prerequisites: none. Morris. (NS)

EES 026 (GCP 026). Energy – Origins, Impacts, and Options (3)
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. Prerequisites: none. Zeitler. (NS)

EES 027 (GCP 027). Natural Hazards: Impacts and Consequences (3)
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. Prerequisites: none. Meltzer. (NS)

EES 028. Conservation and Biodiversity (3)
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. Prerequisites: none. Booth. (NS)

EES 031. Introduction to Environmental and Organismal Biology (3)
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. Lectures. Hargreaves. (NS)

EES 032. Oceanography (3)
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. Prerequisites: none. Peters. (NS)

EES 042. The Natural History of Costa Rica (3)
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. Prerequisite: Consent of instructor (applications through the Study Abroad Office). Limited enrollment. Requires payment of additional program fee and transportation to Costa Rica. Morris (NS)

EES 89 [GCP 089]. Geographic Analysis of our Changing World (3)
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. Lecturedemonstrations. May be combined with EES 022 or EES 004 for 4 credits. Prerequisites: none. Hargreaves (NS)

EES 90. Freshman Seminar (3)

EES 93. Freshman Supervised Internship in Earth and Environmental Sciences (1-2)
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. Prerequisite: consent of supervising faculty.

EES 100. (GCP 100, ES 100) Earth Systems Science (4)
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: EES 22. Felzer. (NS)

EES 105. (ASTR 105, PHY 105) Planetary Astronomy (4)
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. (NS)

EES 115. Surficial Processes (4)
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: EES 22. Pazzaglia. (NS)

EES 131. Introduction to Rocks and Minerals (4)
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. Prerequisite: EES 22. Bebout (NS)

EES 152. Ecology (4)
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. Prerequisite: EES 22. Booth (NS)

EES 200. Earth History (4)
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. Prerequisite: EES 100. Pazzaglia and Hargreaves. (NS)

EES 223. Structural Geology and Tectonics (4)
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. Prerequisite: EES 115 or EES 131. Anastasio. (NS)

EES 250. Terrestrial Ecosystems (4)
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. Prerequisite: EES 115 or EES 152. Yu. (NS)

EES 293. Supervised Internship in Earth and Environmental Sciences (1-4)
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 93, EES 293 and 393 may be applied to EES B.A. and B.S. degrees (additional credits apply to free electives). Prerequisite: consent of supervising faculty.

Advanced Undergraduates and Graduate Students

EES 301. Seismology: Images and Dynamics of the Earth's Interior (4) [3 for graduate registration]
An examination of how earthquakes and active source seismology are used to image subsurface structure and stratigraphy and to understand tectonic processes. Fundamentals of seismic wave propagation in the Earth. Study of earthquakes, reflection, and refraction techniques at crustal, lithospheric, and whole Earth scales. Practical applications, experiment design, data collection, processing, analysis, and interpretation. Field and laboratory projects. Prerequisites: EES 100, or consent of the instructor. Meltzer (NS)

EES 306. Geologic Records of Environmental Change (4) [3 for graduate registration]
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. Prerequisite: EES 100. Kodama. (NS)

EES 316. (CEE 316) Hydrogeology (4) [3 for graduate registration]
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. EES 22, or consent of instructor. Peters (NS)

EES 320. (CEE 320) Engineering Hydrology (3)
Rainfall-runoff analysis, overland flow, hydrograph theories, modeling. Frequency analysis of extreme events. Flood routing. Design storms. Floodplain hydraulics, floodplain delineation. Prerequisite: CEE 222. (ES 2), (ED 1), (NS)

EES 323. (CEE 323) Environmental Groundwater Hydrology (3) spring
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: CE 121 or CEE/EES 316 or permission of instructor. (ES 2, ED 1), (NS)

EES 325. Remote Sensing of Terrestrial and Aquatic Environments (4) [3 for graduate registration]
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: EES 22, or EES 89, or consent of instructor. Ramage. (NS)

EES 327. (CEE 327) Surface Water Quality Modeling (3)
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: CEE 121, CEE 222 and CEE 270. (ES 3), (ED 3)

EES 334. Geosphere Structure and Evolution (4) [3 for graduate registration]
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: EES 131 or consent of instructors. Bebout and Kodama. (NS)

EES 341. Field Camp in Earth and Environmental Sciences (6) summer.
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, among them integrated GIS/GPS computer-based geologic mapping, section measuring, structural analysis, field geophysics, stream hydrology, landscape ecology, limnology, and plant identification and physiology. Four weeks in the field; summer session. Prerequisites: Consent of Field Camp Director Pazzaglia (students must apply through the Lehigh Field Camp Program); declared major in EES; EES 22, and at

least four EES courses at the 100-level or above. Pazzaglia (NS).

EES 352. Limnology (4) [3 for graduate registration]
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. Prerequisite: EES 200 or permission of instructor. Morris (NS)

EES 357. Paleoecology and Landscape History (4) [3 for graduate registration]
Principles and methodologies of paleoecology, 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. Prerequisite: EES 100, or consent of course instructors. Yu (NS)

EES 358. Microbial Ecology (4) [3 for graduate registration]
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). Prerequisite: EES 152, or consent of instructor. Morris (NS)

EES 365. Ecophysiology (4) [3 for graduate registration]
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. Prerequisite: EES 152 and either EES 200 or BIOS 120. Hargreaves. (NS)

EES 379. (CEE 379) Environmental Case Studies (3 to 4)
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: EES 22 or CEE 276 (CHE 276) or permission of the instructor. (NS)

EES 380. Senior Seminar in Earth and Environmental Sciences (4)
Multidisciplinary capstone seminar in the Earth and Environmental Sciences. The seminar will emphasize review of the scientific literature, synthesis, and skills in written and oral communication. Topics vary with offering. May be repeated for credit for use as a free elective that counts towards graduation requirements. Not open to graduate students. Prerequisites: EES 200, and senior standing. Staff. (NS)

EES 386. Wetland Science (4) [3 for graduate registration]
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. Prerequisite: EES 152 or consent of instructor. Not available to students who have taken ES 461, Wetland Policy and Valuation. Booth (NS)

EES 393. Supervised Research in Earth and Environmental Sciences (1-4)
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). Prerequisite: consent of supervising faculty. (NS)

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, 415, 426, and 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*.

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 CO2 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;
- Paleoecological 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.

Graduate Courses

EES 402 (ES 402) Scientific Foundations for Environmental Policy Design (3)
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. Sahagian (NS)

EES 403. Earth System Modeling
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. Felzer

EES 405. Paleo- and Environmental Magnetism (3)
Topics in paleomagnetism and environmental magnetism. Class will design and conduct a research project, read the relevant literature and write a research paper. May be repeated for credit. Prerequisite: Consent of course instructor. Kodama

EES 407. Seismology (3)
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. May be repeated for credit. Prerequisite: an introductory geophysics course. Meltzer

EES 411. Physical and Chemical Processes at the Earth's Surface (3)
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. Peters and Pazzaglia

EES 412. Advanced Fluvial and Tectonic Geomorphology (3)
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 a 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. Prerequisite: EES 21, 25, 115, or consent of instructor. Pazzaglia.

EES 414. Glacial and Quaternary Geology (3)
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. Prerequisite: Consent of instructor. Evenson

EES 415. Paleoclimatology (3)
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. Prerequisite: graduate standing in EES, or consent of course instructor. Yu.

EES 426. Tectonic Processes (3)
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. Prerequisites: graduate standing in EES, or consent of department chairperson. Staff

EES 427. Orogenic Belts (3)
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. Topically variable may be repeated for credit. Prerequisite: Consent of instructor. Anastasio

EES 429. Methods and Applications of Geochronology (3)
Examination of isotopic techniques used to measure geologic time, and their applications. Lectures, laboratories, research projects, field trips. Prerequisite: graduate standing in EES. May be repeated for credit. Zeitler

EES 438. Petrogenetic Processes (3)
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. Prerequisite: consent of course instructor. Bebout

EES 453. Advanced Microbial Ecology (3)
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. Prerequisite: graduate standing or consent of course instructor. Morris

EES 457. Advanced Remote Sensing of the Environment (3)
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. Prerequisites: graduate standing in EES or permission of the instructor. Ramage.

EES 459. Reconstructing Environmental Change (3)
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. Prerequisite: EES 415, or consent of course instructor. Booth.

EES 471. Stable Isotope Chemistry - Theory, Techniques, and Applications in the Earth and Environmental Sciences (3)
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. Prerequisite: consent of instructor. Bebout

EES 473. Aqueous Geochemistry (3)
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. Prerequisites: Graduate standing in EES or permission of the instructor. Peters.

EES 484. Ecosystem Processes (3)
Theoretical and experimental approaches to understanding physical and chemical influences in aquatic environments on organisms and their community, population, and systems ecology. Field trip. Prerequisite: graduate standing in EES. Staff

EES 485. Advanced Topics in Geophysics (1-6)
Intensive study of topics in geophysics not covered in more general courses. May be repeated for credit. Prerequisites: MATH 21, EES 21, or permission of the instructor.

EES 487. Bio-Optics (3)
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. Prerequisite: EES 484 or consent of course instructor. Hargreaves

EES 490. Thesis Research (1-6)
Masters' thesis research directed by research committee. 3-6 credits required for EES M.S. programs. May be repeated for credit. Prerequisite: Permission of research adviser.

EES 491. Investigations in Earth and Environmental Sciences (1-3)
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 (1-3)
Intensive study of topics in modern and Quaternary geology not covered in more general courses. May be repeated for credit.

EES 493. Advanced Topics in Tectonics (1-3)
Intensive study of tectonic processes and products not covered in more general courses. May be repeated for credit.

EES 494. Advanced Topics in Ecosystem Ecology (1-3)
Intensive study of ecosystem processes not covered in more general courses. May be repeated for credit.

EES 496. Advanced Topics in Geochemistry (1-3)
Intensive study of geochemical processes not covered in more general courses. May be repeated for credit.

EES 497. Advanced Topics in Paleoecology and Paleoclimatology (1-3)
Intensive study of paleoecology and paleoclimatology not covered in more general courses. May be repeated for credit.

EES 499. Dissertation Research (1-9)
Ph.D. dissertation research directed by research committee. May be repeated for credit. Prerequisite: Permission of research adviser.

Eckardt Scholars Program

Director. Heather B. Johnson, Ph.D., Associate Professor
610-758-3816; hbj2@lehigh.edu

The Eckardt Scholars Program is a selective and unique honors program in the College of Arts and Sciences emphasizing interdisciplinary exploration as well as student choice and flexibility in designing an independent course of study. Students in the program are exempt from the Arts & Sciences distribution requirements and work with the director to create a course of study that best suits their academic interests and ambitions. The program includes a significant component of independent research in the form of a College Scholar Thesis requirement as a capstone event.

For program requirements, see *Eckardt Scholars Program*, section III.

389. Honors Project for Eckardt Scholars (1-8)
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. Prerequisite: consent of department chairperson.

ECK 81. Eckardt Scholars Seminar (4)
Seminar for first-year Eckardt Scholars. Prerequisite: consent of program director (HU)

ECK 181. Eckardt Scholars Seminar (4)
Seminar for sophomore Eckardt Scholars. Prerequisite: consent of program director (HU)

ECK 281. Eckardt Scholars Seminar (4)
Seminar for junior and senior Eckardt Scholars. Prerequisite: consent of program director (HU)

ECK 282. Independent Study (2-4)
Directed readings for Eckardt Scholars. Pre-requisite: consent of program director (HU)

Economics

Professors. J. Richard Aronson, Ph.D. (Clark); Shin-Yi Chou, Ph.D. (Duke); James Dearden, Ph.D. (Penn State), chair, department of economics; Mary E. Deily, Ph.D. (Harvard); Thomas J. Hyclak, Ph.D. (Notre Dame); Arthur E. King, Ph.D. (Ohio State); Judith A. McDonald, Ph.D. (Princeton); Vincent G. Munley, Ph.D. (S.U.N.Y.); Anthony P. O'Brien, Ph.D. (Berkeley); Larry W. Taylor, Ph.D. (North Carolina); Robert J. Thornton, Ph.D. (Illinois); Todd A. Watkins, Ph.D. (Harvard).

Associate Professors. Frank R. Gunter, Ph.D. (Johns Hopkins); Chad Meyerhoeffer, Ph.D. (Cornell);

Assistant Professors. Ernest Kong Wah Lai, Ph.D. (Pittsburgh); Muzhe Yang, Ph.D. (Berkeley).

Active Emeriti. Nicholas W. Balabkins, Ph.D. (Rutgers); Alvin Cohen, Ph.D. (Florida); Jon T. Innes, Ph.D. (Oregon).

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.

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.

Minor Requirements: (12 credits)

- ECO 119 – Intermediate Macroeconomic Analysis (3)
- ECO 339 – International Trade (3)
- ECO 340 – International Finance (3)
- One of the following:
    - ECO 209 – Comparative Economic Systems
    - ECO 240 – Ireland's Public Sector
    - ECO 303 – Economic Development
    - ECO 342 – Economic Development in China

Minor in Public Policy Economics

This 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.

Minor Requirements: (12 credits)

- ECO 119 – Intermediate Macroeconomic Analysis (3)
- ECO 353 – Public Finance: Federal (3)
- Two of the following:
    - ECO 235 – Labor Economics
    - ECO 311 – Environmental Economics
    - ECO 312 – Urban Economics
    - ECO 336 – Business and Government
    - ECO 354 – Public Finance: State and Local

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:

1. The economics core (16 credits): ECO 1, ECO 105 or 146, ECO 119, ECO 029 and ECO 045.
2. Collateral calculus courses (7 or 8 credits): MATH 51 and 52 or MATH 21 and 22. MATH 51 and 52 are terminal math classes for students planning on careers in fields that are primarily non-quantitative. MATH 21 and 22 are for students considering careers or graduate programs that require a stronger math background.
3. Five elective courses in economics at the 200- or 300-level (15 credits). 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 1. Required courses in the minor are: ECO 105 or 146, 119 or 029, and two elective courses. 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.

Undergraduate Courses

ECO 1. Principles of Economics (4)
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. (SS)

ECO 029. Money, Banking, and Financial Markets (3)
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. Prerequisite: ECO 1. (SS)

ECO 045. Statistical Methods (3)
Descriptive statistics, probability and probability distributions, sampling, estimation, hypothesis testing, chi-square tests, simple regression and correlation. (ND) Note: CBE students may not take MATH 12 as a replacement for ECO 045.

ECO 64. (AAS 64, HIST 64). Plantation to Ghetto (2)
Examination of topics in the economic history of African Americans from the 1500s to the present. Explores the slave trade, slavery, the post-Civil War South, the black family, migration, urbanization, and race and poverty. Prerequisites: ECO 1 recommended. (SS)

ECO 105. Intermediate Microeconomic Analysis (3)
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. Prerequisite: ECO 1 and MATH 51 or 21 or their equivalents. Not available for credit to students who have taken ECO 146. (SS)

ECO 111. (ES 111). Introduction to Environmental Economics (4)
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. Prerequisite: ECO 1. (SS)

ECO 119. Intermediate Macroeconomic Analysis (3)
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. Prerequisite: ECO 1. (SS)

ECO 130. (WS 130) Economics of Race and Gender (2)
The question of the role of race and gender in economic decision-making is explored. Various types of discrimination are discussed in an economic framework and possible remedies are evaluated. The historical role of race and gender in the economy is also discussed. Prerequisite: ECO 1. (SS)

ECO 131. The Canadian Economy (2)
This course analyzes the economic challenges facing the Canadian economy. Some of the issues include: Canada's record on inflation and unemployment; the distribution of income; the role of natural resources; and Canada's health-care and educational systems. Canada's monetary and fiscal policies, and Canada's performance in the international economy will also be examined. Prerequisite: ECO 1. (SS)

ECO 134. Evolution of the Automobile Industry (2)
This course traces the development of the automobile industry from its origin at the turn of the century to the present. Topics include: the Model T and mass production; the development of installment purchases; dealer-company relations; worker-company relations; the rise of imports; and the decline of traditional mass production. Prerequisite: ECO 1. (SS)

ECO 146. Applied Microeconomic Analysis (3)
The application of economic analysis to managerial and public policy decision-making. Prerequisites: ECO 1, MATH 21 or equivalent course, and ECO 045. Not available for credit to students who have taken ECO 105. (SS) Note: MATH 12 does not serve as a pre-requisite for ECO 146.

For Advanced Undergraduates and Graduate Students

ECO 209. Comparative Economic Systems (3)
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. Prerequisite: ECO 1. (SS)

ECO 210. Economic Evolution (3)
Structural changes, social transformation, and sources of the long-term growth of the U.S. economy. Prerequisite: ECO 1. (SS)

ECO 231. Business History (3)
The historical context of the development of the modern business firm in the United States. The roles of entrepreneurship, economic structure, technology, and government policy in the shaping of current business practices. Prerequisite: ECO 1. (SS)

ECO 234. Labor-Management Relations (3)
An analytical study of the U.S. system of industrial relations, including the evolution of the labor movement, worker choice on the issue of union representation, the process of collective bargaining, and the impact of collective bargaining on the management of the firm. Prerequisite: ECO 1. (SS)

ECO 235. Labor Economics (3)
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. Prerequisite: ECO 1. (SS)

ECO 237. Transportation Economics (3)
The principles of transportation in theory and practice. Transport models and their relationship to economic activity. Analysis and evaluation of transportation policies, industry structure and performance. Prerequisite: ECO 1. (SS)

ECO 240. Ireland's Public Sector (3)
This course focuses on public sector programs—and the method used to finance them—in Ireland and compares their structure to that found in both the United States and other countries of Western Europe. Topics include: the policy of neutrality and military (peace-keeping) operations; environmental protection; social welfare programs; health care; education at the primary, secondary and tertiary levels; and key infrastructure areas such as urban planning and transportation systems. Special attention is devoted to how membership in the European Union has impacted the evolution of these programs in Ireland. Prerequisite: ECO 1. (Offered only through Lehigh in Ireland Study Abroad Program). (SS)

ECO 245. Statistical Methods II (3)
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: Economics 045, or a comparable course in introductory statistics. (ND)

ECO 246. Business Cycles and Forecasting (3)
A study of short-term business fluctuations, growth, forecasting and stabilization. Prerequisites: ECO 1 and a course in statistics. (ND)

ECO 259. Athletic Complex Design (3)
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. Prerequisite: ECO 1. (SS)

ECO 273. Community Consulting Practicum (3)
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. Prerequisite: ECO 1. (SS)

ECO 303. Economic Development (3)
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. Prerequisite: ECO 105 or 146. (SS)

ECO 311. Environmental Economics (3)
Resource allocation implications of environmental degradation. Analysis of the benefits and costs associated with alternative pollution control programs and strategies. Prerequisite: ECO 105 or 146. (SS)

ECO 312. Urban Economics (3)
The analysis of economic problems related to urban areas; the nature and function of cities; the economic and spatial characteristics of urban activity. Prerequisite: ECO 105 or 146. (SS)

ECO 313. History of Economic Thought (3)
A survey of the important historical writings that form the foundation of today's mainstream economic theory. Emphasis is on the period from 1750 to 1950 and on such notable economists as Smith, Ricardo, Walras, Marshall, and Keynes. Prerequisite: ECO 105 or 146 or 119. (SS)

ECO 314. Energy Economics (3)
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. Prerequisite: ECO 105 or 146. (SS)

ECO 315. Industrial Organization (3)
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. Prerequisite: ECO 105 or 146. (SS)

ECO 322. Competitor and Market Analysis (3)
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: ECO 105 or 146, ECO 045 and MATH 21, 31 or 51. (SS)

ECO 323. Evolution of Business Strategy (3)
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. Prerequisite: ECO 1. (SS)

ECO 324. The Economics of the Sports Industry (3)
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. Prerequisite: ECO 105 or 146. (SS)

ECO 325 (MKT 325). Quantitative Marketing Analysis (3)
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: MKT 111, ECO 045, ECO 105 or 146, and MATH 21, 31 or 51. (SS)

ECO 327. Real Options and Investment Strategy (3)
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. Prerequisite: FIN 323. (ND)

ECO 332. Monetary-Fiscal Policy (3)
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. Prerequisite: ECO 119 or 029. (SS)

ECO 333. The Economics of Business Decisions (3)
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: ECO 105 or 146, ECO 045, ECO 245, and MATH 21, 31 or 51. (SS)

ECO 336. Business and Government (3)
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. Prerequisite: ECO 105 or 146. (SS)

ECO 339. International Trade (3)
The theory of international trade; the theory of tariffs; United States commercial policies; the impact of growth and development of the world economy. Prerequisite: ECO 105 or 146. (SS)

ECO 340. International Finance (3)
Analysis of balance of payments and disturbances and adjustment in the international economy; international monetary policies. Prerequisite: ECO 119 and 029. (SS)

ECO 342. Economic Development in China (3)
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. (SS)

ECO 343. European Economic Integration (3)
Study of the problems of economic integration throughout Europe, especially in the Post-Cold War era among Western, Central and Eastern European nations. Prerequisite: ECO 209 (may be taken concurrently with permission of instructor). (SS)

ECO 346. Numerical Methods for Business Decisions (3)
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. Prerequisite: FIN 323. (ND)

ECO 351. Introduction to Mathematical Economics (3)
Application of mathematical techniques to economic problems of optimization and to economic models. Prerequisites: ECO 105 or 146 and 119 and MATH 21, 31 or 51. (ND)

ECO 352. Advanced Statistical Methods (3)
Advanced probability theory, probability and sampling distributions, and classical statistical inference. Index numbers, multiple regression, correlation, and analysis of variance. Spectral analysis, Box-Jenkins auto-regressive and moving average stochastic processes. Prerequisites: ECO 105 or 146 and a course in statistics. (ND)

ECO 353. Public Finance: Federal (3)
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. Prerequisite: ECO 105 or 146. (SS)

ECO 354. Public Finance: State and Local (3)
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. Prerequisite: ECO 105 or 146. (SS)

ECO 357. Econometrics (3)
Problems in construction, evaluation and use of econometric models. Applications based on research and case studies. Prerequisites: ECO 105 or 146 or 119, ECO 045 or equivalent course in statistics, and ECO 245. (ND)

ECO 358 (IE 358). Game Theory (3)
A mathematical analysis of how people interact in strategic situations. Applications include strategic pricing, negotiations, voting, contracts and economic incentives, and environmental issues. Prerequisites: ECO 105 or 146 and MATH 21, 31 or 51. (SS)

ECO 362. Martindale Research Seminar (1-3)
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. (ND)

ECO 368. Health Economics (3)
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: ECO 105 or 146 and a course in statistics. (SS)

ECO 371. Special Topics in Economics (3)
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. Prerequisite: ECO 105 or 146 or 119. This course may count towards the ECO major only once; it does not count towards the ECO minor. (ND)

Graduate Courses

ECO 401. Basic Statistics for Business and Economics (3)
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)
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. Prerequisite: Calculus and ECO 401 or equivalent.

ECO 411. History of Economic Thought (3)
Selected topics in the history of economic thought, with special attention to the origins of modern economic theory. Prerequisite: a graduate course in economic theory.

ECO 412. Mathematical Economics (3)
Applications of various mathematical techniques in the formation and development of economic concepts and theories. Prerequisite: consent of the instructor.

ECO 413. Advanced Microeconomic Analysis (3)
A survey of methods of decision-making at the microeconomic level; price theory and econometric applications. Prerequisite: ECO 402 or equivalent.

ECO 414. Advanced Topics in Microeconomics (3)
Resource allocation and price determination. Theories of choice of consumers, firms, and resource owners under various market forms. Prerequisites: ECO 413 or equivalent.

ECO 415. Econometrics I (3)
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. Prerequisite: ECO 401 or equivalent.

ECO 416. Econometrics II (3)
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: ECO 415 or equivalent and calculus.

ECO 417. Advanced Macroeconomic Analysis (3)
Macroeconomic theory and policy. Emphasis on theoretical models and policy implications.

ECO 418. Advanced Topics in Macroeconomics (3)
Models of employment, income and growth in monetary economies. Policies for economic stability and growth. Prerequisite: ECO 417 or equivalent.

ECO 425. Cost-Benefit Analysis (3)
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: ECO 401 and ECO 402 or equivalents; ECO 357 or ECO 415; statistical software beyond EXCEL; or instructor permission.

ECO 429. Monetary Theory (3)
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)
The economics of public spending and taxation; principles of government debt management; theories of budgeting and cost-benefit analysis and public choice.

ECO 436. Economic History of the United States (3)
Analysis of the colonial economy, transition to industrialization, and the role of trade and transportation in America's development. A consideration of the importance of slavery to the 19th-century American economy and other New World economies. Origin and development of banking and financial markets. Prerequisites: ECO 401 and ECO 402 or equivalents.

ECO 440. Labor Economics I (3)
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: ECO 401 and ECO 402 or equivalents.

ECO 441. Labor Economics II (3)
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: ECO 402 and ECO 415 or equivalents.

ECO 447. Economic Analysis of Market Competition (3)
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: ECO 401 and ECO 402 or equivalents; 2 semesters of calculus; or instructor permission.

ECO 451. Urban Economics (3)
The application of traditional and spatial economics to the location of economic activity focusing on the urban economic problems of business location, housing, land value, land use, and intra-urban transportation.

ECO 453. Government Regulation of Business (3)
Analysis of the economic justification for government regulation of private enterprise. Topics include antitrust policy, utilities, and health, safety, and environmental regulation. Prerequisite: ECO 402 or equivalent.

ECO 454. Economics of Environmental Management (3)
Economic theory of natural resources. Optimal policies for the development of renewable and nonrenewable resources and environmental quality. Prerequisite: ECO 402 or equivalent.

ECO 455. Health Economics I (3)
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. Prerequisite: ECO 402 and ECO 415 or equivalents.

ECO 456. Industrial Organization (3)
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)
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: ECO 401 and ECO 402 or equivalents or instructor permission.

ECO 460. Time Series Analysis (3)
Classical decomposition of time series, trend analysis, exponential smoothing, spectral analysis and Box-Jenkins autoregressive and moving average methods.

ECO 461. Forecasting (3)
Methods of economic and business forecasting.

ECO 463 (IE 458). Topics in Game Theory (3)
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, international trade, and finance. Prerequisites: Two semesters of calculus, ECO 412 and ECO 413, or permission of the instructor.

ECO 464. Applied Econometrics I (3)
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. Prerequisite: ECO 416 or equivalent.

ECO 465. Applied Econometrics II (3)
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 labaor economics. Prerequisite: ECO 416 or equivalent.

ECO 466. Health Economics II (3)
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: ECO 402 and ECO 416 or equivalents.

ECO 471. International Economic Development (3)
An introduction to the basic theoretical concepts in international economic development and an evaluation of their application by means of a representative sample of the literature.

ECO 472. International Trade Theory (3)
Theories of comparative advantage, factor price equalization, trade and welfare, tariffs, trade, and factor movements. Prerequisite: ECO 413 or consent of the chair.

ECO 473. International Monetary Economics (3)
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. Prerequisite: ECO 417 or consent of the chair.

ECO 480. Economics of Technological Change (3)
Explores theoretical models and empirical evidence on the economics of innovation and technical change. Includes examination of: the role of technology in competitiveness, industrial structure, and economic growth; alternative models of the innovative process; incentives for and other conditions affecting research and development; the evaluation of the justifications for government support of R&D. Prerequisite: ECO 402 or equivalent.

ECO 490. Master's Thesis

ECO 492. Special Topics in Economics (1-3)
Extended study of an approved topic not covered in scheduled courses. May be repeated for credit.

ECO 496. Doctoral Pre-Dissertation Research Project (up to 9 credits)
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

Education, College of

The College of Education has one academic department, the Department of Education and Human Services. The department faculty and program offerings are listed below followed by descriptions of course offerings. More details on specific degree requirements and on university graduate school regulations can be found in section IV, Graduate Study and Research.

Department of Education and Human Services

Professors. Gary M. Sasso, Ph.D. (Univ. of Kansas), dean; Ward M. Cates, Ed.D. (Duke), associate dean; George J. DuPaul, Ph.D. (Rhode Island), chairperson; Linda M. Bambara, Ed.D. (Vanderbilt), associate chairperson; Christine L. Cole, Ph.D. (Wisconsin-Madison); Lee Kern, Ph.D. (Univ. of South Florida), Iacocca Professor of Education; Edward S. Shapiro, Ph.D. (Univ. of Pittsburgh); Arnold R. Spokane, Ph.D. (Ohio State); George P. White, Ed.D. (Vanderbilt); Roland K. Yoshida, Ph.D. (Univ. of Southern California); Perry A. Zirkel, J.D., Ph.D. (Connecticut), LL.M. (Yale).

Associate Professors. Floyd D. Beachum, Ed.D. (Bowling Green State) endowed Bennett professor of urban school leadership; Mary Jean Bishop, Ed.D. (Lehigh); Alec M. Bodzin, Ph.D. (North Carolina State); Mary B. Calhoon, Ph.D. (Vanderbilt); Grace I.L. Caskie, Ph.D. (Univ. of North Carolina); H. Lynn Columba, Ed.D. (Louisville); Arpana G. Inman, Ph.D. (Temple); Patricia H. Manz, Ph.D. (Univ. of Pennsylvania); Iveta McGurty Silova, Ph.D. (Columbia); Tina Q. Richardson, Ph.D. (Maryland); Jill Sperandio, Ph.D. (Univ. of Chicago); Alexander W. Wiseman, Ph.D. (Pennsylvania State).

Assistant Professors. Cirleen DeBlaere, Ph.D. (Univ. of Florida); Thomas C. Hammond, Ph.D. (Virginia); Robin L. Hojnoski, Ph.D. (Univ. of Massachusetts); Peggy A. Kong, Ed.D. (Harvard); Gregory J. Palardy, Ph.D. (Univ. of California); Minyi Shih, Ph.D. (Univ. of Texas); Brenna K. Wood, Ph.D. (Univ. of Arizona).

Professors of Practice. Jon E. Drescher, P.D. (St. John's); Sothy Eng, Ph.D. (Texas Tech): Christine G. Novak, Ph.D. (Univ. of Iowa).

Adjunct Faculty. Aimee-Nicole C. Adams, Ph.D. (Lehigh); Tonya B. Amankwatia, Ph.D. (Lehigh); Juan R. Baughn, Ed.D. (Temple); Ian T. Birky, Ph.D. (Oklahoma State); Raymond J. Boccuti, Ed.D. (Lehigh); Timothy E. Bonner, M.Ed. (Kutztown); Carol S. Derham, Ed.D. (Lehigh); Louise E. Donohue, Ed.D. (Lehigh); Roger J. Douglas, Ed.D. (Lehigh); Carolyn E. Evans, B.A. (Arcadia); Laurie Gray Evans, Ph.D. (Lehigh); Deidre R. Farmbry, Ed.D. (Univ. of Pennsylvania); Todd A. Fay, D.Ed. (Penn State); William P. Feigley, Ed.D. (Lehigh); Sandra G. Fellin, Ed.D. (NOVA Southeastern); Diane E. Flisser, Ed.D. (Lehigh); Edwina Frasca-Stuart, Ed.D. (Pennsylvania State); Susan N. Fuller, Ph.D. (Univ. of Nebraska); Deborah L. Gardner, Ph.D. (New Mexico State); Scott R. Garrigan, Ed.D. (Lehigh); Michael P. George, Ed.D. (Univ. of Missouri-Columbia); Nancy L. George, Ed.D. (Univ. of Missouri-Columbia); Ronald Goldberg, Ph.D. (Lehigh); Mary R. Goodman, Ed.D. (Lehigh); William E. Haberl, Ed.D. (Lehigh); Roberta A. Heydenberk, Ed.D. (Lehigh); Warren R. Heydenberk, Ed.D. (Colorado); Daphne Pappas Hobson, Ed.D. (Columbia Univ.); Rachel A. Holler, Ed.D. (Lehigh); Tiedan Huang, M.S. (Lehigh); Kevin Kelly, Ph.D. (Lehigh); Lisa A.W. Kensler, Ed.D. (Lehigh); Ilena D. Key, M.A. (Columbia); Eric M. Klein, Ph.D. (Univ. of So. Carolina); Mark J. Klein, J.D. (Rutgers); Freya Koger, Ph.D. (Lehigh); Christina K. Lutz-Doemling, Ed.D. (Lehigh); Steven V. Mancuso, Ed.D. (Lehigh); Beverly A. Martin, Ed.D. (Lehigh); Lawrence E. Martin, Ph.D. (Kent State); Stacy D. Martin, Ph.D. (Lehigh); Warren F. Mata, Ed.D. (Lehigh); John McGovern, Ed.D. (Temple); James R. Newcomer, Ed.D. (Lehigh); Bridget O'Connell, Ed.D. (Lehigh); Merris M. Page-Smith, Ed.D. (Univ. of Sarasota); Jacqueline S. Phillips, Ed.D. (Univ. of Northern Colorado); Thomas J. Power, Ph.D. (Univ. of Pennsylvania); Ralph H. Pruitt, Ed.D. (Lehigh); Susan L. Rarick, Ph.D. (Lehigh); Carol M. Richman, Ph.D. (Virginia Commonwealth); Laura Roberts, Ph.D. (Pennsylvania State); Tina M. Roemersma, Ph.D. (Lehigh); Joseph J. Roy, Ed.D. (Lehigh); Jeffrey M. Rudski, Ph.D. (Univ. of Minnesota); Tina Santilli, M.A. (George Washington); Julie K. Santoro, M.S.P. (Univ. of South Carolina); Thomas L. Seidenberger, Ed.D. (Widener); Bruce S. Sharkin, Ph.D. (Univ. of Maryland); Jack P. Silva, Ed.D. (Lehigh); Timothy J. Silvestri, Ph.D. (Lehigh); Elizabeth Sims-Pottle, Ed.D. (Lehigh); Carole S. Smith, M.S. (Temple); David R. Snyder, Ed.D. (Lehigh); Natalie G. Sokol, Ph.D. (Lehigh); Talida M. State, Ph.D. (Lehigh); Bruce M. Taggart, Ph.D. (Connecticut); Barbara J. Thompson, Ph.D. (Univ. of Maryland); Laurence R. Upton, Ph.D. (Univ. of Minnesota); Samuel A. Varano, Ed.D. (Lehigh); Patricia L. Waller, Ed.D. (Lehigh); Glenn D. Walters, Ph.D. (Texas Tech); James Warfel, Ed.D. (Temple); David R. Weiskotten, Ph.D. (Lehigh); Kenneth K. Zellner, M.Ed. (Kutztown).

Affiliated Faculty. Susan Barrett (Psychology); Mark H. Bickhard (Psychology); Diane T. Hyland (Psychology); Vincent G. Munley (Economics); Ageliki Nicolopoulou (Psychology); John Nyby (Biological Sciences); Padraig G. O'Seaghdha (Psychology); Neal G. Simon (Biological Sciences).

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 below.

Education

EDUC 383. Supervised Research in Applied Psychology (1-3)
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.)

EDUC 388. Statistical Computing (3)
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. Prerequisite: EDUC 408 or consent of instructor.

EDUC 402. Developmental Psychology (3)
Survey of theories and research concerning perceptual, cognitive, social, and personality development through infancy and childhood. Prerequisite: Graduate standing or consent of instructor.

EDUC 403. Research (3)
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)
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)
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)
Emphasis on analysis of variance designs including one-way, factorial, nested, and repeated measures designs. Introduction to multiple regression and the analysis of covariance. Prerequisite: EDUC 408 or consent of instructor.

EDUC 410. Univariate Statistical Models (3)
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. Prerequisite: EDUC 409 or consent of the instructor.

EDUC 411. Multivariate Statistical Models (3)
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 nonstandard models and generalization to complex designs. Prerequisite: EDUC 410 or consent of the instructor.

EDUC 412. Advanced Applications of Psychometric Principles (3)
Conceptual examination of exploratory and confirmatory factor analysis, cluster analysis, latent-trait modeling, and other advanced psychometric topics. Prerequisites: EDUC 409 or equivalent or SCHP/CPSY 427.

EDUC 419. (MLL 419) Second Language Acquisition (SLA) Theory (3)
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. (MLL 421) Intercultural Communication (3)
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. (ESL 422) Theory and Practice for Second Language Learning (3)
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. (ESL 423) Second Language Assessment (3)
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)
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)
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. (CPSY 471) Diversity and Multicultural Perspectives (3)
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. (SR 473) Social Basis of Human Behavior (3)
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)
Design and implement research project under faculty supervision to meet requirements for doctoral programs. May be repeated for credit.

EDUC 491. Advanced Seminars: (with subtitle) (1-6)
Intensive study and discussion of a specialized area. Title will vary. May be repeated for credit as title varies.

EDUC 493. Internship in: (with subtitle) (1-6)
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. Prerequisite: consent of the program director.

EDUC 494. Field Work in: (with subtitle) (3)
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)
Individual or small group study in the field of specialization. Approved and supervised by the major adviser. May be repeated.

EDUC 496. Doctoral Research Seminar (3)
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.

PMGT 401. Project Management: Course Framework & Project Leader Assessment (1)
Introduction to the Project Management Certification Course; syllabus, requirements and deliverables. Students will become acquainted with: the terminology, nine knowledge areas, relationships to other disciplines, project management context and processes. 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)
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, 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. Prerequisite: PMGT 401.

PMGT 403. Project Management: Initiating the Project and Planning Scope and Schedule (2)
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: PMGT 401, PMGT 402

PMGT 404. Project Management: Planning Resources, Communication, Quality and Risk Management (2)
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: PMGT 401, PMGT 402, PMGT 403

PMGT 405. Project Management: Project Leader Communications Expertise and Evaluating Team Performance (1)
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: PMGT 401, PMGT 402, PMGT 403, PMGT 404

PMGT 406. Project Management: Implementing and Managing Projects (2)
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: PMGT 401, PMGT 402, PMGT 403, PMGT 404, PMGT 405

PMGT 407. Project Management: Controlling Performance and Assessing Outcomes (2)
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: PMGT 401, PMGT 402, PMGT 403, PMGT 404, PMGT 405, PMGT 406

PMGT 408. Project Management: Problem Solving, Decision Making and Ethics (1)
This 2day 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: PMGT 401, PMGT 402, PMGT 403, PMGT 404, PMGT 405, PMGT 406, PMGT 407

Comparative and International Education

CIE 400. Comparative and International Education (3)
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)
The goal of the course is 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)
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 onsite 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)
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)
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)
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)
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)
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 fundraising strategy, and raise capital on the basis of proposals developed in class.

CIE 408: Thesis Writing (3)
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.

Counseling Psychology

CPSY 407. (SCHP 407) Crisis Management in the Schools. (3)
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.

CPSY 427. (SCHP 427) Standardized Tests, Measurement and Appraisal (3)
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)
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)
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)
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. Prerequisites: permission of the program coordinator required.

CPSY 440. Introduction to Family Counseling (3)
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)
Theory, research, and technique of counseling within a cultural context. Prerequisites: Admission to CPSY master's program or permission of counseling psychology program coordinator.

CPSY 443. Counseling and Therapeutic Approaches Laboratory (1)
One-credit laboratory will cover counseling skills used in diverse theoretical approaches. Must take along with CPSY 442.

CPSY 445. Elementary & Secondary School Counseling I (4)
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 and Secondary School Counseling II (4)
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 and Secondary School Counseling III (4)
Theory and methods of consultation; development and implementation of student assistance programs; intra-and interagency collaborations. The course will also include observations in schools.

CPSY 451. Helping Skills (3)
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)
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)
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)
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)
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. Prerequisites: admission to the Ph.D. program in counseling psychology or permission of the counseling psychology program coordinator.

CPSY 461. Assessment of Adult Intellectual Functioning (3)
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. Prerequisite: CPSY 427 and permission of the instructor.

CPSY 462. Assessment of Personality (3)
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. Prerequisites: CPSY 427 and admission to the Ph.D. program in counseling psychology.

CPSY 466. Current Issues in Counseling and Therapy (1-6)
Examination of an area of counseling or therapy that is of topical interest to students and faculty. Permission of program director required. May be repeated for credit.

CPSY 470. Independent Study and Research (1-6)
Individual or small group study in the field of counseling. Approved and supervised by the major adviser. May be repeated for credit.

CPSY 471. (EDUC 471) Diversity and Multicultural Perspectives (3)
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)
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. (SCHP 473) Advanced Research Methods in Applied Psychology (1-3)
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)
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. Prerequisite: CPsy 480 and permission of instructor.

CPSY 480. Practicum (1-4)
Twenty hours of weekly supervised practicum training for advanced graduate students in individual, group, and family counseling and therapy. Prerequisites: CPSY 442 and permission of instructor. May be repeated for credit.

CPSY 481. Advanced Multicultural Counseling (3)
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. Prerequisites: CPSY 471, admission to the doctoral program in counseling psychology, and permission of the counseling psychology program coordinator.

CPSY 483. Field Work in Counseling (3-6)
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. Prerequisites: CPSY 480 and permission of the counseling psychology program coordinator.

CPSY 484. (SCHP 484) History and Systems of Psychology (3)
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)
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 DSMIVR medical model will be emphasized. Alternate theories of abnormal psychology will also be discussed.

CPSY 486. Family Counseling Clinic (3-6)
Supervised practicum training for advanced graduate students in family counseling and therapy. Techniques and methods of conducting family counseling and therapy. Prerequisites: CPSY 480 and CPSY 440.

CPSY 487. Advanced Doctoral Practicum I (3)
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. Prerequisite: Admission to the doctoral program in counseling psychology and permission of the counseling psychology practicum coordinator.

CPSY 488. Advanced Doctoral Practicum II (3)
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. Prerequisites: CPSY 487 and permission of the counseling psychology practicum coordinator.

CPSY 489. Advanced Doctoral Practicum III (1)
Supervised field experience in counseling and therapeutic settings for doctoral students with specific populations. In consultation with onsite 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. Prerequisites: CPSY 488 and permission of the counseling psychology practicum coordinator.

CPSY 491. Advanced Doctoral Practicum IV (1)
Supervised field experience in counseling and therapeutic settings for doctoral students with specific populations. In consultation with onsite 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. Prerequisites: CPSY 489 and permission of the counseling psychology practicum coordinator.

CPSY 492. Advanced Field Placement (1-3)
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. Prerequisites: CPSY 491 and permission of the counseling psychology practicum coordinator.

CPSY 498. Counseling Psychology Doctoral Internship (1)
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. Prerequisite: CPSY 491 and permission of the counseling psychology program coordinator. (Repeatable for a total of 3 credits).

Educational Leadership

EDL 400. Organizational Leadership and Change Management (3)
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)
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 405. The Principalship II (3)
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 408. Central Office Internship I (2)
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 to the school board, human resource manager, instructional leader, financial manager, and director of community relations.

EDL 409. Central Office Internship II (2)
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. Prerequisite: Central Office Internship I.

EDL 414. Principal Internship I (2)
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)
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)
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)
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)
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)
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)
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)
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)
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)
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)
Advanced supervised field experience in all aspects of district-wide curriculum and instructional activities. Requires monthly seminar meetings. Prerequisite: EDL 428.

EDL 430. Development and Administration of Special Education Programs (3)
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)
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)
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)
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 a 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)
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)
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)
Supervised field experience in all aspects of district-wide special education programs. Requires monthly seminar meetings. Prerequisite: EDL 438.

EDL 440. Development and Administration of Pupil Services Programs (3)
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)
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)
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)
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)
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)
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)
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)
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)
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)
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) (1-6)
Intensive study and discussion of a specialized area. Title will vary. May be repeated for credit as title varies.

EDL 476. School Resources Management (3)
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)
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)
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)
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)
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)
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)
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. Prerequisite: Official standing as a doctoral student in educational leadership.

School Psychology

SCHP 402. (SPED 402) Applied Behavior Analysis (3)
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)
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)
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. (CPSY 407) Crisis Management in the Schools (3)
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)
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)
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)
Administration and interpretation of individual tests of intelligence used in school evaluation and preparation of psychological reports. Prerequisite: permission of instructor.

SCHP 423. Behavioral Assessment (3)
Techniques of behavioral assessment including direct observation, interviews, checklists, rating scales, self-monitoring and role-play tests. Prerequisite: permission of instructor.

SCHP 425. Assessment and Intervention in Educational Consultation (3)
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. Prerequisites: SCHP 402, SCHP423.

SCHP 426. Advanced School and Family Interventions (3)
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. Prerequisite: SCHP 402 or permission of instructor.

SCHP 427. (CPSY 427) Standardized Tests, Measurement and Appraisal (3)
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 (with subtitle) (1-3)

SCHP 431. Practicum in Consultation Procedures (1-3)
Supervised experience in conducting school-based consultations. Co-requisite, SCHP 412.

SCHP 432. Practicum in Assessment of Intelligence (1-3)
Supervised experience in the administration and interpretation of intelligence tests. Co-requisite, SCHP 422.

SCHP 433. Practicum in Behavioral Assessment (1-3)
Supervised experience in conducting behavioral assessments in school settings. Co-requisite, SCHP 423.

SCHP 434. (SPED 434) Applied Research Practicum (1-3)
Designing and conducting research projects in applied settings.

SCHP 435. Practicum in Assessment & Intervention in Educational Consultation (1-3)
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 (with subtitle) (1-3)
Supervised field experience in school psychology with a specific population or setting. May be repeated for credit. Permission of instructor required.

SCHP 437. Advanced Child Psychopathology (3)
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. Prerequisites: admission to doctoral program or by permission of instructor.

SCHP 438. Health/Pediatric Psychology (3)
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. Prerequisites: admission to doctoral program in school psychology or permission of instructor.

SCHP 439. Comprehensive School Health Programs (3)
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)
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. Prerequisite: SCHP 438 or SCHP 439 or permission of instructor.

SCHP 442. Doctoral Practicum in School Psychology (1-6)
Field-based experience in providing psychological services in school and/or clinical settings. Prerequisite: admission to doctoral program. May be repeated for credit.

SCHP 443. Certification Internship (1-6)
Fulltime 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.

SCHP 444. Doctoral Internship (1-6)
Fulltime 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.

SCHP 473. (CPSY 473) Advanced Research Methods in Applied Psychology (1-3)
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 (CPSY 484). History and Systems of Psychology (3)
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 (with subtitle) (3)
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. Prerequisite: admission to doctoral program.

Special Education

SPED 330. Special Topics in Special Education: (with subtitle) (1-3)
Current issues in the education of individuals with special needs. Titles vary. May be repeated for credit as title varies.

SPED 332. Education and Inclusion for Individuals with Special Needs (3)
Legal, educational and social issues related to the special education of individuals with mental retardation, physical disabilities, emotional/behavioral disorders, learning disabilities, visual and hearing impairments, health impairments and those who are intellectually gifted. Emphasis will be on meeting the diverse needs of students in general education classrooms and settings.

SPED 338. Emotional and Behavioral Disorders of Children (3)
Definition, classification, etiology, treatment, and historical perspective of children and adolescent disorders.

SPED 402. (SCHP 402) Applied Behavior Analysis (3)
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 418. Life Skills and Transition Strategies (3)
Curriculum and methods for teaching skills of daily living and preparing students with disabilities for transition to adult living. Includes vocational training, community skills, home and daily living, self-care, leisure, communication and functional academics. Emphasis on transition planning for students with physical disabilities, emotional disturbance, learning disabilities, developmental disabilities, traumatic brain injury, autism, severe disabilities and related challenges.

SPED 419. Academic and Curricular Strategies for Individuals with Disabilities (3)
Methods course designed to increase knowledge of instruction of reading, language arts, mathematics and content area skills. Emphasis on instructional design and strategies, evaluation of commercial textbooks and possible modifications needed for use with individuals with disabilities.

SPED 420. Intern Teaching: Certification (2-3)
Competency-based practice in application of procedures for teaching a broad spectrum of individuals with special needs in preparation for Level I Certification as a Teacher of the Mentally or Physically Handicapped. Prerequisite: consent of program coordinator one semester before registering for this course.

SPED 428. Positive Behavior Support (3)
The design of comprehensive, multi-component behavior support plans for individuals with disabilities who engage in challenging behaviors. Topics include functional assessment strategies, antecedent and setting event interventions, alternative skill training, consequence strategies, lifestyle interventions and teaming strategies. Taught from a non-categorical perspective. Prerequisite: SPED 402 or permission of the instructor.

SPED 429. Professional Seminar (3)
Master's seminar on current issues in the area of special education and research design. Prerequisite is 18 graduate credits in special education.

SPED 430. Advanced Seminar in Special Education (3)
Advanced issues relating to the field of special education. Titles will vary.

SPED 434. (SCHP 434) Applied Research Practicum (1-3)
Designing and conducting research projects in applied settings.

SPED 440. Early Academic Intervention (3)
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. Learning Disabilities: Inclusion and Issues (3)
Explores major topics, issues, and trends in the area of learning disabilities. An overview of historical foundations of learning disabilities, theoretical perspectives and medical aspects, definition, etiology, characteristics, assessment, service delivery models, educational approaches, and instructional design. Emphasis on inclusion strategies for

adjusting and adapting to the mainstream settings in preschool, school, and post school environments.

SPED 444. Classroom Management (3)
Introduction to positive behavior support strategies to improve student behavior. Topics include school-wide and class-wide interventions and functional assessment to develop individualized behavior support plans. Prerequisite: Enrollment in special education program.

SPED 446. Practicum/Seminar in Academic Interventions (3)
Supervised field work with emphasis on designing and implementing academic interventions. Emphasis on collaboration with general education teachers and parents. Requires one-hour monthly seminar meetings. This course is restricted to students enrolled in the Academic Intervention Specialist program.

SPED 448. Practicum/Seminar in Positive Behavior Specialist 1 (3)
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)
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 and Planning for Individuals with Disabilities (3)
Educational assessment procedures for individuals with special needs. Understanding and applying formal and informal assessments. Emphasis on curriculum-based assessment for placement and monitoring student progress in instructional materials. Translating assessment information to develop an individualized instructional plan for a student with a disability.

SPED 465. Advanced Methods for Inclusion (3)
Advanced techniques for educating students with disabilities in general education based on current research and practice. Accommodations and planning for physical inclusion. Instructional inclusion through embedded instruction, adaptations, and curriculum overlapping. Decision hierarchies for level of instructional adaptation. Social inclusion methods through methods of social facilitation. Taught from a non-categorical perspective and addresses students with all levels of disability (e.g., mild and severe). Prerequisite: SPED 332, admission to the special education program, or permission of instructor.

SPED 490. Doctoral Seminar in Special Education (3)
Advanced knowledge of issues and research in the education of individuals with special needs. Topics will vary. May be repeated for credit. Prerequisite: admitted for doctoral studies.

Teaching, Learning and Technology

LST 401. Overview of Learning Sciences and Technology (3)
Foundations and key concepts in Learning Sciences and Technology. Cognition and brain-based research with a focus on technology's role in learning.

LST 403. Designing Learning Environments (3)
Social, cognitive, and physical factors in teaching and learning. Systems theory applied to learning settings. Special emphasis on motivational theories. Prerequisite LST 401 or permission of instructor.

LST 420. Critical Reading and Writing (3)
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 312. Classroom Practice (1-3)
Experience in elementary and secondary classrooms as related to theories of child and adolescent development, classroom didactics, and philosophies of education. Problem-centered discussion and observations. May be repeated for credit. Prerequisite: consent of the program director.

TLT 314. Seminar in Elementary and Secondary Education (3)
Critical analysis and discussion of classroom instructional practices based on experiences of participants as they engage in teaching experiences. Prerequisite: consent of the program director.

TLT 367. (ES 367) Environmental Education (3)
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 391. Workshops (1-3)
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.

TLT 394. Special Topics in Education: (with subtitle) (1-3)
Examination of a topic of research or professional interest in education. Subtitle will vary. May be repeated for credit as subtitle varies.

TLT 405. Introduction to Testing and Evaluation (3)
Construction and evaluation of the teacher-made test. Selection of published tests and interpretation of individual and group results. Use and misuse of tests in assessing achievement.

TLT 406. Tools for Teaching and Learning (3)
Application of technology in school-based instructional settings. This course addresses the use of technology tools and resources to enhance and manage learning. Students will demonstrate skills in design and development of Web sites, evaluation and use of educational software, production and integration of digital media, and other key competencies.

TLT 407. Designing for Teaching and Learning (3)
Theoretical, philosophical and curricular foundations of instruction. This course explores theories of learning and their application, implications for the use of technology and standards-based education. Special emphasis on planning, developing and assessing instruction. Prerequisite: Successful prior completion of TLT 406.

TLT 408. Development, Classroom Management and Assessment: Elementary (3)
Classroom strategies and techniques to provide an effective elementary classroom setting are highlighted. Emphasis on classroom organization to facilitate instruction, establishing rules and procedures, and conducting formative and summative assessments in elementary classrooms.

TLT 409. Development, Classroom Management and Assessment: Secondary (3)
Classroom strategies and techniques to provide an effective secondary classroom setting are highlighted. Emphasis on classroom organization to facilitate instruction, establishing rules and procedures, and conducting formative and summative assessments in secondary classrooms.

TLT 410. The Writing Process (3)
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 412. Social Studies in Elementary Education (3)
Elementary curriculum, content, teaching strategies, and instructional materials of the social studies field. Emphasis on organizing content, using appropriate methods, testing and evaluation, and innovations for social studies at the elementary level. Examines textbooks, courses of study, and teacher-made materials.

TLT 420. Reading in Elementary Education (3)
Principles of teaching reading in elementary schools. Selection of appropriate materials, methods, and techniques. Beginning reading instruction and the development of strategies for teaching vocabulary and comprehension in narrative and expository texts.

TLT 422. Language Arts in Elementary Education (3)
Principles of language learning and the development of communication skills in elementary schools. Methods of teaching listening, speaking, handwriting, spelling, punctuation, and grammar. Selection of appropriate materials and textbooks.

TLT 424. Children's Literature in Elementary Education (3)
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 Elementary Education (3)
Principles of the elementary science program. Demonstrations and discussions of appropriate materials and techniques for teaching science concepts to elementary school students.

TLT 428. Mathematics in Elementary Education (3)
Mathematical skills and concepts for the elementary school program. Sets, systems of numeration, experience with numbers, operations with numbers, number concepts and numerals, and elements of geometry.

TLT 430. Programs for Gifted and Talented (3)
Characteristics of gifted children; teaching gifted children; programs for the gifted in elementary and secondary schools.

TLT 431. Social Studies in Middle Level and High School Education (3)
Secondary curriculum, content, teaching strategies, and instructional materials for the social studies field. Emphasis on organizing content, using appropriate methods, testing and evaluation, and innovations for social studies at the secondary level. Explores textbooks, courses of study, and teacher-made materials.

TLT 432. Reading and Critical Thinking in Middle Level and High School Education (3)
Focuses on expository reading development in content areas such as language arts, mathematics, science and social studies. Practical teaching strategies in critical areas, such as comprehension and study skills. Review of research and methods for improving the reading development of students.

TLT 434. English in Middle Level and High School Education (3)
Curricula, philosophy, methods, strategies, and materials in the teaching of English. Literature, genres, and the nature of text and text differences. Critical analysis and drawing inferences from narrative text and poetry. Applications of technology and assessment principles.

TLT 436. Science in Middle Level and High School Education (3)
Curricula, philosophy, methodology, strategies and safety in the teaching of middle and high school science. Emphasis on laboratory and instructional technology, at risk and underrepresented students and current models of science education.

TLT 438. Mathematics in Middle Level and High School Education (3)
Curricula, instructional activities, and manipulative aids applicable to mathematics courses in middle level and high schools. Teaching strategies and materials appropriate for teaching mathematics will be emphasized.

TLT 440. Pre-professional Seminar (3)
Study, directed observation of, and initial practice in the various phases of teaching in a laboratory-demonstration school or in area elementary and secondary schools. Prerequisite: consent of the program director.

TLT 442. Intern Teaching (2-3)
Intensive practice in the application of principles of teaching. Supervision is provided by the Cooperating school and by the university. Prerequisite: consent of the program director.

TLT 444. Intern Teaching Seminar (3)
Critical analysis and discussion of classroom instructional practices. Discussion and illustration based on experience of participants as they engage in intern teaching. Prerequisite: consent of the program director.

TLT 450. Technology in School Settings: (with subtitle) (1-3)
Focused examination of problems, key issues, and approaches to the use of technology in school settings. Topics will vary (for example, Technology's Role in Facilitating School Restructuring; Teaching for Brain based Learning; Enhancing Gifted Education Through Technology). May be repeated for credit as topic varies.

TLT 452. The Systematic Design of Instruction (3)
Introductory exploration of instructional design models and philosophies and their implications for teaching and learning using technology. Heavy focus on instructional message design. Applies perception theory, communication theory, and learning theory to the design of instructional media. Students in this course design instructional materials employing the theories and guidelines explored. Pre/co-requisite: LST 401.

TLT 454. Applied Instructional and Interface Design Principles (3)
Exploration and application of design models for learning. Special emphasis on graphical user interfaces in education and training. Prerequisite: TLT 452.

TLT 456. Advanced Instructional Design (3)
Advanced instructional design and interface issues. Design of instructional environments, selection of instructional metaphors, impact of the interface on the user, and demands of designing for newer learning technologies. Prerequisite: TLT 454.

TLT 458. Website and Resource Development for Learning (3)
Introduction to resource development and HTML editing tools used in the creation of eLearning Websites. Covers fundamentals of: HTML and commercial Web creation software packages; scanners and digital video cameras; and use of digital resource creation-and-manipulation programs. Prerequisite: TLT 406 or permission of instructor.

TLT 460. Interactive Multimedia Programming for Learning (3)
Introduction to creating educational applications utilizing sound, video, graphics and other digital resources. Prerequisite: TLT 458.

TLT 462. Advanced Development of Instructional Resources and Technologies (subtitle) (3)
Focus on using more sophisticated 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; Audio Resource Development; Media Production for Instructional Programming). May be repeated for credit under different topic. Prerequisite: TLT 460.

TLT 470. Integrating Technology in the Classroom (3)
Planning for integration of instructional technology in individual classrooms. Analysis of available technologies, both hardware and software, and identification of technologies matched to instructional needs. Focus on assessing the impact of technology on student outcomes

TLT 471. Planning for Implementing Technology at the School or District Level (3)
Logistics of implementing technology for a school or school district. Covers staffing, budgeting, facilities, staff development, and proposal preparation. Students in the course create complete technology plans.

TLT 474. Budgeting, Maintaining, and Evaluating Technology (3)
Generating budgets for technology implementation, planning for maintenance and continuity in technology services, evaluating the effectiveness and impact of technology implementations.

TLT 476. Technology Program Evaluation (3)
Techniques for evaluating technology implementations. Focus on instrumentation, data collection and analysis, drawing conclusions from data sets, and preparing reports for funders.

TLT 480. Curricular Design and Innovation (3)
Curricular models and their features, with a focus on how curricular design promotes learning in K-12 settings. Special emphasis on technology-enabled curricula, designing for brain-based learning, and curriculum's role in innovation.

TLT 492. Classroom Research Methods (3)
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)
Designing and conducting research projects in classroom settings.

Electrical and Computer Engineering

Professors. Filbert J. Bartoli, Ph.D. (Catholic University of America), chair, and Chandler Weaver chair; Rick S. Blum, Ph.D. (Pennsylvania), R. W. Wieseman chair of electrical engineering; D. Richard Decker, Ph.D. (Lehigh); Yujie J. Ding, Ph.D. (Johns Hopkins), Class of '61 professor; Douglas R. Frey, Ph.D. (Lehigh); Miltiadis Hatalis, Ph.D. (Carnegie Mellon); James C. M. Hwang, Ph.D. (Cornell); Thomas L. Koch, Ph.D. (Cal Tech), Daniel E. and Patricia M. Smith professor, Director of the Center for Optical Technologies; Alastair D. McAulay, Ph.D. (Carnegie Mellon); Alan J. Snyder, Ph.D. (Pennsylvania), Vice President and Associate Provost for Research and Graduate Studies.

Associate Professors. Tiffany Jing Li, Ph.D. (Texas A&M); Shalinee Kishore, Ph.D. (Princeton); Karl H. Norian, Ph.D. (Imperial College, London); Nelson Tansu, Ph.D. (Wisconsin-Madison); Svetlana Tatic-Lucic, Ph.D. (Cal Tech.); Meghanad D. Wagh, Ph.D. (I.I.T., Bombay).

Assistant Professors. Sushil Kumar, Ph.D. (Massachusetts Institute of Technology); Parv Venkitasubramaniam, Ph.D. (Cornell); Zhiyuan Yan, Ph.D. (Illinois Urbana-Champaign)

Professors of Practice. William A. Best, M.S. (Virginia Tech), William Haller, M.S. (Lehigh), associate chair, director of engineering minor program, and electrical engineering minor.

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 laboratory, junior electronic circuits 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.

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 135 credit hours. The recommended sequence of courses follows:

See freshman year requirements, section III.

sophomore year, first semester (17 credit hours)

ECE 33	Introduction to Computer Engineering (4)
ECE 81	Principles of Electrical Engineering (4)
PHY 21, 22	Introductory Physics II and Laboratory II (5)
MATH 23	Analytic Geometry and Calculus III (4)

sophomore year, second semester (18 credit hours)

ECE 121	Electronic Circuits Lab (2)
ECE 123	Electronic Circuits (3)
ECE 126	Fundamentals of Semiconductor Devices (3)
MATH 205	Linear Methods (3)
ECO 1	Principles of Economics (4)
	HSS elective (3)

junior year, first semester (17-18 credit hours)

ECE 108	Signals and Systems (4)
ECE 182	Junior Lab (1)
ECE 202	Introduction to Electromagnetics (3)
MATH 208	Complex Variables (3)
	HSS elective (3-4)
	free elective (3)

junior year, second semester (17 credit hours)

ECE 125	Circuits and Systems (3)
ECE 138	Digital Systems Laboratory (2)
ECE 203	Introduction to Electromagnetic Waves (3)
MATH 231	Probability and Statistics (3)
	approved technical elective* (3)
	free elective (3)

senior year, first semester (18-19 credit hours)

ECE 136	Electromechanics (3)
ECE 257	Senior Lab I (3)
	HSS elective (3-4)
	approved technical electives* (6)
	free elective (3)

senior year, second semester (17-18 credit hours)

ECE 258	Senior Lab II (2)
	approved technical electives* (9)
	HSS elective (3-4)
	free elective (3)

**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.

A. 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	Intro to Micro- and Nano-fabrication (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)

B. Signal Processing and Communications

ECE 337	Intro 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 345	Speech Synthesis and Recognition

	(3)
ECE 364	Introduction to Cryptography and Network Security (3)
ECE 387	Digital Control (3)
ECE 389	Control Systems Laboratory (2)
ME 342	Control Systems (3)

C. 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)

D. Computers

CSE ***	Any CSE course except CSE 12, CSE 15, 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: ECE 350 Special Topics (3) (The area of each course must be evaluated individually)

Minor in Electrical Engineering

Minor Program Director: William R. Haller, Associate Chair

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 81	Principles of Electrical Engineering (4) OR ECE 83 and ECE 162 plus departmental approval
ECE 108*	Signals and Systems (4 credit hours)
ECE 121	Electrical Circuits Laboratory (2 credit hours)
ECE 123	Electronic Circuits (3 credit hours)

One of the following Electrical and Computer Engineering Electives:

ECE 33	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

*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.

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, students must select three (3) courses from the following five (5) different areas: ECE 401 Advanced Computer Architecture; ECE 402 Advanced Electromagnetic Theory; ECE 441 Fundamentals of Wireless Communications; ECE 420 Advanced Circuits and Systems; ECE 451 Physics of Semiconductor Devices.

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. The required core courses are: Communication Theory (ECE 342), Fundamentals of Wireless Communications (ECE 441), and Computer Networks (ECE 404). 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. ECE 342 must be the first course taken and the core courses should precede advanced courses.

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.

Electrical and Computer Engineering (ECE)

For Undergraduate Students

ECE 33. (CSE 33) Introduction to Computer Engineering (4) fall
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. Prerequisite: ENGR 1 or CSE 17.

ECE 81. Principles of Electrical Engineering (4) fall
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 83 for credit. Prerequisite: MATH 22. Co-requisite: Phys 21.

ECE 83. Introduction to Electrical Engineering (3) spring
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 81 for credit. Prerequisite: Math 22, Co-requisite: Phys 21.

ECE 108. Signals and Systems (4) fall
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. Prerequisite: ECE 81.

ECE 121. Electronic Circuits Laboratory (2) spring
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. Prerequisite: ECE 81.

ECE 123. Electronic Circuits (3) spring
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. Prerequisite: ECE 81.

ECE 125. Circuits and Systems (3) spring
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. Prerequisite: ECE 108.

ECE 126. Fundamentals of Semiconductor Devices (3) spring
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. Prerequisite: ECE 81.

ECE 136. Electromechanics (3) fall
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. Prerequisite: ECE 81.

ECE 138. Digital Systems Laboratory (2) spring
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. Prerequisite: ECE 33.

ECE 162. Electrical Laboratory (1) spring
Experiments on circuits, machines, and electronic devices. Elementary network theory. Survey laboratory for students not majoring in electrical or computer engineering. Prerequisite: ECE 81, or ECE 83.

ECE 182. Junior Lab (1) fall
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.

ECE 201. (CSE 201) Computer Architecture (3) spring
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. Prerequisite: ECE 33.

ECE 202. Introduction to Electromagnetics (3) fall
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: MATH 205, Phys. 21.

ECE 203. Introduction to Electromagnetic Waves (3) spring
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. Prerequisite: ECE 202.

ECE 212. Control Theory (3)
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. Prerequisite: ECE 125.

ECE 256. Honors Project (1) spring
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)
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 session per week. Prerequisite: Senior status or departmental approval

ECE 258. Senior Lab II (2)
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. Prerequisite: ECE 257 or departmental approval.

ECE 308. Physics and Models of Electronic Devices (3)
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. Prerequisite: ECE 126.

ECE 310. Wireless Circuits (3) spring
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. Prerequisite: ECE203

ECE 319. Digital System Design (3) fall
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. Prerequisite: ECE 138.

ECE 320. Logic Design (3)
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. Prerequisite: ECE 33. Wagh

ECE 324. Microprocessors (3) spring
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) Prerequisite: ECE 33

ECE 325. Semiconductor Lasers I (3)
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. Prerequisite: ECE 203.

ECE 326. Semiconductor Lasers II (3)
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. Prerequisite: ECE 325

ECE 332. Design of Linear Electronic Circuits (3)
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: ECE 123 and ECE 125. Frey.

ECE 333. Medical Electronics (3)
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. Prerequisite: ECE 123 or equivalent. Norian.

ECE 336. (CSE 336) Embedded Systems (3)
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. Prerequisite: CSE 17.

ECE 337. Introduction to Micro- and Nanofabrication (3)
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. Prerequisite: Mat33 or ECE351 or consent of the instructor.

ECE 338. Quantum Electronics (3)
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. Prerequisite: ECE 203.

ECE 339. Graphical Signal Processing (3)
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. Prerequisite: ECE 108.

ECE 341. Fundamentals of Wireless Communications (3)
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. Prerequisite: ECE 108 or permission of instructor.

ECE 342. Communication Theory (3)
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: ECE 125 and MATH 309 or MATH 231.

ECE 343. Digital Signal Processing (3)
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. Prerequisite: ECE 108.

ECE 344. Statistical Signal Processing (3)
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: MATH 231 or MATH 309, and ECE 108. Blum.

ECE 347. Introduction to Integrated Optics (3)
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: ECE 202 and ECE 203.

ECE 348. Lightwave Technology (3)
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. Prerequisite: ECE 203.

ECE 350. Special Topics (3)
Selected topics in the field of electrical and computer engineering not included in other courses. May be repeated for credit.

ECE 351. Microelectronics Technology (3)
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. Prerequisite: ECE 126.

ECE 355. Applied Integrated Circuits (3)
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: ECE 108 and 123. Frey.

ECE 361. Introduction to VLSI Circuits (3)
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. Prerequisite: ECE 123.

ECE 362. Introduction to VLSI System Design (3)
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. Prerequisite: ECE 138.

ECE 364. Introduction to Cryptography and Network Security
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. Prerequisite: Junior or Senior standing.

ECE 371. Optical Information Processing (3)
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. Prerequisite: ECE 108, ECE 202. McAulay.

ECE 372. Optical Networks (3)
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. Prerequisite: ECE 81, ECE 202. McAulay.

ECE 387 (CHE 387, ME 387). Digital Control (3)
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. Prerequisite: CHE 386 or ECE 212 or ME 342 or consent of instructor.

ECE 389 (CHE 389, ME 389). Control Systems Laboratory (2)
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: CHE 386, ME 343, ECE 212.

ECE 392. Independent Study (1-3)
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. Prerequisite: Consent of instructor.

For Graduate Students

ECE 401 (CSE 401). Advanced Computer Architecture (3)
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. Prerequisite: ECE 201 or equivalent.

ECE 402. Advanced Electromagnetics (3)
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: ECE 202 and ECE 203.

ECE 404 (CSE 404). Computer Networks (3)
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)
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)
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. Prerequisites: ECE 108 and either MATH 231 or MATH 309 or equivalents.

ECE 411. Information Theory (3)
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)
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. Prerequisite: ECE 343 or consent of the department chairman. Wagh

ECE 414. Signal Detection and Estimation (3)
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: ECE 108 and MATH 231 or MATH 309. Blum

ECE 415. Numerical Processors (3)
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. Prerequisite: ECE 201. Wagh

ECE 416. VLSI Signal Processing (3)
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. Prerequisite: ECE 361, ECE 343, or equivalent.

ECE 417. Pattern Recognition (3)
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. Prerequisites: MATH 205 and MATH 231, or equivalent.

ECE 420. Advanced Circuits and Systems (3)
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. Prerequisites: Graduate standing, ECE 125 or equivalent.

ECE 423. Digital Image Processing (3)
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. Prerequisite: ECE 343 or equivalent.

ECE 425. Semiconductor Lasers I (3)
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. Prerequisite: ECE 203.

ECE 426. Semiconductor Lasers II (3)
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.

ECE 431. Topics in Switching Theory (3)
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. Prerequisite: ECE 320 or equivalent. Wagh

ECE 432. Spread Spectrum and CDMA (3)
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). Prerequisite: ECE341 or ECE342 or ECE410 or consent of instructor.

ECE 433 (CHE 433, ME 433). State Space Control (3)
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. Prerequisite: ME 343 or ECE 212 or CHE 386 or consent of instructor.

ECE 434 (CHE 434, ME 434). Multivariable Process Control (3)
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. Prerequisite: CHE 433 or ME 433 or ECE 433 or consent of instructor.

ECE 435. Error-Correcting Codes (3)
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. Prerequisite: CSE 261 or equivalent.

ECE 436 (CHE 436, ME 436). Systems Identification (3)
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-imbedding techniques for nonlinear system parameter identification included. Prerequisite: CHE 433 or ME 433 or ECE 433 or consent of instructor.

ECE 437 (CHE 437, ME 437). Stochastic Control (3)
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. Prerequisite: CHE 433 or ME 433 or ECE 433 or consent of instructor.

ECE 438. Quantum Electronics (3)
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. Prerequisite: ECE 203.

ECE 441. Fundamentals of Wireless Communications (3)
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. Prerequisite: ECE 342 or equiv.

ECE 443. RF Power Amplifiers for Wireless Communications (3)
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. Prerequisite: ECE 346 or equivalent.

ECE 447. Introduction to Integrated Optics (3)
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: ECE 202 and ECE 203.

ECE 448. Lightwave Technology (3)
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. Prerequisite: ECE 203.

ECE 450. Special Topics (3)
Selected topics in electrical and computer engineering not covered in other courses. May be repeated for credit.

ECE 451. Physics of Semiconductor Devices (3)
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. Prerequisite: ECE 126 or equivalent. Decker, Hatalis

ECE 452. Advanced Semiconductor Diode and Transport Theory (3)
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. Prerequisite: ECE 451.

ECE 454. Turbo Codes and Iterative Decoding (3)
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. Prerequisite: ECE 435 or instructor's approval

ECE 455. Theory of Metal Semiconductor and Heterojunction Transistors (3)
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. Prerequisite: ECE 451.

ECE 460. Engineering Project (3-6)
Project work in an area of student and faculty interest. Selection and direction of the project may involve interaction with industry. Prerequisite: consent of department chairperson.

ECE 461. Theory of Electrical Noise (3)
Definitions: noise temperature, spectral density. Noise sources: quantum, thermal, shot, generation-recombination, flicker noise. Representation and optimization of noisy networks. Prerequisites: Phys 31 and ECE 126.

ECE 463. Design of Microwave Solid State Circuits (3)
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)
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. Prerequisite: Graduate student status.

ECE 465. VLSI Implementation of Error Control Coding (3)
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. Prerequisite: ECE 435

ECE 467. Semiconductor Material and Device Characterization (3)
This course covers the main characterization techniques used in semiconductor industry. Emphasis is given to the electrical characterization methods although some optical, and physical analytical techniques are reviewed. The principles and the experimental set up for measuring the following parameters are covered: resistivity; carrier and doping concentration; contact resistance and Schottky barrier height; device series resistance; MOSFET's channel length and threshold voltage; carrier mobility; oxide and interface trapped charge; and carrier lifetime. Laboratory sessions provide hands-on experience on some of the above methods. Prerequisites: ECE 126 and ECE 308, or equivalent. Hatalis

ECE 469. Process Modeling for Semiconductor Devices (3)
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. Prerequisite: ECE 308 or 351. Hwang

ECE 471. Optical Information Processing (3)
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. Prerequisite: ECE 108.

ECE 472. Optical Networks (3)
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. Prerequisite: ECE 81.

ECE 474. Analog CMOS VLSI Design (3)
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. Prerequisite: ECE 355 or equivalent.

ECE 476. Analysis and Design of Analog Integrated Circuits (3)
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. Prerequisite: ECE 308 or equivalent.

ECE 478. Analysis and Design of Digital Integrated Circuits (3)
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. Prerequisite: ECE 308 or equivalent.

ECE 479. Advanced MOS VLSI Design (3)
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. Prerequisites: ECE 308 (or equivalent) and ECE 361.

ECE 483. Advanced Semiconductor Devices for VLSI Circuits (3)
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. Prerequisite: ECE 451.

ECE 485. Heterojunction Materials and Devices (3)
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. Prerequisite: ECE 451. Hwang

ECE 486. Integrated Solid-State Sensors (3)
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. Prerequisite: ECE 451.

ECE 491. Research Seminar (1-3)
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. Prerequisite: Consent of instructor.

ECE 492. Independent Study (1-3)
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. Prerequisite: Consent of instructor.

ECE 493. Solid-State Electronics Seminar (3)
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. Prerequisite: consent of instructor. May be repeated for credit.

Electrical Engineering

See listings under Electrical and Computer Engineering.

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 curriculums 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 course sequence in the column on the left will complete 133 credit hours, including all of the required electrical engineering courses, by the end of the fourth year and the rest of 163 credit hours at the end of the fifth year. Since the electrical engineering degree requires 136 credit hours, students normally will complete the requirements for that degree at the end of the ninth semester. It is possible for a student to earn the electrical engineering degree at the end of the eighth semester by accumulating the extra credit hour through advanced placement and/or overload credits.

In the alternative course sequence in the column on the right, the student completes 132 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 are:

EE-EP **EP-EE**

Freshman year (see Section III)

Sophomore year, first semester

PHY 21	(4)	PHY 21	(4)
PHY 22	(1)	PHY 22	(1)
ECE 33	(4)	ECE 33	(4)
ECE 81	(4)	ECE 81	(4)
MATH 23	(4)	MATH 23	(4)
	[17]		[17]

Sophomore year, second semester

PHY 31	(3)	PHY 31	(3)
ECE 121	(2)	ECE 121	(2)
ECE 123	(3)	ECE 123	(3)
ECE 182	(1)	ECE 182	(1)
MATH 205	(3)	MATH 205	(3)
MATH 208	(3)	MATH 208	(3)
HSS	(3)	HSS	(3)
	[18]		[18]

Junior year, first semester

ECE 108	(4)	ECE 108	(4)
PHY 212	(3)	PHY 212	(3)
MATH 231	(3)	EP-Ap.Elec. (3)	
MATH 322	(3)	MATH 322	(3)
ECO 1	(4)	ECO 1	(4)
	[17]		[17]

Junior year, second semester

PHY 213	(3)	PHY 213	(3)
PHY 215	(4)	PHY 215	(4)
ECE 125	(3)	ECE 125	(3)
ECE 126	(3)	ECE 126	(3)
ECE 138	(2)	PHY 262	(2)
HSS	(3)	HSS	(3)
	[18]		[18]

Senior year, first semester

ECE 257	(3)	PHY 340 or ME 104	(3)
PHY 362	(3)	PHY 362	(3)
PHY 363	(3)	PHY 363	(3)
ECE-Ap.Elec.	(3)	EP-Ap.Elec.	(3)
HSS	(6)	HSS	(3)
	[18]		[15]

Senior year, second semester

ECE 136	(3)	ECE 138	(2)
ECE-Ap.Elec.	(9)	EP-Ap.Elec.	(5)
Elective	(4)	HSS	(3)
		Electives	(8)
	[16]		[18]

Fifth year, first semester

EP-Ap.Elec.	(6)	ECE-Ap.Elec.	(3)
Electives	(6)	MATH 231	(3)
PHY 340 or	(3)	ECE 257	(3)
ME 104		Electives	(6)
	[15]		[15]

Fifth year, second semester

PHY 262	(2)	ECE 136	(3)
EP-Ap.Elec.	(6)	ECE-	

		Ap.Elec. (9)	
Electives	(7)	Elective	(4)
	[15]		[16]
Total Credits	[163]	Total Credits	[163]
Credits in 4 yrs [133]	Credits in 4 yrs		

[132]

The 23 credits of EP-approved electives must include at least three courses from the following: PHY 363, 369, (352 or 355), (348 or 365), and 380. The 24 credits of ECE-approved electives must be approved by the student's advisor.

Engineering

See Section III for additional information on the P.C. Rossin College of Engineering and Applied Science.

Undergraduate students who are officially enrolled in the college's co-op program are eligible for 1-6 credits of free electives of ENGR 200, taken as P/F, typically 3 credits for the fall semester of junior year work experience and another 3 credits the following summer.

ENGR 1. Engineering Computations (3) fall-spring
An introductory survey of computing for students in engineering and the sciences. Basic programming concepts, structures and algorithms. Applications to solving scientific problems. Case studies from utilization of computers in various engineering disciplines. Prerequisite: none. Mandatory for and open only for first year RCEAS students.

ENGR 5. Introduction to Engineering Practice (3)
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 50: Directed Study (1-3)
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. Maybe repeated for credit. RCEAS permission required.

ENGR 130: Engineering Communications (1) summer
Experience and theory in oral and written communications preparing students for their first Co-Op work assignments. Required of all Engineering Co-Op students. Prerequisite: ENGR 200, Concurrently.

ENGR 160. Engineering Internship (1-3)
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)
Supervised cooperative work assignment to obtain practical experience. Prerequisite: acceptance into the program. P/F grading.

ENGR 211 (BUS 211). Integrated Product Development (IPD) I (3) spring
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. Prerequisite: junior standing in engineering, business or arts and science. (Mechanical Engineering students must register for ME 211).

ENGR 212. (BUS 212) Integrated Product Development II (2) fall
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. Prerequisite: ENGR 211

ENGR 400. Engineering Co-op for Graduate Students (3)
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 can be applied towards a master's degree and no more than an additional nine credits towards a Ph.D. The credits must be taken P/F.

ENGR 452. (CHE 452, ME 452) Mathematical Methods in Engineering (3) fall
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-Louiville 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 475. Research (1)
Projects conducted under the supervision of a faculty advisor. Includes analytical, computational or experimental work, literature searches, assigned readings. Regular meetings with the advisor to consider progress made and future direction are required. The course is open only to graduate students and may be repeated for credit. Prerequisite: Graduate standing and departmental approval.

Engineering Minor

See Section III for additional information on the Engineering Minor under the heading of the P.C. Rossin College of Engineering and Applied Science.

Core Prerequisites to begin the program: Math 51 (or equivalent) and Physics 5 (or equivalent). May be taken concurrently with EMC1 and EMC2.

Required Courses: EMC1 and EMC2.

Electives: 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.

Group A: Engineering Fundamentals

EMC 105	Engineering Structures & Motion
EMC 110	Energy Engineering
EMC 115	Engineering Materials & Electronics
EMC 120	Systems Engineering

Group B: Integrated Engineering

EMC 42 (CSE 42)	Game Design
EMC 150	Information & Knowledge Engineering
EMC 155	Enterprise Engineering
EMC 156	Embedded Systems
EMC 160	Computer Aided Engineering & Control Systems
EMC 168 (IE 168)	Production Analysis
EMC 170	Software Engineering & Collaborative Environments
EMC 171 (CHE 171, CEE 171, ES 171)	Fundamentals of Environmental Technology
EMC 174	Process Engineering

EMC 1 Macro and micro view of engineering (3)
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. Prerequisite: Math 51 (or equivalent); may be taken concurrently.

EMC 2 Engineering Practicum (3)
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. Prerequisites: Math 51 (or equivalent) and Physics 5 (or equivalent); may be taken concurrently.

EMC 42 (CSE 42) Game Design (3)
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. Prerequisite: None

EMC 105 Engineering Structures and Motion (3)
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. Prerequisite: EMC 1 or EMC 2; may be taken concurrently.

EMC 110 Energy Engineering (3)
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. Prerequisite: EMC 1 or EMC 2; may be taken concurrently.

EMC 115 Engineering Materials and Electronics (3)
"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. Prerequisite: EMC 1 or EMC 2; may be taken concurrently.

EMC 120 Systems Engineering (3)
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. Prerequisite: EMC 1 or EMC 2; may be taken concurrently.

EMC 150 Information and Knowledge Engineering (3)
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. Prerequisite: EMC 1 or EMC 2; may be taken concurrently.

EMC 155 Enterprise engineering (3)
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. Prerequisite: EMC 1 or EMC 2; may be taken concurrently.

EMC 156 Embedded Systems (3)
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, debouching. 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. Prerequisite: EMC 1 or EMC 2; may be taken concurrently.

EMC 160 Computer aided engineering and control systems (3)
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. Prerequisite: EMC 1 or EMC 2; may be taken concurrently.

EMC 168 (IE 168) Production Analysis (3)
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. Prerequisite: Math 21 OR Math 51

EMC 170 Software Engineering & Collaborative Environments (3)
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. Prerequisite: EMC 1 or EMC 2; may be taken concurrently.

EMC 171 (CHE 171, CEE 171, ES 171) Fundamentals of Environmental Technology (4)
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. Prerequisite: One advanced science course or permission of instructor.

EMC 174 Process Engineering (3)
Semiconductor process engineering, including technology to process raw silicon wafer to electronics integrated circuits (ICs). Crystal growth, thin film deposition, photolithography, doping technology. Prerequisite: EMC 1 or EMC 2; may be taken concurrently.

EMC 252 (CSE 252, STS 252) Computers, the Internet, and Society (3)
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. (SS)

Engineering Mathematics

Professors. Philip A. Blythe, Ph.D. (Manchester, England), chair; D. Gary Harlow, Ph.D. (Cornell); Jacob Y. Kazakia, Ph.D. (Lehigh); Alistair K. Macpherson, Ph.D. (Sydney); Herman F. Nied, Ph.D. (Lehigh); Eric Varley, Ph.D. (Brown).

Associate professors. Alparslan Öztekin (Illinois); Eugenio Schuster (California at San Diego).

Emeritus professors. Terry J. Delph, Ph.D. (Stanford); Dominic G.B. Edelen, Ph.D. (Johns Hopkins); Fazil Erdogan, Ph.D. (Lehigh); Stanley H. Johnson, Ph.D. (Berkeley); Arturs Kalnins, Ph.D. (Michigan); Kenneth N. Sawyers, Ph.D. (Brown); Gerald F. Smith, Ph.D. (Brown).

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).

English

Professors. Scott Gordon, Ph.D. (Harvard) *chairperson;* Elizabeth N. Fifer, Ph.D. (Michigan); Edward J. Gallagher, Ph.D. (Notre Dame); Barry M. Kroll, Ph.D. (Michigan) *Robert D. Rodale Professor of Writing;* Barbara Pavlock, Ph.D. (Cornell); Barbara H. Traister, Ph.D. (Yale)

Associate Professors. Kate Crassons, Ph.D. (Duke); Beth Dolan, Ph.D. (North Carolina); Dawn Keetley, Ph.D. (Wisconsin); Edward E. Lotto, Ph.D. (Indiana) *director*, Center for Writing, Math and Study Skills; Seth Moglen, Ph.D. (U.C. Berkeley); Amardeep Singh, Ph.D. (Duke); Stephanie Watts, Ph.D. (Missouri); Edward Whitley, Ph.D. (Maryland).

Assistant Professors. Lyndon Dominique, Ph.D. (Princeton); Suzanne Edwards, Ph.D. (University of Chicago); Mary Foltz, Ph.D. (University of Buffalo, SUNY); Michael Kramp, Ph.D. (Washington State); Jenna Lay, Ph.D. (Stanford); Bob Watts, Ph.D. (Missouri).

Professor of Practice, *Writer-in-Residence and Director,* Berman Center. Ruth K. Setton, Ph.D. (Rice)

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:

English 100	Working with Texts (4)
English 290	Senior Seminar (4)

Four 300-level courses distributed over the following periods (British or American survey may substitute for one 300 level course):

- British to 1660 (ENGL. 125, 327, 328, 360, 362, 364)
- British 1660-1900 (ENGL. 125,126, 331, 366, 367, 369, 371, 372)
- American to 1900 (ENGL. 123, 374, 376, 377, 378)
- 20th C American, British, World, Film, Popular Culture (Engl124, 126, 379, 380, 383, 384, 385, 386, 387)

In addition, each English major elects at least three more 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

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: ENGL 142, 143, or 144. They must also take: ENGL 342, 343 or 344, and at least 4 credit hours of elective courses chosen from: ENGL 142, 143, 144, 170, 201, 281, 342, 343, 344 or 483. Note: the same course cannot fulfill both the core requirement except in the case of courses that can be repeated for credit—201, 342, 343 and 344—which can be taken twice, once for core credit and once as an elective. And must take both: ENGL 305 and 306.

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 English 1 and 2). For the additional credits beyond the 36 required of all English majors, honors students must take the following courses:

ENGL 309	Interpretation: Critical Theory & Practice, or
ENGL 312	Studies in Literary and Cultural Theory and
ENGL 307	Thesis Proposal, and
ENGL 308	Thesis

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 ENGL 142, 143, or 144 and a literature course at the100- or 300-level. They must also take ENGL 342, 343, or 344 and a 4 credit elective taken from the following ENGL 142, 143, 144, 170, 201, 281, 342, 343, 344, or 483. **Note:** the same course **cannot** fulfill both the core requirements except in the case of a course that can be repeated for credit—201, 342, 343, and 344—which can be taken twice, once for core credit and once as an elective.

To minor in writing, students take ENGL142, 143, 144, or 171, and ENGL 201, 342, 343 or 344. They must also take two more courses chosen from: ENGL 142, 143, 144, 171, 201, 281, 342, 343, 344, JOUR 11, 111, 123, 212. **Note:** the same course **cannot** fulfill both the core requirements except in the case of a course that can be repeated for credit —201, 342, 343, and 344—which can be taken twice, once for core credit and once as an elective.

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 one course in medieval British or early American literature (origins through 1776); two courses in British literature, origins through 1660, or American literature, origins through 1820, in addition to the one fulfilling the previous requirement; two courses in British literature, 1660 through 1900, or American literature, 1820 through 1900; two courses, British, American, or world literature, 1900 to present; and one theory course, in literature, writing, or film. 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. English 485 and 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.

Freshman Composition Requirement

With the two exceptions noted below, all undergraduate students take six credit hours of freshman English courses: English 1 and English 2 (or one of the alternatives to ENGL 2 such as 4, 6, 8 or 10. The exceptions are:

- Students who receive Advanced Placement or received 700 or higher on the writing section of the SAT.
- 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 1, followed by ENGL 2, 4, 6, 8, or 10 or be enrolled in ENGL 3, followed by ENGL 5 (or 2, 4, 6, 8, or 10).

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.

Freshman Courses

ENGL 1. Composition and Literature (3) fall
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.

ENGL 2. Composition and Literature II (3) spring
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. Prerequisite: a grade of C- or higher in ENGL 1.

ENGL 3. Composition and Literature I for International Writers (3) fall
Idiomatic English both oral and written, with a strong emphasis on producing well-organized, coherent essays. Enrollment limited to non-native speakers; placement is determined by placement testing or ESL director's recommendation.

ENGL 4. Composition and Literature II: Special Topic A (3) spring
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. Prerequisites: ENGL 1 and consent of department.

ENGL 5. Composition and Literature II for International Writers (3) spring
Continuation of English 3.

ENGL 6. Composition and Literature: Special Topic B (3) spring
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. Prerequisites: ENGL 1 and consent of department.

ENGL 007 (GC 007). Global Literature (3)
This multidisciplinary seminar asks students to develop informed opinions about what it means to be a global citizen, using rhetorical and persuasive techniques to address issues in economics, exile, and the environment. Additional narrative and expository reflections on students' intersession trip are required. Open only to students in the Global Citizenship program. Fulfills the English 2 requirement where needed. (HU)

ENGL 8. Composition and Literature: Special Topic C (3) spring
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. Prerequisites: ENGL 1 and consent of department.

ENGL 10. Composition and Literature: Special Topic D (3) spring
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. Prerequisites: ENGL 1 and consent of department.

ENGL 11. Literature Seminar for Freshmen (3) fall, spring
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. Prerequisite: score of 4 on Advanced Placement Test in English or 700-749 or higher on the writing section of the SAT.

Undergraduate Courses

English 52, 54, 56, and 58 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 English 1 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 English 126 whether or not they have had, or ever plan to take, English 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.

ENGL 38. (AAS 38) Introduction to African Literature (3)
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. (HU)

ENGL 52. (CLSS 52) Classical Epic (3)
Study of major epic poems from Greece and Rome. Works include Homer's Illiad and Odyssey, Apollonius' Argonautica, Vergil's Aeneid, and Ovid's Metamorphoses. (HU)

ENGL 54. (CLSS 54, THTR 54) Greek Tragedy (3)
Aspects of Greek theater and plays of Aechylus, Sophocles, and Euripides in their social and intellectual contexts. (HU)

ENGL 56. (CLSS 56) The Ancient Novel (3)
Examination of the origins of the novel in Greece and Rome. Includes the picaresque novel. (HU)

ENGL 58. (CLSS 58, THTR 58) Greek and Roman Comedy (3)
Study of comedy as a social form through plays of Aristophanes, Menander, Plautus, and Terence. (HU)

ENGL 60. (THTR 60) Dramatic Action (4)
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. (HU)

ENGL 91. Special Topics (1-4)
A topic, genre, or approach in literature or writing not covered in other courses. (HU)

ENGL 100. Working with Texts (4)
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. Departmental approval required. (HU)

ENGL 115. (HMS 115) Topics in Literature, Medicine, and Health (4)
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. (HU)

ENGL 120. Literature from Developing Nations (4)
Contemporary literature from Africa, Central and South America, and Asia. Prerequisite: six hours of freshman English. (HU) Cannot be taken pass/fail.

ENGL 121. Topics in African-American Literature (4)
Selected works of African American literature and/or the literatures of the African diaspora. May be repeated for credit as title varies. Prerequisite: six hours of first-year English. (HU) Cannot be taken pass/fail.

ENGL 123. American Literature I (4)
American literary works through the mid-19th century. Prerequisite: six hours of freshman English. (HU) Cannot be taken pass/fail.

ENGL 124. American Literature II (4)
American literature from the middle of the 19th century to the present. Prerequisite: six hours of freshman English. (HU) Cannot be taken pass/fail.

ENGL 125. British Literature I (4)
British literature and literary history from Beowulf through the Pre-Romantics. Prerequisite: six hours of freshman English. (HU) Cannot be taken pass/fail.

ENGL 126. British Literature II (4)
British literature and literary history from the Romantic period into the 20th century. Prerequisite: six hours of freshman English. (HU) Cannot be taken pass/fail.

ENGL 127. (THTR 127) The Development of Theatre and Drama I (4)
Historical survey of western theatre and dramatic literature from their origins to the Renaissance. (HU)

ENGL 128. (THTR 128) The Development of Theatre and Drama II (4)
Historical survey of western theatre and dramatic literature from the Renaissance to the modern era. (HU)

ENGL 142. Introduction to Writing Poetry (4)
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. Prerequisite: six hours of freshman English. (ND)

ENGL 143. Introduction to Writing Creative Non-Fiction (4)
Practice in writing non-fiction from immediate experience, with emphasis on accurate, persuasive description writing. Prerequisite: six hours of freshman English. (ND)

ENGL 144. Introduction to Writing Fiction (4)
Instruction in the craft of writing fiction. Practice in and classroom criticism of stories written by students taking the course. Prerequisite: six hours of freshman English. (ND)

ENGL 155. The Novel (4)
Selected novels, with attention to such matters as narrative, characterization, and cultural context. Prerequisite: six hours of freshman English. (HU) Cannot be taken pass/fail.

ENGL 157. Poetry (4)
Selected traditional and modern poetry, with attention to voice, form, and cultural context. Prerequisite: six hours of freshman English. (HU) Cannot be taken pass/fail.

ENGL 163. Topics in Film Studies (4)
History and aesthetics of narrative film. May be repeated for credit as subject varies. Prerequisite: six hours of freshman English. (HU) Cannot be taken pass/fail.

ENGL 170. Amaranth (1)
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. Prerequisite: consent of the department chairperson. May be repeated for credit. (ND)

ENGL 171. Writing for Audiences (4)
Practice in writing in a variety of discourse modes for different audiences. Consideration of the role of style, clarity, and careful observation in writing. Prerequisite: six hours of freshman English. (ND)

ENGL 175. Individual Authors (4)
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. Prerequisite: six hours of freshman English. (HU) Cannot be taken pass/fail.

ENGL 177. Individual Works (4)
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. Prerequisite: six hours of freshman English. (HU) Cannot be taken pass/fail.

ENGL 183. Independent Study (1-4)
Individually supervised study of a topic in literature, film, or writing not covered in regularly listed courses. Prerequisite: consent of the department chairperson. (HU)

ENGL 187. Themes in Literature (4)
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. Prerequisite: six hours of freshman English. (HU) Cannot be taken pass/fail.

ENGL 189. Popular Literature (4)
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. Prerequisite: six hours of freshman English. (HU) Cannot be taken pass/fail.

ENGL 191. Special Topics (1-4)
A topic, genre, or approach in literature or writing not covered in other courses. Prerequisite: six hours of freshman English. (HU)

ENGL 201. Special Topics in Writing (1-4)
Approaches not covered in other writing courses. Individual projects. May be repeated for credit. (ND)

ENGL 281. Writing Internship (1-4)
Projects on- or off-campus in professional, governmental, or service organizations. Experience must include extensive writing that can be submitted for review. Enrollment limited to juniors or seniors with a major or minor in English. May be repeated for credit. Prerequisite: approval of department internship adviser or department chair. (ND)

ENGL 282. Professional Internship (2-4)
Supervised projects, on- or off-campus, in professional, government, or service organizations. An interested student must submit a proposal, demonstrating the project's relevance to the study of language, texts, or communication, to the department's internship adviser. May be repeated for credit. Internship credits do not count toward major in English. Prerequisite: junior or senior standing and approval by department internship adviser. (ND)

ENGL 290. Senior Seminar (4)
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. Department Approval Required. Prerequisite: senior English major standing. (HU)

ENGL 291. Special Topics (1-4)
A topic, genre, or approach in literature or writing not covered in other courses. (HU)

Graduate Students taking 300-level courses receive 3 credits; undergraduates receive 4 credits.

ENGL 301. Topics in Literature (4)
A theme, topic, or genre in literature, such as autobiography as literature and the gothic novel. May be repeated for credit as titles vary. (HU)

ENGL 305. Creative Writing Thesis Proposal (fall only) (1)
Preparation to write creative thesis. Requirements include writing a proposal and bibliography. (ND)

ENGL 306. Creative Writing Thesis (spring only) (3)
Portfolio of original creative work in poetry, fiction, or creative non-fiction, plus introductory researched essay. Required for concentration in creative writing. (ND)

ENGL 307. Undergraduate Thesis Proposal (1)
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. (HU)

ENGL 308. Undergraduate Thesis (3)
Open to advanced undergraduates who wish to submit theses in English. Prerequisite: consent of department chairperson. (HU)

ENGL 309. Interpretation: Critical Theory and Practice (4)
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. (HU)

ENGL 310. Introduction to Methods of English as a Second Language Instruction (4)
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. (HU)

ENGL 311. (WS 311) Literature of Women (4)
Constructions of gender in literature from different historical periods, traditions, and nationalities, with a focus on the ways that women writers imagine their own literary authority. Content changes each semester. (HU)

ENGL 312. Studies in Literary and Cultural Theory (4)
Study of a particular contemporary theoretical approach to literature, film, or other cultural texts. May be repeated for credit as the topic changes. (HU)

ENGL 314. Teaching English as a Second Language: A Practicum (3)
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. Prerequisite: English 310.

ENGL 315. (HMS 315) Topics in Literature, Medicine, and Health (4)
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. (HU)

ENGL 316. Native American Literature (4)
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. (HU)

ENGL 318. Topics in African-American Literature and Culture (4)
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. (HU)

ENGL 321. History of the English Language (4)
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. (HU)

ENGL 323. Anglo-Saxon Language and Literature (4)
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. (HU)

ENGL 324. Anglo-Saxon Poetry (4)
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. (HU)

ENGL 327. Major Medieval Writers (4)
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. (HU)

ENGL 328. (THTR 328) Shakespeare (4)
An introduction to Shakespearean drama including comedies, histories, tragedies, and romances. Emphasis on textual study, cultural contexts, and performance strategies. (HU)

ENGL 331. Milton (4)
The poetry and prose of John Milton in the context of the English Revolution. Particular attention to the intersection of

theology and philosophy, and of the personal with the political. (HU)

ENGL 342. Advanced Poetry Writing (4)
An intensive writing workshop in which student poems and related literary texts receive close reading and analysis. Prerequisite: ENGL 142 or permission of writing minor advisor. May be repeated for credit. (ND)

ENGL 343. Advanced Creative Non-Fiction (4)
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. Prerequisite: ENGL 143, or permission of writing minor advisor. (ND)

ENGL 344. Advanced Fiction Writing (4)
An intensive writing workshop in which student stories and related literary texts receive close reading and analysis. May be repeated for credit. Prerequisite: ENGL 144, or permission of writing minor advisor. (ND)

ENGL 360. Middle English Literature (4)
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. (HU)

ENGL 362. The Sixteenth Century (4)
Humanist, Petrarchan and dramatic traditions in the literature of renaissance England. Readings from such authors as Erasmus, More, Wyatt, Sidney, Spenser, and Marlowe. (HU)

ENGL 364. The Seventeenth Century (4)
Literature of the seventeenth century, by such writers as Donne, Herbert, Jonson, Browne, Burton, Milton, Hobbes, Bunyan, and Locke, chronicling the unprecedented variety of aesthetic, political, and social innovations in this "century of revolution." (HU)

ENGL 366. The Restoration and Early Eighteenth Century (4)
Restoration and early eighteenth-century literature, with attention to the cultural forces that shaped the writers and their works. Readings will include Dryden, Behn, Rochester, Wycherley, Congreve, Swift, Finch, Pope, Addison and Steele. (HU)

ENGL 367. The Eighteenth Century (4)
Poetry, drama and prose of the eighteenth century, with attention to cultural forces that shaped the writers, their works, and their position in the canon. Readings of Montagu, Burney, Wollstonecraft, Austen, Fielding, Richardson, Johnson, Sheridan, Sterne, in addition to a few earlier writers. (HU)

ENGL 369. British Romantic Literature (4)
Poetry and prose of Wordsworth, Coleridge, Byron, Shelley, and Keats within the contemporary, political, religious, and social context. (HU)

ENGL 371. British Victorian Literature: Prose and Poetry (4)
Poetry and prose of Tennyson, Browning, Arnold, Swinburne, Carlyle, Mill, Newman, and Ruskin within the contemporary political, religious, and social contexts. (HU)

ENGL 372. British Victorian Literature: Fiction (4)
Major fiction of the Victorian era by such writers as Dickens, Eliot, Thackeray, and Hardy within historical, social, and aesthetic contexts. (HU)

ENGL 374. Early National Literature (4)
United States literature from the Revolution until 1820, emphasizing fiction, poetry and non-fiction that was engaged in forming, and contesting, a national literature and a new national consciousness. Writing will include Franklin, Jefferson, the Federalist writers, Crevecoeur, Occum, Wheatley, Brown, Rowson, Foster, Irving, Cooper, and Rush. (HU)

ENGL 375. Major Authors (1-4)
The works of one or more major literary figures studied in depth. May be repeated for credit as titles and authors vary. (HU)

ENGL 376. Early American Literature (4)
The literature of New England, the Middle Colonies, the South, and the Southwest from Columbus to the close of the eighteenth century, emphasizing our cultural and artistic diversity. (HU)

ENGL 377. American Romanticism (4)
Emerson, Thoreau, Whitman, Hawthorne, Melville, Dickinson, Poe, and their contemporaries. Philosophical, historical, and social background, as well as the aesthetic study of romantic literary works. (HU)

ENGL 378. American Realism (4)
Theory and practice of realistic and naturalistic fiction from the Civil War to the early twentieth-century: Twain, Howells, James, Norris, Crane, Dreiser, Wharton, and regionalists. (HU)

ENGL 379. Modern American Literature (4)
American literature before World War II. Lectures and class discussion of major fiction and poetry. (HU)

ENGL 380. Contemporary American Literature (4)
American literature since World War II. Lectures and class discussions of new writers and of recent works of established writers. (HU)

ENGL 382. Themes in American Literature (4)
Intensive study of one topic in American literature. Readings from the colonial period to the present. May be repeated for credit as title varies. (HU)

ENGL 383. Modernism and Post-Modernism in Fiction (4)
The "anti-realistic' novel; time/space, point of view, narrative voice, structure as meaning. Kafka, Woolf, Beckett, Nabokov, Robbe-Grillet, Faulkner, Borges, Hawkes, Stein. (HU)

ENGL 384. Twentieth-Century World Literature (4)
World literature (Europe, Asia, South America, Africa) from 1900 to present. (HU)

ENGL 385. Modern British and Continental Literature (4)
World English literature and continental literature before World War II. Lectures and class discussion of major fiction. (HU)

ENGL 386. Contemporary British and Post-Colonial Literature (4)
World English literature and continental literature after World War II. (HU)

ENGL 387. Film History, Theory, and Criticism (4)
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. (HU) Cannot be taken pass/fail.

ENGL 388. Independent Study (1-4)
Individually supervised study of a topic in literature, film, or writing not covered in regularly listed courses. Prerequisite: consent of department chairperson. (HU)

ENGL 391. Special Topics (1-4)
A topic, genre, or approach in literature or writing not covered in other courses. (HU)

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.

ENGL 400. Supervised Teaching (1)
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. Prerequisite: Consent of the department chairperson.

ENGL 433. Medieval Genres and Authors (3)
This course, which may be repeated for credit as the title varies, 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.

ENGL 435. Topics in Medieval Literature (3)
This course, which may be repeated for credit as the title varies, 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.

ENGL 439. Sixteenth-Century British Literature (3)
Course may be repeated for credit as title varies. Possible offerings:
Love and Politics: Poetry of the English Renaissance. Study of sonnet sequences, Ovidian lyrics, and the epyllion with an eye to both their sexual politics and their political valence in the Tudor court. Works by Wyatt, Surrey, Marlowe, Sidney, Fulke, Greville, Spenser, Donne, and Shakespeare.
London Unmasked: Representations of the City in Renaissance Literature. An exploration of the love/hate relationship of early modern writers with London. Poetry, pamphlets, sermons, and especially city comedy from Jonson, Dekker, Shakespeare, Donne, and others.

ENGL 441. Seventeenth-Century British Literature (3)
Course may be repeated for credit as title varies. Possible offerings:
Satan in Literature. When we think of Satan, we tend to imagine a ruddy fellow with a widow's peak and goatee. But this figure is the traditional symbol of Satan, not the reality. In fact, to imagine Satan in this way is to commit a precisely Satanic error. Properly understood, the term 'Satan' refers to a quite specific tendency of human thought: the tendency to take signs for the reality to which they refer. This error can take many forms. To religion, it is known as 'idolatry.' To science, it is known as 'magic.' And to economics, it is known as 'capitalism.' Satan can certainly also manifest himself outside the human mind, but these external manifestations may not be the most appropriate site for studying his nature. The Hebrew word 'Satan' means both enemy and accuser, and we ought to contemplate the effects of this alien and hostile element in human psychology. In this course we will investigate the nature of Satan as described in a variety of literary texts drawn from a wide range of historical and cultural situations. The authors studied will include Johann Spies, Christopher Marlowe, John Milton, Lord Byron, Edgar Allen Poe, Fyodor Dostoevsky, Thomas Mann, and Ngugi Wa Thiongo.

Magic in Renaissance Poetry. The late-sixteenth and early seventeenth-centuries saw a precipitous rise of interest in and practice of magic throughout Europe. Magicians such as Cornelius Aggrippa, Paracelsus, Giordano Bruno and John Dee achieved unprecedented influence in popular and intellectual *milieux* alike. This course will look for the influence of magical thinking on the literature of the period, with special attention to the theories of representation. Magic presupposes a performative view of the sign, it assumes that words can do things. Similar beliefs appear to animate the poetry of Donne, Traherne, Herbert, Marvell and Vaughan. We will read these and other poets, alongside some of the periods most influential texts of theoretical and practical magic.

ENGL 442: British Literature of the Restoration (3)
Course may be repeated for credit as title varies. Possible offerings:

Cultural Fictions and Public Lying. The English Civil War taught many thinkers that stable cultures require subjects to agree not to see certain "truths," that public life depends on necessary fictions about which all must deceive themselves. Primary texts by Hobbes, Cavendish, Behn, Wycherley, Swift, and Mandeville; recent writing by Goffman, Bourdieu, Keller, and Haraway.

Witchcraft and History. Eighteenth-century texts continue to use the contradictory "logic" of witchcraft to police women's behavior. Primary texts (Shakespeare, Behn, Defoe, Haywood, Pope, Davys) and recent theoretical writings (Bourdieu, Foucault) will help us think through how we make claims about the past that the participants themselves may have been unaware of or unable to articulate.

ENGL 443: Eighteenth-century British Literature (3)
Course may be repeated for credit as title varies. Possible offerings:

Austen, Burney, Edgeworth and the 1790s. This course emphasizes these women's writers' complex relation to the rebellious and conservative 1790s and will include not only their fiction from the period (including novels Austen drafted then: Pride and Prejudice, Sense and Sensibility, and Northanger Abbey) but also that of some representative gothic novelists (especially Radcliffe) as well as some radical writers (Hays, Wollstonecraft) along with conservative ones (More, Burke).

Literature in the Marketplace. Novels, magazines, children's books and other new forms of prose fiction took shape in eighteenth-century England. The course focuses on ways in which these forms are now being re-read against evidence about the eighteenth-century marketplace, where readers and writers (consumers and producers) intersect with each other and with developments in the book trade (issues of copyright, the professionalization of authorship, etc.) as studied in the relatively new discipline of book history. We will consider archival materials as well as canonical and uncanonical literature.

ENGL 445: British Romantic Literature (3)
Course may be repeated for credit as title varies. Possible offerings:

Romanticism and the Cult of Childhood. Investigating the gender, class, and race issues raised by idealizing particular kinds of childhood in the Romantic era, we will read works that feature children by Rousseau, Wordsworth, Coleridge, Robinson, and Blake. We will also contextualize children's literature by Edgeworth, Smith, Trimmer, Barbauld, the Lambs, etc., within the heated debate about the relative value of moralistic, utilitarian, and imaginative works for children.

ENGL 447: British Victorian Literature (3)
Course may be repeated for credit as title varies. Possible offerings:

Nineteenth-century Narrative and the Making of Selves. This course investigates the intersection of narrative and the construction of interiority and subjectivity in nineteenth-century British novels, poetry, and autobiography. Our study will interrogate notions of the "self," psychic or moral growth, the un- or sub-conscious. We will examine the ways in which narratives construct "selves," in the context of nineteenth-century theories of the mind as well as more recent Psychoanalytical, Gender, and Cultural Theory.

The Problem of Knowledge in the Victorian Age: Nineteenth-century Britain was haunted by the problem of knowledge. "We have but faith; we cannot know," wrote Tennyson in *In Memoriam,* echoing the common quandary concerning the status of spiritual experience. Earlier Thomas Love Peacock had rejected poetry's claim to be a serious pursuit: such a way of grasping the world is obsolete; the new and the only reliable mode of knowing is science. Readings—drawn from the work of Mill, Tennyson, Browning, Arnold, Clough, Pater, Wilde, Darwin, and Huxley—will reveal the intensity of this debate and the striking formulations it produced in poetry, scientific writing, and social critique.

ENGL 449: Modern British Literature (3)
Course may be repeated for credit as title varies. Possible offerings:

Virginia Woolf and the Limits of Biography. Where is the line between diagnosis and interpretation? To what purpose do scholars studying Woolf's work invoke her biography? How does Woolf herself play with and interrogate biography as a genre? Reading Woolf's novels and essays, we will examine the achievements and limits of "psychiatric criticism," interrogate our culture's desire to "know" a writer, and discuss Woolf's own complex rendering of the biographical impulse in her fiction.

Topics in British Modernism. Survey course featuring several major British writers between 1900 and 1945. The course explores different critical and methodological perspectives on writers like James Joyce, Virginia Woolf, T.S. Eliot, D.H. Lawrence, W.B. Yeats, and E.M. Forster.

ENGL 451: Contemporary British Literature (3)
Course may be repeated for credit as title varies. Possible offerings:

Contemporary British and Postcolonial Literature. Survey course featuring British, South Asian, African, and Caribbean writers, between 1945 and the present. The course is organized around themes which vary at the discretion of the instructor.

Contemporary Literature from the United Kingdom and the Commonwealth. The course includes authors such as Rushdie, Munro, O'Brien, Phillips, and Carter among others. Themes include political and social change, race, gender and ethnicity, cultural and historical conflict.

ENGL 471. Early American Literature (3)
Course may be repeated as title varies. Possible offerings:

First Contact: Then and Now. When worlds collide. Voices from and about various frontiers, borderlands, and liminal spaces, from Canada to the Caribbean, from New England to New Spain. Imagining, discovering, exploring, conquering, domesticating, and inventing "America" in original accounts and modern film representations.

The Literature of Justification. How did the European nations justify making war on and taking lands from Native Americans? What were the philosophical and legal justifications of imperial and colonial expansion? Study of the discourse of conquest, of language as the perfect instrument of empire.

ENGL 473: Antebellum American Literature (3)
Course may be repeated for credit as title varies. Possible offerings:

Class in Antebellum American Literature. The category "class" has been under-explored, often invisible, within U.S. culture. Reading primarily sentimental and sensational fiction (from Cummins' The Lamplighter to Lippard's Quaker City), we will ask: where and how is class rendered visible?

The Global Nineteenth Century. An exploration of internationalism in antebellum U.S. literature and culture. We will examine the ways that nineteenth-century Americans laid the political, economic, technological, and cultural groundwork for our current U.S.-dominated era of globalization. In addition to reading what recent scholars have to say about the history of globalization, we will read such nineteenth-century American authors as Whitman, Melville, John Rollin Ridge, and Martin Delany, and study such phenomena as the transatlantic telegraph and the Crystal Palace Exhibition.

ENGL 475. Late Nineteenth-century American Literature (3)
Course may be repeated for credit as title varies. Possible offerings:

Realism and Romanticism in Urban and Regional Turn of the Century Novels. This course takes as its starting point two assumptions about U.S. social history and American literary history: by the turn of the twentieth century the United States had become an overwhelmingly urban rather than rural culture; and by the late-nineteenth century the major focus of American literature had shifted from romanticism to realism. This course will test those assumptions by reading four "urban realist" novels and four romances."

Realism and Naturalism in American Literature. This course will explore realist and naturalist writing as an evolving effort to represent the powerful social forces shaping American life in an era of rapid industrialization—and to assess the possibility of individual and collective agency in such a society. The role of realist and naturalist idioms in shaping the theoretical narratives of Marxism and psychoanalysis will also be considered.

ENGL 477. Modern American Literature (3)
Course may be repeated for credit as title varies. Possible offerings:

Modernism and Mourning. Combining psychoanalytic theory and social history, this course will explore major modernist works as efforts to grieve for systemic social injuries such as racism, misogyny, and the alienations produced by monopoly capitalism. Writers studied will include Eliot, Hemingway, Cather, Toomer, Faulkner, Hughes, H.D., Hurston, and Dos Passos.

The Harlem Renaissance. This interdisciplinary and historically grounded seminar will explore the explosion of African-American literary, artistic and political life that took place in and around Harlem in the opening decades of the twentieth century. The course will include political writings, fiction and poetry, and music.

ENGL 478. Contemporary American Literature (3)
Course may be repeated for credit as title varies. Possible offerings:

Contemporary Native American Fiction. Fiction by American Indian writers since the 1970s. We will read works by Leslie Marmon Silko, James Welch, Michael Dorris, Susan Power, and Sherman Alexie. The course will have a mini-focus on the growth of an Ojibwe novelist named Louise Erdrich through three of her novels. We will pay attention in our discussions to ways to present Indian fiction to non-Indian undergraduate students.

Late Twentieth-century American Literature. Masters of poetry, drama, or fiction of the second half of the twentieth century. Poets might include Stone, Ashbery, Merrill, Clifton, Bell, and others. Dramatists might include Norman, A. Wilson, L. Wilson, Foote, Mamet, and others. Fiction might include Boyle, Carver, Baxter, Ford, Oates, and others. Past themes have included the small town in American drama, the double, experimentation, and tradition.

ENGL 479. Twentieth-century World Literature (3)
Course may be repeated for credit as title varies. Possible offerings:

Terror, Rebellion, and Revolution in Contemporary World Literature. This course traces the sources, processes, and outcomes of violent revolutions in contemporary fiction and film, establishing the historical context and examining themes like community conflict, the role of difference, and the use and abuse of power. Possible authors include Mafouz, Naipaul, Chamoiseau, Sembene, Conde, and Phillips; possible films include *State of Siege, Ararat, Asama*, and *Kandahor.*

Writing, the Body, and the Other. This course explores the representation of writing in modern literary texts, specifically the power of writing to inscribe both "identity" and "difference." We begin with the premise that the self-constituting power of writing (expressed through rhetorics of authorship) is closely tied to writing's role in the construction of various concepts of the "other." Primary texts by twentieth-century British and postcolonial writers and the introduction of the post-structuralist tradition in literary theory.

ENGL 480. Composition and Rhetoric (3)
Course may be repeated for credit as title varies. Possible offerings:

Ethics and the Teaching of College English. What does it mean to be a *good* teacher of college English? In this seminar we're going to consider this basic question, with a twist: while *good* usually means "effective" in this question, we are going to take it suggest "ethical." My hope is that we can find ways to deploy "ethics" to explore some concerns at the heart of college teaching, opening a space to talk about why the teaching of English matters.

The Subject in Cultural Studies: The Criticism of Agency. Cultural Studies takes as its founding gesture a concern for subjectivity, the ways in which the individual human subject is shaped by culture. After making this gesture, various branches of the discipline divide according to a particular subject matter, feminism, colonialism, historicism, popular culture, and so on. In this course we will pay particular attention to the founding gesture and the tricks that it can play on us. We will read literary criticism and rhetorical criticism in order to understand the often hidden assumptions and beliefs behind cultural studies in all its forms. We will consider works by Bourdieu, Cixous, Burke, Butler, Bakhtin, Paul Smith, Said, Kristeva, Foucault, and others.

ENGL 481. Theory and Criticism (3)
Course may be repeated for credit as title varies. Possible offerings:

Theories of Gender and Feminism. In this course we will study the critical works of some of the most important feminist theorists. We will be interrogating foundational concepts such as: woman, gender, sex, love, pleasure, desire, the body, the unconscious, oppression, agency, patriarchy, equality, difference, the local and the global. Theorists will include: Simone de Beauvoir, Diana Fuss, Judith Butler, Julia Kristeva, Denise Riley, Chandra Talpade Mohanty, Gayle Rubin, Joan Scott, Teresa de Lauretis, Eve Kosofsky Sedgwick, Gayatri Chakravorty Spivak, Donna Haraway, bell hooks, Pierre Bourdieu, Rosi Braidotti, Jessica Benjamin, and Chela Sandoval.

Queer Film Theory and Criticism. In the early 1990s a cycle of films dubbed "New Queer Cinema" emerged along with a "new queer" film theory—both influenced by political activism and by academic work by figures like Michel Foucault, Eve Sedgwick, and Judith Butler. Questions arose about this queer film and film theory. How were they different from the gay and lesbian films and film theory that came before? Was "queer" being used to erase specific lesbian, gay, bisexual, and trans approaches to film? What did "queer" mean, exactly? This course will address these questions, and many others, that were provoked by Queer 90s films and film theory. Topics and issues covered in the course will include the history of representation, audience/spectatorship, production contexts and sub-textual coding. Also examined will be the intersection of queerness with race, class, and gender.

The New Economic Criticism. Over the last few years, a long-standing tendency among some literary critics to draw analogies between their discipline and economics seems to have coalesced into something resembling a "school". Recent anthologies, conferences and articles have made reference to it as the "new economic criticism". The course will ask whether we are justified in speaking of such a movement, and if so, what are its distinguishing characteristics, and why has it emerged at the present historical juncture. We will read theoretical texts (Derrida, Lyotard, Jameson), secondary studies (Hans-Christophe Binswanger, Marc Shell, Jean-Joseph Goux), and also some of the primary studies to which these refer (Goethe, Mallarme, Shakespeare).

How to Read Deconstructively. Deconstruction aims to produce a way of thinking that weakens the scope of authority itself – any authority – through creative skepticism. This course will begin by directly engaging some of the key theoretical texts by writers such as Friedrich Nietzsche, Martin Heidigger, Jacques Derrida, Gayatri Chakravorty Spivak. But the real goals of the course are to show how deconstruction is used and, crucially, how it is useful.

ENGL 483. Creative Writing and Literary Studies (3)
Course may be repeated for credit as title varies. Possible offerings:

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. Prerequisite: consent of instructor.

ENGL 485. Introduction to Writing Theory (2)
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)
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)
Hands-on introduction to the tools and skills necessary to teach with the computer, along with some attention to appropriate pedagogy. Prerequisite: consent of graduate program coordinator.

ENGL 490. Master's Thesis (3)
Writing master's thesis papers.

ENGL 491. Special Topics (1-3)
A topic, genre, or approach in literature or writing not covered in other courses. May be repeated for credit as title varies. Prerequisite: consent of the graduate program coordinator.

ENGL 493. Graduate Seminar (3)
Intensive study of the works of one or more authors, or of a type of literature. May be repeated for credit as title varies.

ENGL 495. Independent Study (3)
Individually supervised course in an area of literature, film or writing not covered in regularly listed courses. Prerequisite: consent of the graduate program coordinator.

ENGL 499. Dissertation (1-9)
Research and study for comprehension exams.

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.

Director: Todd. A. Watkins, Ph.D. (Harvard), Arthur F. Searing Professor of Economics, and Director, Baker Institute for Entrepreneurship, Creativity and Innovation

Additional Program Faculty: Pasquale J. Costa, B.S. (Penn State); Dale F. Falcinelli, M.S. (Lehigh); William Forster, Ph.D. (U. Virginia, Darden); William R. Haller, B.S. (Lehigh); Sandra F. Holsonback, Ph.D. (Lehigh); Christopher D. McDemus, J.D. (Widener); Bruce E. Moon, Ph.D. (Ohio State); Holona L. Ochs, Ph.D. (Kansas); John B. Ochs, Ph.D. (Penn State); Neal G. Simon, Ph.D. (Rutgers); Robert J. Trent, Ph.D. (Michigan State).

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 consists of at least 18 credit hours: ECO 1 plus at least 14 credit hours of ENTP and capstone courses. Required courses:

- ECO 1 Principles of Economics (4 credit hours)
- ENTP 101: Entrepreneurship I (3 credit hours)

And, at least 6 additional credit hours in other ENTP courses, or alternatives approved by the minor director in consultation with the student.

And, at least two experiential Capstone courses (minimum 5 credit hours) from the following list, or alternatives approved by the minor director.

- ENTP 311: The Garage: Launching Entrepreneurial Ventures I (3)
- ENTP 312: The Garage: Launching Entrepreneurial Ventures II (3)
- ENTP 307/IR307: International Social Entrepreneurship Practicum (4)
- ENTP 310/POLS310: Social Entrepreneurship: How to Change the World (4)
- IBE 380: Capstone Projects I (3)
- IBE 385: Capstone Projects II (3)
- MGT 311: LUMAC Management Assistance Counseling (3)
- CSB 312: Design of Integrated Business Applications I (3)
- CSB 313: Design of Integrated Business Applications II (3)
- BUS 211/ENGR 211: Integrated Product Development I (3)
- BUS 212/ENGR 212: Integrated Product Development II (2)
- Or other independent experiential project approved by the minor director.

Students must complete the minor with an average GPA of at least 2.0 in those courses to qualify.

Undergraduate Courses in Entrepreneurship and Social Ventures

ENTP 101–Introduction to Entrepreneurship (3)
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 though guest speakers to successful entrepreneurs and to Lehigh and community resources for entrepreneurs. Prerequisite: ECO 1 (may be taken simultaneously) or permission of the minor director.

ENTP 201–Entrepreneurship & Enterprise (3)
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. Prerequisite: ENTP 101 or permission of minor director.

ENTP 306/MGT 306–Decision Making in Small Business and Non-profit Enterprise (3)
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: Fin 125; Mkt 111

ENTP 307/IR 307–International Social Entrepreneurship (4)
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. (SS)

ENTP 309/POLS 309–Nonprofit Administration (4)
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. (SS)

ENTP 310–Social Entrepreneurship: How to Change the World (4)
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. Prerequisite: Eco 1 and at least junior standing, or permission of the minor director. (SS)

ENTP 311–The Garage: Launching Entrepreneurial Ventures I (3)
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. Prerequisite: ENTP 101 or permission of the minor director.

ENTP 312–The Garage: Launching Entrepreneurial Ventures II (3)
Continuation of ENTP 311. Investigates and pursues in detail the critical steps and activities necessary when entrepreneurs seriously pursue launching new ventures. Prerequisite: ENTP 311 or permission of minor director.

ENTP 320/BIOS 320–The Business of Life Science (3)
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. Prerequisite: BIOS 120 or consent of instructor.

Graduate Entpepreneurship Courses & Venture Series

See the GBEN listings under Business and Economics Graduate Courses.

Environmental Initiative

Program Directors: Frank J. Pazzaglia, Earth and Environmental Sciences and Derick G. Brown, Civil and Environmental Engineering

Undergraduate Committee Chair: Sharon M. Friedman, Department of Journalism and Communication.

Graduate Committee Chair: John Martin Gillroy, Environmental Studies and Department of International Relations.

Professors: David J. Anastasio, Ph.D. (Johns Hopkins), Earth and Environmental Sciences; Gray E. Bebout, Ph.D. (U.C., Los Angeles), Earth and Environmental Sciences; David Cundall, Ph.D. (Arkansas), Biological Sciences; Stephen H. Cutcliffe, Ph.D. (Lehigh), Chair of History and Director of Science, Technology and Society program; Edward B. Evenson, Ph.D. (Michigan), Earth and Environmental Sciences; Sharon M. Friedman, M.A. (Penn State), Journalism and Communication and Director of Science and Environmental Writing Program; John B. Gatewood, Ph.D. (Illinois), Sociology and Anthropology; John Martin Gillroy, Ph.D. (Chicago), Environmental Studies and International Relations; Kenneth P. Kodama, Ph.D. (Stanford), Earth and Environmental Sciences; Kenneth L. Kraft, Ph.D. (Princeton), Religion Studies; Anne S. Meltzer, Ph.D. (Rice), Earth and Environmental Sciences; Sibel Pamukcu, Ph.D. (L.S.U.), Associate Chairperson of Civil and Environmental Engineering; Frank J. Pazzaglia, Ph.D. (Penn State), Chair of Earth and Environmental Sciences; Dork Sahagian, Ph.D. (Chicago), Earth and Environmental Sciences; Arup K. Sengupta, Ph.D. (Houston), Chemical Engineering; Richard N. Weisman, Ph.D. (Cornell), Civil and Environmental Engineering; Peter K. Zeitler, Ph.D. (Dartmouth), Earth and Environmental Sciences.

Associate Professors: Alec M. Bodzin, Ph.D. (North Carolina State), Education; Robert K. Booth, Ph.D. (Wyoming), Earth and Environmental Sciences; Derick G. Brown, Ph.D. (Princeton), Civil and Environmental Engineering; Frank L. Davis, Ph.D. (North Carolina), Political Science; Bruce R. Hargreaves, Ph.D. (U.C. Berkeley), Earth and Environmental Sciences; Breena Holland, Ph.D. (Chicago), Environmental Studies and Political Science; Kristen L. Jellison, Ph.D. (MIT), Civil and Environmental Engineering; Edward E. Lotto, Ph.D. (Indiana) Director of Center for Writing, Math and Study Skills; Donald P. Morris, Ph.D. (Colorado), Earth and Environmental Sciences; Stephen C. Peters, Ph.D. (Michigan), Earth and Environmental Sciences; Joan M. Ramage, Ph.D. (Cornell), Earth and Environmental Sciences; Albert H. Wurth, Jr., Ph.D. (North Carolina), Political Science; Zicheng Yu, Ph.D. (Toronto), Earth and Environmental Sciences.

Assistant Professors: Benjamin S. Felzer, Ph. D. (Brown), Earth and Environmental Sciences; Mary C. Foltz, Ph.D. (Buffalo), English; Thomas C. Hammond, Ph.D. (Virginia), Education.

The Environmental Initiative is a broadly interdisciplinary program of education, research, and outreach. The curricula include courses in 4 colleges and 10 departments in social sciences, humanities, education, science, mathematics and engineering.

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.

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 and Core Courses (26-28 credits)

Required Courses:

ES 1	Introduction to Environmental Studies (4)
ES 2 (EES 2) (GCP 2)	Introduction to Environmental Science (3)
ES 4 (EES 4)	The Science of Environmental Issues (1)
ES 105 (POLS 105)	Environmental Policy and Planning (4)
ES 381	Senior Seminar: Issues in Environmental Studies (4)

Core Courses: At Least 3 of the 6 following courses:

ES 106 (POLS 106)	Environmental Values and Ethics (4)
ES 111 (ECO 111)	Introduction to Environmental Economics (4)
ES 121 (ANTH 121)	Environment and Culture (4)
ES 125 (JOUR 125)	Environment, the Public and Mass Media (4)
CEE 272	Risk Assessment (2)
ES 315 (HIST 315)	American Environmental History (4)

Major Electives (12 credits including 1 course at the 200 level or above. Additional core courses can be used to fulfill this requirement):

ANTH 145	Human Evolution (4)
ANTH 305	Anthropology of Fishing (4)
CEE 379 (EES 379)	Environmental Case Studies (3-4)
ECO 311	Environmental Economics (3)
ENGL 201-11	The Environmental Imagination (4)
ENGL 380	Contemporary American Literature of Environmental Crisis (4)
EES 89	Geographical Analysis of our Changing World (4)
EES 386	Wetland Science (4)
ES 10	Environment and the Consumer Society (4)
ES 93	Lehigh Earth Observatory Field/Laboratory Internship(1-4)
ES 100 (GCP 100, EES 100)	Earth System Science (4)
ES 107 (POLS 107)	Politics of the Environment (4)
ES 115 (JOUR 115)	Communicating about the Environment
ES 116 (JOUR 116) (HMS 116)	Risky Business (4)
ES 122	Sustainable Development: The Costa Rican Experience (3)
ES 131	Internship (1-2)
ES 171 (CEE 171)	Fundamentals of Environmental Technology (4)
ES 181	Independent Study (1-4)
ES 254 (REL 254, ASIA 254)	Buddhism and Ecology (4)
ES 293	Advanced Lehigh Earth Observatory Field/Laboratory Internship (1-4)
ES 328 (POLS 328)	U.S. Politics and Environment (4)
ES 331	U.S. Environmental Law I: Pollution & Risk Abatement (4)
ES 333 (IR 333)	International Environmental Law & Policy (4)
ES 338	Environmental Risk: Perception & Communication (4)
ES 339 (IR 339)	Global Security and the Environment (4)
ES 343 (IR 343)	Comparative Environmental Law & Policy (4)
ES 355 (POLS 355)	Environmental Justice & the Law (4)
ES 367 (TLT 367)	Environmental Education (3)
ES 371	Special Topics (1-4)
ES 375 (POLS 375)	Seminar: Green Polity (4)
ES 391	Honors Thesis (4)
ES 394 (TLT 394)	Teaching and Learning with Geospatial Tools (3-4)
IR 344	Politics of Oil (4)
JOUR 123	Basic Science and Technical Writing (4)

JOUR 323 (STS 323) (HMS 323)	Health and Environmental Controversies (4)
POLS 338	Markets, Politics and the Law (4)
POLS 348	Land Use, Growth Management and the Politics of Sprawl (4)
REL 6	Religion and the Ecological Crisis (4)

In addition, new courses may be offered annually. Students should check with the program director for an updated list.

Collateral Requirements (14-16 credits)

Required (8 credits)

MATH 12.	Basic Statistics (4)

A calculus course may be substituted with permission of the program director.

SOAN 111	Research Methods and Data Analysis (4)

Science Electives: At least one EES and one other science course (6-8) credits OR a minor in EES (see EES program descriptions).

Minor in Environmental Studies

A minor in Environmental Studies consists of four 4-credit courses, for a total of 16 credits. These should include ES 1, one course from the required or core set of courses for the major, and two courses from either the core or elective courses for the major. At least one course must be at the 300-level.

Environmental Studies Undergraduate Courses

ES 1. Introduction to Environmental Studies (4)
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 (SS). Please select ES 2 to fulfill the natural science (NS) requirement. Staff (SS)

ES 2 (EES 2) (GCP 2). Introduction to Environmental Science (3)
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. Sahagian (NS/GC)

ES 4 (EES 4). The Science of Environmental Issues (1)
Analysis of current environmental issues from a scientific perspective. The focus of the course will be weekly discussions based on assigned readings. Pre- or co-requisite: introductory-level course in EES. Staff (NS)

ES 10. Environment and the Consumer Society (4)
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. Staff (SS)

ES 93. Lehigh Earth Observatory Field/Laboratory Internship (1-4)
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 (GCP 100, EES 100). Earth System Science (4)
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: EES 22. Felzer (NS)

ES 104 (IR 104). Political and Environmental Geography (4)
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. (SS)

ES 105 (POLS 105). Environmental Policy and Planning (4) Fall
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. Holland (SS)

ES 106 (POLS 106). Environmental Values and Ethics (4) Spring
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. Holland (SS)

ES 107 (POLS 107). The Politics of the Environment (4)
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. Wurth (SS)

ES 111 (ECO 111). Introduction to Environmental Economics (4)
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. Prerequisite: ECO. 1. (SS)

ES 115 (JOUR 115). Communicating about the Environment (4)
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. (SS)

ES 116 (JOUR 116) (HMS 116). Environmental Health Risks and the Media (4)
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. Friedman (SS)

ES 121 (ANTH 121). Environment and Culture (4)
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. Gatewood (SS)

ES 122. Sustainable Development: The Costa Rican Experience (3)
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). Cutcliffe, Morris, & Weisman (SS)

ES 125 (JOUR 125). Environment, the Public and the Mass Media (4)
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. Friedman (SS)

ES 131. Internship (12)
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. Prerequisite: consent of the program director. (ND)

ES 171 (CEE 171). Fundamentals of Environmental Technology (4)
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. Prerequisite: A course designated NS. Not available to students in RCEAS. (ND)

ES 181. Independent Study (1-4)
Directed readings or research on an Environmental Studies topic. May be repeated for credit up to four credits. Prerequisite: consent of the program director. (HU or SS)

ES 254 (REL 254, ASIA 254). Buddhism and Ecology (4)
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? Kraft (HU)

ES 293. Advanced Lehigh Earth Observatory Field/Laboratory Internship (1-4)
A continuation of LEO Internship 93, this course will entail further development of supervised projects and leadership opportunities. PPast 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. Prerequisite: ES 93. (NS, SS, or HU).

ES 315 (HIST 315) American Environmental History (4)
Relationship between Americans and their natural environment from the colonial period to the present: impact of European settlement, attributes toward wilderness, role of technological development, rise of preservation and conservation movements, establishment of national parks, recent environmental protection legislation. (SS) Cutcliffe

ES 328. (POLS 328) U.S. Politics and the Environment (4)
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. Wurth (SS)

ES 331. U.S. Environmental Law I: Pollution & Risk Abatement (4)
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. Gillroy (SS)

ES 333 (IR 333). International Environmental Law & Policy (4)
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. Gillroy (SS)

ES 338. Environmental Risk: Perception & Communication (4)
Starting with the distinction between traditional pollution problems and environmental risk, this course will focus on risk as it is perceived from outside the institutional policy process and how risk dilemmas are communicated from that institutional structure to experts and the public at large. This course will examine perception and communication experiences within the United States and abroad. (SS)

ES 339 (IR 339). Global Security and the Environment (4)
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. (SS)

ES 340 (IR 340) (ES 440). International Environmental and Science Policy (3)
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. Prerequisite IR/GS 10 and department permission. (SS)

ES 343 (IR 343). Comparative Environmental Law & Policy (4)
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. Gillroy (SS)

ES 355 (POLS 355). Environmental Justice & The Law (4)
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. Prerequisite: ES or POLS 105. Holland (SS)

ES 367 (TLT 367). Environmental Education (3)
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. Bodzin.

ES 371. Special Topics (1-4)
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. Prerequisite: consent of the program director. (HU or SS)

ES 381. Senior Seminar: Issues in Environmental Studies (4)
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: ES 1, 2 or another EES course, and one core course or consent of the program director. (SS)

ES 391. Honors Thesis (1-4)
Directed undergraduate research thesis required of students who apply and qualify for graduation with program honors. Prerequisite: consent of the program director. (HU or SS)

ES 394 (TLT 394). Teaching and Learning with Geospatial Tools (3-4)
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.

Graduate Studies

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 Courses in Environmental Law:

ES 331/431	U.S. Environmental Law I: Pollution & Risk Abatement (3)
ES 432 U.S.	Environmental Law II: Natural Resources & Public Lands (3) ES 333/433 International Environmental Law & Policy (3)
ES 343/443	Comparative Environmental Law & Policy (3)

Core Courses in Policy Analysis, Valuation & The Law:

ES 401	Philosophical-Policy and Environmental Legal Design (3)
ES 435	Environmental Valuation For Policy Design & Legal Analysis (3)
ES 336/436	Environmental Justice & The Law (3)
ES 338/438	Environmental Risk: Perception & Communication (3)

Elective Courses:

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.

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.

Required Courses: (2)

ES 401	Philosophical-Policy and Environmental Legal Design (3)
ES/EES 402	Scientific Foundations for Environmental Policy Design (3)

Core Courses: (at least 4 of 9)

ES 431	U.S. Environmental Law I: Pollution & Risk Abatement (3)

ES 432	U.S. Environmental Law II: Natural Resources & Public Lands (3)
ES 433	International Environmental Law & Policy (3)
ES 438	Environmental Risk: Perception & Communication (3)
ES 439	Global Security and the Environment (3)
ES 443	Comparative Environmental Law & Policy (3)
ES 455 (POLS 455)	Environmental Justice and the Law (3)
ES 461 (EES 461)	Wetland Policy and Valuation (3)
ES 465	International Law and Policy Design (3)

Electives (3) Including at least one Foundation Course, except that one or more Core Courses may be substituted for Foundation or Context Courses

Foundation

ES 440	International Environmental and Science Policy (3)
EES 358	Microbial Ecology (3) **or**
EES 365	Ecophysiology (3) **or**
CEE/EED 379	Environmental Case Studies
POLS 438	Markets, Justice and Law (3)

Context

HIST 315	American Environmental History (3)
POLS 416	American Public Policy (3)
POLS 421	Research Methods (3)
POLS 448	Land Use, Growth Management and the Politics of Sprawl Methods (3) moved to numerical order)
POLS 475	Seminar: Green Polity (3)
EES 325	Remote Sensing of Terrestrial and Aquatic Environments (3)
CEE 471	Environmental Risk Management (3)

THESIS: A six credit thesis (ES 490) 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 Courses

ES 401 Philosophical-Policy and Environmental Legal Design (3)
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. (Gillroy/ Holland)

ES 402 (EES 402). Scientific Foundations for Environmental Policy Design (3)
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. Sahagian

ES 431. U.S. Environmental Law I: Pollution and Risk Abatement (3)
The study of bureaucracy and problems of public and nonprofit organization and management; executive leadership; personnel management systems and regulatory administration. Gillroy

ES 432. U.S. Environmental Law II: Natural Resources & Public Lands (3)
This course combines a study of natural resources law with an understanding of the politics and legal processes that create, change, and regulate the economic use of nature. It studies extraction law from two models of regulation: the Market Sector Approach and the Ecosystem Approach. Using these two standards for charting the relationship between humanity and nature, students will analyze timber, water, mineral extraction, public lands regulations, wildlife, wilderness and federal planning and environmental impact assessment in terms of their ethical, political, economic and policy components. Gillroy

ES 433 International Environmental Law & Policy (3)
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. Gillroy (SS)

ES 435. Environmental Valuation For Policy Design & Legal Analysis (3)
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. Holland

ES 438. Environmental Risk: Perception & Communication (3)
Starting with the distinction between traditional pollution problems and environmental risk, this course will focus on risk as it is perceived from outside the institutional policy process and how risk dilemmas are communicated from that institutional structure to experts and the public at large. This course will examine perception and communication experiences within the United States and abroad. (SS)

ES 439. Global Security and the Environment (3)
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. (SS)

ES 440 (IR 340) (ES 340) International Environmental and Science Policy (3)
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. Prerequisite IR/GS 10 and department permission (SS)

ES 443 Comparative Environmental Law & Policy (3)
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. Gillroy (SS)

ES 455 (POLS 455). Environmental Justice & The Law (3)
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. Holland (SS)

ES 461 (EES461) Wetland Policy and Valuation (3)
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. Booth

ES 465. International Law and Policy Design (3)
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). Gillroy (SS)

ES 490. Thesis (1-6)

ES 495. Independent Study (1-4)

Finance

Professors. Paul Brockman, Ph.D. (LSU), Joseph R. Perella and Amy M. Perella, chair; Stephen G. Buell, Ph.D. (Lehigh); Richard J. Kish, Ph.D. (Florida), chairman, Perella Department of Finance; Nandu Nayar, Ph.D. (Iowa), Hans Baer Chair in International Finance; Ajai K. Singh, Ph.D. (Iowa) *Perella Bolton Chair in Finance*; Geraldo M. Vasconcellos, Ph.D. (Illinois).

Associate Professors. Anne-Marie Anderson, Ph.D. (Arizona); Stephen F. Thode, D.B.A. (Indiana).

Assistant Professors. Yung-Yu Ma, Ph.D. (Utah); S. McKay Price, Ph.D. (Florida State); Jesus M. Salas, Ph.D. (Oklahoma); Ke Yang, Ph.D. (Iowa).

Professors of Practice. Daniel A. Bayak, M.B.A. (Scranton); David H. Myers, Ph.D. (Washington); Samuel C. Weaver, Ph.D. (Lehigh).

Active Emeriti. James A. Greenleaf, Ph.D. (N.Y.U.)

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.

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 2-course depth requirement; and a minimum 2-course breadth requirement as outlined below.

2-Course Foundation Requirement

FIN 323	Investments
FIN 328	Corporate Financial Policy

2-Course Depth Requirement

Choose 3 depth electives from the following list of finance offerings.

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
FIN 336	Real Estate Finance
FIN 377	Advanced Topics -- Investments

2-Course Breadth Requirement

Choose at least 2 breadth electives within one of the following six breadth tracks.

Track 1: Financial Analysis (6 credits)

ACCT 315	Financial Accounting I
ACCT 316	Financial Accounting II

Track 2: Financial Marketing (choose 2: 6 credits)

MKT 312	Marketing Research
MKT 319	Development and Marketing of New Products
MKT 320	Global Marketing
MKT 325/ECO 325	Quantitative Marketing Analysis
MKT 332	Sales Management

Track 3: Analytical Finance (Choose 2 of the following: 6 credits)

IE 316	Optimization Models and Applications
IE 339	Stochastic Models and Applications
Math 310	Random Processes and Applications
MATH 205	Linear Methods OR
MATH 242	Linear Algebra
MATH 231	Probability and Statistics OR
MATH 309	Theory of Probability

Track 4: Financial Economics (choose 1 from each group: 6 credits)

ECO 322	Competitor and Market Analysis OR
ECO 333	Economics of Business Decisions
ECO 339	International Trade OR
ECO 340	International Finance OR
ECO 203	Microfinance

Track 5: Real Estate Valuation (Must take all 3 courses: 7 credits)

IPRE 301	Case Studies in Real Estate Value Creation
Bus 347	Practicum in Real Estate I
Bus 348	Practicum in Real Estate II

Track 6: Expanded Finance (choose 2: 6 credits)

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
FIN 336	Real Estate Finance
FIN 377	Advanced Topics - Investments

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.

FIN 125. Introduction to Finance (3)
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: ECO 029, ECO 045, MATH 21, ACCT 151.

Finance Foundation Courses:

FIN 323. Investments (3)
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: FIN 125 and ECO 146.

FIN 328. Corporate Financial Policy (3)
The study of management issues related to capital budgeting, working capital, leasing, mergers, and financing. Prerequisites: FIN 125 and ECO 146.

Finance Depth Requirement Courses:

FIN 324. Security Analysis and Portfolio Management (3)
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: FIN 323 and FIN 328.

FIN 330. Financial Markets and Institutions (3)
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: FIN 323 and FIN 328.

FIN 333. Global Finance (3)
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. Prerequisite: FIN 323 and FIN 328.

FIN 334. Derivatives and Management of Risk (3)
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. Prerequisite: FIN 323 and FIN 328.

FIN 335. Advanced Topics – Financial Management (3)
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. Prerequisite: FIN 323 and FIN 328.

FIN 336. Real Estate Finance (3)
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. Prerequisite: FIN 323 and FIN 328.

FIN 377. Advanced Topics – Investments (3)
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. Prerequisites: FIN 323 and FIN 328.

Additional finance offerings that cannot be used to fulfill the finance depth requirement:

FIN 371. Directed Readings (3)
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. Prerequisite: consent of sponsoring instructor.

FIN 372. Special Topics (1-3)
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. Prerequisite: consent of sponsoring instructor.

FIN 273. Finance Internship I (1 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. Prerequisites: ECO 029, ECO 045, MATH 21, ACCT 151, declaration of a finance major, and department approval.

FIN 373. Finance Internship II (1 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. Prerequisites: FIN 323, FIN 328, declaration of a finance major, and department approval.

FIN 374. Portfolio Management Practicum (1-3)
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. Prerequisites: FIN 323 and permission of instructor.

FIN 382. Guest Speaker Seminar Series (1)
This course is designed to help prepare students for 'real' world problems by exposing them to a variety of career opportunitites. 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.

Graduate Courses

Course descriptions for the College of Business and Economics graduate courses can be found in this section (Section V) under the heading of Business and Economics Graduate Courses.

Fine Arts

See listings under Art and Architecture.

Foreign Culture and Civilization

See listings under Modern Languages and Literature.

Foreign Literature

See listings under Classics and under Modern Languages and Literature.

French

See listings under Modern Languages and Literature.

Geology

See listings under Earth and Environmental Sciences.

German

See listings under Modern Languages and Literature.

Global Citizenship

Global Citizenship Program

Gisella Gisolo, Ph.D., director
Coxe Hall, 32 Sayre Drive, Bethlehem, PA 18015
Phone (610) 758-6646; Fax (610) 758-5156; email: gig207@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--often constructed through theological and cultural traditions. Religious extremism, trade policies, human rights, and g 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

Year 1:	GCP 010 Introduction to Global Citizenship (3) (Fall) GCP/ENGL 007 Global Literature (3) (Spring)
Year 2:	GCP 085 Practicum (1) (Fall) Global Citizenship Intersession Trip (0) (Winter Break)
Year 3:	GCP 285 Junior Practicum (2) (Fall or Spring)
Years 4:	GCP 385 Global Citizenship Capstone (4) (Fall and Spring)
Floating Requirements:	3 GC-designated electives (9 to 12 credits) Second study abroad experience (min. 5 weeks long)

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 in Global Citizenship

GCP 010. Introduction to Global Citizenship (3)
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 1 equivalent.

GCP 007 (ENGL 007). Global Literature (3)
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 2 equivalent.

GCP 085. Practicum (1)
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 385. Global Citizenship Capstone Course (4)
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.

Global Studies

Program Director. Jack Lule, Ph.D. (Georgia) Director, Globalization and Social Change Initiative and Joseph B. McFadden Distinguished Professor of Journalism; 610-758-4177; jack.lule@lehigh.edu

Professors. Marie-Helene Chabut, Ph.D. (U.C. San Diego), Chair and Professor of Modern Languages and Literature; Bruce Moon, Ph.D. (Ohio State), International Relations

Associate professors. Vera Fennell, Ph.D. (Chicago) Political Science and Global Studies; Janet Laible, Ph.D. (Yale) Political Science; Rob Rozehnal, Ph.D. (Duke) Religion Studies and Director of Global Islamic Studies; John Savage, Ph.D. (NYU),History

Assistant professors. Nandini Deo, Ph.D. (Yale), Political Science; John Jirik, Ph.D. (Texas), Journalism and Communication and Global Studies; Bruce Whitehouse Ph. D. (Brown) Sociology and Anthropology and Global Studies.

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 and requires a United Nations workshop, which includes a seminar and visit to the UN. Some students actually become delegates to the UN for international NGOs.

Careers in Global Studies. Career opportunities are numerous for graduates of Global Studies. Professions in the 21st 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

Introductory Course

GS 1 Introduction to Global Studies (4)

Core Courses (4 courses; 16 credits): One course from each core area that explores how globalization shapes and is shaped by:

History

GS/HIS 101 Histories of Globalization (4)

Culture

GS/MLL 6	Globalization and Culture (4) or
GS/ANTH 106	Cultural Studies and Globalization (4)

Political Economy

GS/IR/POLS 125	International Political Economy (4) or
GS/SSP 126	The Political Economy of Globalization (4)

Politics

GS/IR 10	Introduction to World Politics (4) or
GS/POLS 3	Comparative Politics (4) or
GS/POLS/PHIL 100	Introduction to Political Thought (4)

Advanced Coursework (2 courses; 8 credits): Two courses from the following list or other GS courses, chosen in consultation with the adviser:

GS/HIS 107	Technology and World History (4)
GS/POLS/ASIA 201	Democracy and Dictatorship in South Asia (4)
GS/REL/GCP 244	Globalization and Religion (4)
GS/IR 245	International Organizations (4)
GS/COMM 248	Global Communication (4)
GS 315	Seminar in Globalization and Culture (4)
GS 318	Seminar in Globalization & Communication (4)
GS/ANTH/GCP 320	Global Capitalism (4)
GS/MLL/GCP 321	Intercultural Communication (4)
GS/GCP/HMS/SSP 322	Global Health Issues (4)
GS/ANTH/AAS 324	Globalization and Development in Africa (4)
GS/POLS 325	Nationalism in Comparative Perspective (4)
GS/SSP 329	Global Migration (4)
GS/POLS/WS 342	Gender and Third World Development (4)
GS/IR 347	Non-State Actors in a Globalized World (4)

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.

Area Studies (2 courses; 8 credits): 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

Senior Seminar (1 course; 4 credits):

GS 375	Senior Seminar in Global Studies (4)

Collateral Requirements:

Intermediate language proficiency: (Intermediate II or equivalent) in a language taught at Lehigh, other than the student's native language

Study abroad: 12 credits of study abroad, taken in one semester, or two, 6-credit summer sessions (coursework can be substituted, with the guidance of an adviser, if student is financially or academically unable to study abroad)

UN Workshop: seminar and trip to United Nations

Global Studies Minor

A minor in Global Studies consists of four courses, including GS 1 and three courses from the list of core and advanced classes, with one class at the 200 level or above. The UN Workshop, study abroad or Lehigh Abroad are strongly recommended.

Course Listings

GS 1 Introduction to Global Studies (4)
MTVInternational. 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. Lule (SS/GCP)

GS 3 (POLS 3) Comparative Politics (4)
The political systems of foreign countries; approaches to the study of comparative politics. (SS)

GS 6 (MLL6) Globalization and Cultures (4)
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. (HU)

GS 10 (IR 10) Introduction to World Politics (4)
Introduction to the major principles, concepts, and theories of international relations, along with 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. (SS)

GS 100 (PHIL 100, POLS 100) Introduction to Political Thought (4)
A critical examination of political ideologies: Liberalism, Marxism, Fascism, and Islamism. Matthews (ND)

GS 101 (HIST 101) Histories of Globalization (4)
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. Savage (HU)

GS 106 (ANTH 106) Cultural Studies and Globalization (4)
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. Whitehouse (SS)

GS 107 (HIST 107) Technology and World History (4)
Development of technology and its relationship to political, economic, military, and cultural aspects of world civilization from pyramids to the present period. Smith (SS)

GS 125 (IR 125, POLS 125) International Political Economy (4)
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: Eco 1 and IR 10. Moon (SS)

GS 126 (SSP 126) The Political Economy of Globalization (4)
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. (SS)

GS 201 (POLS 201, ASIA 201) Democracy and Dictatorship in South Asia (4)
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. Deo (SS)

GS 244 (REL 244) Globalization and Religion (4)
See description under Religion Studies

GS 245 (IR 245) International Organization (4)
Examines how Cooperation is achieved and sustained in world politics. Under what circumstances does Cooperation take place? What role do formal international organizations (such as the UN) play? What roles do norms, values, and ethics play? Can Cooperation last? Questions pursued theoretically and in practical terms across topical issues (e.g., human rights, poverty, the environment, international law). Prerequisite: IR 10. (SS)

GS 248 (COM 248) Global Communication (4)
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. Jirik. SS

GS 315 (ANTH 315) Seminar in Globalization and Culture (4)
Advanced seminar that focuses on research and discussion of specialized topics in globalization and culture. Subjects vary by semester. May be repeated for credit. Junior or senior standing and departmental permission required. Whitehouse. SS

GS 318 Seminar in Globalization and Communication (4)
Advanced seminar that focuses on research and discussion of specialized topics in globalization and communication. Subjects vary by semester. May be repeated for credit. Junior or senior standing and departmental permission required. Staff (SS)

GS 320 (ANTH 320, GCP 320) Global Capitalism (4)
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. Staff (SS)

GS 321 (MLL 321, MLL 421, GCP 321) Intercultural Communication (4)
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. (HU/ED)

GS 322. (GC 322, HMS 322, SSP 322) Global Health Issues (4)
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. Lasker (SS)

GS 324 (ANTH 324, AAS 324) Globalization and Development in Africa (4)
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"? Whitehouse (WI) (SS)

GS 325 (POLS 325) Nationalism in Comparative Perspective (4)
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. Prerequisite: POLS 3. Laible

GS 328 (SSP 328) Global Food Systems (4)
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. (SS)

GS 329 (SSP 329) Global Migration (4)
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 trans-nationalization of social relations, alters existing livelihoods, transforms economic production and social support arrangements, and recreates racial, ethnic, and national identities. (SS)

GS 339 (POLS 339, ASIA 339) The Rise of the State in Modern East Asia (4)
An examination of the role of Asian nationalism in the construction of the modern state form in Asia. Fennell (SS)

GS 342 (POLS 342, WS 342) Gender and Third World Development (4)
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. Prerequisite: POLS 1 or WS 1.

GS 343 (AAS 343, ASIA 343, POLS 343) Global Politics of Race: Asia and Africa (4)
An examination of the concept of "race" and its impact on domestic and international politics. Fennell (SS)

GS 347 (IR 347) Non-State Actors in a Globalized World (4)
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.) Prerequisite: IR 10. Staff (SS)

GS 351 (HIST 351) Gangs of New York (3)
The course will use the Martin Scorcese 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. Simon (HU)

GS 355 (HIST 355) Destruction and Reconstruction of Europe, 1879-1950 (3)
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. Baylor (SS)

GS 375 Senior Seminar in Global Studies (4)
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. Staff (WI) (SS)

GS 390 Readings in Global Studies (1-4)
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. (HU)

GS 391 Special Topics in Global Studies (1-4)
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. (SS)

GS 392 Internship in Global Studies (1-4)
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. Lule (SS)

GS 394 Honors Thesis in Global Studies (1-4)
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. (SS)

Government

See listings under Political Science.

Greek

See listings under Classics.

Health, Medicine, and Society

Program Director. Elizabeth A. Dolan, Associate Professor of English and Director for Health, Medicine, and Society
610-758-3317; bdolan@lehigh.edu

An interdisciplinary Health, Medicine, and Society minor is offered in the College of Arts and Sciences. An interdepartmental 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 Professor Elizabeth Dolan.

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 21st 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

Required Core Courses: (Take one of the following three courses as your core course. If you take more than one of these three courses, it will count as an elective).

HMS/SSP 160	Medicine and Society
HMS 170	Medical Humanities
HMS 180	Introduction to Public Health

Course Requirements (at least three additional courses from the list below or other courses designated HMS)

HMS/ENGL 115	Topics in Literature, Medicine, and Health
HMS/JOUR/ES 116	Environmental Health Risks and the Media
HMS/STS/HIST 118	History of Modern Medicine
HMS/SSP 152	Alcohol, Science, and Society
HMS/SSP 162	AIDS and Society
HMS/REL 226	From Black Death to AIDS: Plague, Pandemic, Ethics and Religion
HMS 291	Independent Study HMS/PSYC 305 Abnormal Psychology
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/SSP/WS 341	Women and Health
HMS 354/POLS 354	U.S. Health Care Politics
HMS/PSYC 386	Psychological Perspectives on Health and Illness in Children and Adolescents
ANTH 160	Health, Illness, and Healing
BIOS 10	Bioscience in 21st Century
PHIL/REL 116	Bioethics
ECO 368	Health Economics

Undergraduate Courses in Health, Medicine, and Society

HMS 115 (ENGL 115). Topics in Literature, Medicine, and Health (4)
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. (HU)

HMS 116 (JOUR/ES 116). Environmental Health Risks and the Media (4)
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. S. Friedman (SS)

HMS 118 (STS/HIST 118). History of Modern Medicine (4)
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. Grafe (HU)

HMS 152 (SSP 152). Alcohol, Science, and Society (4)
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. McIntosh (SS)

HMS 160 (SSP 160). Medicine and Society (4)
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. Lasker (SS)

HMS 162 (SSP 162). AIDS and Society (4)
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. (SS)

HMS 170. Medical Humanities (4)
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. Dolan (HU)

HMS 180. Introduction to Public Health (4)
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. Coyle (SS)

HMS 226 (REL 226). From Black Death to AIDS: Plague, Pandemic, Ethics and Religion (4)
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 give to ethical analysis of the institutional response to pandemic disease as distortions have occurred for political, social, and religious reasons. Steffen (HU)

HMS 291. Independent Study (4)
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 complete HMS/SSP 160 in a previous term. (SS or HU).

HMS 305 (PSYC 305). Abnormal Psychology (4)
Examines research and theory on the patterns, causes, and treatment of various forms of abnormal behavior. Prerequisite PSYC 153 or consent of instructor. Department permission required. (SS)

HMS 315 (ENGL 315). Topics in Literature, Medicine, and Health (3-4)
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. (HU)

HMS 322 (SSP/GS/GCP 322). Global Health Issues (4)
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. Lasker (SS)

HMS 323 (JOUR/STS 323). Health and Environmental Controversies (4) **spring**
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. S. Friedman (SS)

HMS 327 (PSYC 327). Health Psychology (4)
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. Prerequisite: PSYC 110. Department permission required. (SS)

HMS 341 (SSP/WS 341). Women and Health (4)
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. (SS)

HMS 354 (POLS 354). U.S. Health Care Politics (4)
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. Olson (SS)

HMS 386 (PSYC 386). Psychological Perspectives on Health and Illness in Children and Adolescents (4)
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. Department permission required. (Advanced Psychology Seminar) Barrett (SS)

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

The Department of Industrial and Systems Engineering administers the HSE masters program. 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 IE 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 semester sequence as shown in the table below.

Recommended sequence of courses in the HSE M.Eng. program

Number	Title	Credit Hours
Fall		
IE 470	Introduction to Healthcare Systems	3
IE 471	Quality and Process Improvement in Healthcare	3
IE 426	Optimization Modeling	3
	Statistics (IE 410, Math 312, or Math 338)	3
	Technical Elective	3
	Fall Total	**15**
Spring		
IE 473	Information Technology in Healthcare	3
IE 472	Financial Management in Healthcare	3
IE 474	Healthcare Systems Engineering Capstone Project	3
IE 404	Simulation	3
	Technical Elective	3
	Spring Total	15
	PROGRAM TOTAL	**30**

The option to extend the Capstone project course into the following summer session also exists, but at present we anticipate most students will complete this as a one semester course. 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 ISE Department at (610) 758-4050 or from the HSE program website: http://www.lehigh.edu/ise/hse.html

HSE Course Descriptions

Introduction to Healthcare Systems (IE 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 (IE 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 (IE 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 (IE 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 (IE 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.

Hebrew

Modern Hebrew is taught in the Department of Modern Languages and Literature. Biblical Hebrew is taught in the Department of Religion Studies.

History

Professors. Michael G. Baylor, Ph.D. (Stanford); Stephen H. Cutcliffe, Ph.D. (Lehigh), chairperson History and STS; Steven L. Goldman, Ph.D. (Boston), Andrew W. Mellon Distinguished Professor in the Humanities; C. Robert Phillips, Ph.D. (Brown); James S. Saeger, Ph.D. (Ohio State); William R. Scott, Ph.D. (Princeton); Roger D. Simon, Ph.D. (Wisconsin); Jean R. Soderlund, Ph.D. (Temple).

Associate Professors. Gail A. Cooper, Ph.D. (U.C., Santa Barbara); Monica Najar, Ph.D (Wisconsin); John Pettegrew, Ph.D. (Wisconsin); John Savage, Ph.D. (N.Y.U.); John K. Smith, Ph.D. (Delaware).

Assistant Professors. William J. Bulman, Ph.D. (Princeton); Nitzan Lebovic, PhD. (UCLA), Helene and Allen Apter chair in Holocaust Studies and Ethical Values; Michelle LeMaster, Ph.D. (Johns Hopkins)

Professor of Practice. Kimberley Carrell-Smith, Ph.D. (Delaware).

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 (History 391, 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 12, Basic Statistics, to fulfill their college math requirement.

Department Major Requirements

A history major consists of 35 hours, normally nine courses, as follows:

HIST 11	Survey of Europe to 1648.
HIST 12	Survey of Europe Since 1648.
HIST 201	Historical Perspectives, or
HIST. 202	Historical Research

One course in the history of Asia, Africa, or Latin America: HIST 5, 49, 50, 75, 76, 177, 340, 341, 342, 359, 368.

HIST 104, 300, 303, 331, 371, 391, 392, or provisional courses may be used to fulfill this requirement in accordance with their contents and emphases.

Minimum of 12 hours of courses numbered 303 or higher (except HIST 306).

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 History 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 (4), required
HIST 306	Internship in Public History (4),required
ART 175, 275, 370, or 375	Museology (3)
EDT 405	Website and Resource Development (3) (seniors by petition)
HIST 336	Bethlehem and the Lehigh Valley (4)
HIST 338	Techniques in Public History (2-4 credits, may be repeated for up to 8 credits)
HIST 339	Managing Nonprofit Organizations (4) HIST/ANTH 370 Historical Archeology (4)

Undergraduate Courses in History

Petitions are required for first-year students to take 100level or higher courses, and for sophomores to take 200level or higher courses. HU fills humanities distribution requirements; SS fills social science requirements; ND not designated.

HIST 5. (AAS 5) African Civilization (4)
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. (SS) Scott

HIST 7. Technology in America's Industrial Age (4)
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. (SS) Smith

HIST 8. Technology in Modern America (4)
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. (SS) Smith

HIST 11. Survey of Europe to 1648 (4)
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. (HU) Baylor

HIST 12. (GCP 12) Survey of Europe Since 1648 (4)
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. (HU) Savage

HIST 15. English History (4)
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. (HU) Bulman

HIST 16. English History (4)
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. (HU) Bulman

HIST 21. (CLSS 21) Greek History (4)
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. (SS) Phillips

HIST 22. (CLSS 22) Roman History (4)
Rome from its origins to A.D. 476.Political, social and religious developments.Transformation of the late Roman Empire to the early medieval period. (SS) Phillips

HIST 41. United States to 1865 (4)
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. (SS) LeMaster, Najar, Soderlund,

HIST 42. United States, 1865-1941 (4)
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. (SS) Carrell-Smith, Najar

HIST 43. United States Since 1939 (4)
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. (HU) Pettegrew

HIST 49. History of Latin America (4)
Spanish and Portuguese colonization of America and the struggles for independence, preceded by a brief view of the ancient American civilizations and Iberian backgrounds. (SS) Saeger

HIST 50. History of Latin America (4)
Continuation of HIST 49.The development of the Latin American nations in the 19th and 20th centuries. (SS) Saeger

HIST 64. (AAS 64, ECO 64) Plantation to Ghetto (2)
Examination of topics in the economic history of African Americans from the 1500s to the present.Explores the slave trade, slavery, postCivil War South, the black family, migration, urbanization, and race and poverty. (SS) O'Brien, Scott

HIST 75. (MLL 75, Asia 75) Chinese Civilization (4)
The development of traditional Chinese thought, beliefs, technology, and institutions from a historical perspective, from earliest times to China's encounter with the West. (HU or SS) Pankenier

HIST 76 (Asia 76, MLL 76) Understanding Contemporary China (4)
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. (SS)

HIST 90. FirstYear Seminar in History (4)
Seminar for first-year students on a particular theme or topic.(HU or SS depending on topic of seminar).

HIST 101 (GS 101) Histories of Globalization (4)
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. (HU) Savage

HIST 104. Themes in History (2-4)
Seminar on a particular theme or topic not covered by a currently listed offering.(HU or SS depending on topic of seminar).

HIST 105. Sports in Modern America (4)
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. (HU)

HIST 107. (GS 107) Technology and World History (4)
Development of technology and its relationship to political, economic, military and cultural aspects of world civilization from pyramids to the present. (SS) Smith

HIST 108. Bethlehem and the Lehigh Valley (4)
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. (SS) Smith

HIST 109. The Built Environment of New York: 1624-2001 (4)
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. (HU) Simon

HIST 110. American Military History (4)
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. (SS) Saeger

HIST 111. Engineering in the Modern World (4)
Roles played by engineers and engineering in the modern world, focusing on major achievements and failures, prominent engineers, and evolution of the profession. (SS) Smith

HIST 117. (STS 117/WS117) Women, Science and Technology (4)
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. (SS) Cooper

HIST 118. (HMS 118/STS 118) History of Modern Medicine (4)
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. (HU) Grafe

HIST 120. Revolutionary America (4)
Origins and development of the American republic from 1750 through the adoption of the Federal Constitution. (SS) LeMaster, Najar, Soderlund

HIST 124. (WS 124) Women in America (4)
Roles of women in American society from colonial to present times: attitudes toward women, female sexuality, women's work, and feminism. (SS) Cooper, Najar

HIST 130. (AAS 130) African American History (4)
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. (SS) Scott

HIST 133. (AAS 133/FREN 133/LAS 133/MLL 133/POLS 133) Lehigh in Martinique: Globalization and Local Identity (3-4)
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. (HU)

HIST 135. Era of Jefferson and Jackson (4)
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. (SS) Najar

HIST 136. Era of the Civil War and Reconstruction (4)
American abolitionism and the origins of the Civil War; the Second American Revolution; Reconstruction and its sequel. (SS) Najar

HIST 145. (STS 145) Introduction to the History of Science (4)
The history of modern science, primarily physical and biological, with emphasis on the development of major theoretical models since the 17th century. (SS) Goldman

HIST 150. (REL 150) Medieval Civilization (4)
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. (HU) Savage

HIST 153. (WS 153) Women in European History, 1500-Present (4)
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. (SS)

HIST 154. (REL 154) The Holocaust: History and Meaning (4)
The Nazi Holocaust in its historical, political and religious setting. Emphasis upon the moral, cultural and theological issues raised by the Holocaust. (HU)

HIST 156. The Late Middle Ages and the Renaissance (4)
The transition from medieval to early modern society from the 14th to the early 16thcenturies. The general crisis of European civilization in the late Middle Ages; the rise and development of the Italian Renaissance; the spread of Renaissance culture from Italy to northern Europe. (HU) Baylor

HIST 157. (REL 157) Europe in the Age of the Reformation (4)
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. (HU) Baylor

HIST 158. Europe in the 17th and 18th Centuries (4)
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. (HU) Baylor

HIST 159. Revolutionary Europe, 1789-1870 (4)
Revolutions and reactions; the rise and spread of liberalism, nationalism, and socialism. (HU)

HIST 160. Europe in the Age of Total War, 1870-1945 (4)
Origins of two world wars; revolutionary governments in Germany, Italy, and Russia. (HU)

HIST 161. (CLSS 161) Roman LAW (4)
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. (SS) Phillips

HIST 162. Contemporary Europe (4)
Development of European States since 1945; European Community; Soviet influence and collapse. (HU) Savage

HIST 163. France Since 1789 (4)
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. (SS) Savage

HIST 170. (ASIA 170) The Last Samurai (4)
Explores the revolutionary character of the political upheaval in 1868 that led to the fall of the ruling shogan 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. (HU) Cooper

HIST 177. (Asia 177, MLL 177) China Enters the Modern Age (4)
The collapse of the imperial order and China's agonizing transformation into a modern nation over the past 150 years.The impact of imperialism, war, radical social change, and protracted revolution on Chinese beliefs, values, and institutions. (HU or SS) Pankenier

HIST 179. (AAS 179) Black Political Thought in America (4)
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. (SS) Scott

HIST 180. (REL 180) Religion and the American Experience (4)
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 churchstate relationship. (HU)

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.

HIST 201. Historical Perspectives (4)
Methodologies and interpretations of Western historians from ancient times to the present. (HU) Baylor

HIST 202. Historical Research (4)
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. (SS)

HIST 213. (CLSS 213, REL 213) Ancient Roman Religion (4)
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. (SS) Phillips

HIST 253. (ARCH 253) Paris: Plan of Metropolis (3)
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. (HU) Savage.

HIST 303. Topics in History (2-4)
Intensive study in a particular area of history for advanced students. Topics may vary; may be repeated for credit with consent of advisor. (HU or SS depending on topic of seminar)

HIST 305. Public History (3-4)
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. (SS) Carrell-Smith

HIST 306. Internship in Public History (2-4)
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. (ND) Carrell-Smith

HIST 308. Industrial America Since 1945 (3-4)
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. (SS) Cooper

HIST 311. (CLSS 311) Twins and Sins: The Rise of Rome (3-4)
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. (SS) Phillips

HIST 312. (CLSS 312) Decline and Fall of the Roman Empire (3-4)
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. (SS) Phillips

HIST 313. (CLSS 313) Golden Age of Greek Democracy (3-4)
Greek history of the 7th through 5th centuries B.C. Emphasis on the contrasting political and social systems of Athens and Sparta with consideration of related economic and military history. Attention to art, gender, literature, religion. Discussion and lectures; papers. (SS) Phillips

HIST 314. (CLSS 314) Age of Caesar and Christ (3-4)
Roman history of the 1st century A.D. Political, cultural, and socioeconomic changes; special attention to the evolution of absolute power.Lectures, discussions, papers. (SS) Phillips

HIST 315. (ES 315) American Environmental History (3-4)
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. (SS) Cutcliffe

HIST 318. History of North American Indians (3-4)
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. (SS) LeMaster, Soderlund

HIST 319. Colonial America (3-4)
Founding and growth of colonies in North America through 1763.Emphasis on motives for settlement, Native American-European relations, and the economic, social, and political development of the British West Indies and mainland provinces. (SS) LeMaster, Soderlund

HIST 323. American Cultural History Since 1900 (3-4)
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. (HU) Pettegrew

HIST 325. (SSP 325, WS 325) History of Sexuality and the Family in the U.S. (3-4)
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. (SS) Najar

HIST 326. (SSP 326) Social Class in American History (3-4)
Emphasis on the 19th and 20th century, focusing on: emergence of a whitecollar 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. (SS) Simon

HIST 328. American Intellectual History Since 1900 (3-4)
Social, literary, and political thought in the 20thcentury 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. (HU) Pettegrew

HIST 331. (AAS 331) United States and Africa (3-4)
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. (SS) Scott

HIST 332. (AAS 332) Slavery and the American South (3-4)
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. (SS)

HIST 333. American City to 1900 (3-4)
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. (SS) Simon

HIST 334. American City in the Twentieth Century (3-4)
Immigration; Progressive “reforms;” urban planning and zoning; impact of automobile and suburbanization; Depression and New Deal; public housing and racial ghettoes; urban decline and “renewal.”Required field trip. (SS) Simon

HIST 337 History and Community Memory (3-4)
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. (SS) CarrellSmith.

HIST 338 Techniques in Public History (2 or 4)
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. (HU)

HIST 339. Managing Nonprofit Organizations (3-4)
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. (SS)

HIST 340. (Asia 340) Japanese Industrialization (3-4)
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. (SS) Cooper

HIST 341. Mexico and Central America (3-4)
Emphasis on Mexico and Guatemala from the era of the Aztec through the wars of independence to the 20th-century revolutions. (SS) Saeger

HIST 342. Argentina, Brazil and Chile (3-4)
Eighteenth-century Spanish imperial readjustments, independence, the emergence of new societies, 20th-century extremist movements, and the problems of developing nations. (SS) Saeger

HIST 345. Victorian Britain (3-4)
Development of democracy, liberalism, religious ferment, industrialization, class conflict, socialism, and empire in Victorian Britain. (HU)

HIST 346. Great Britain in the 20th Century (3-4)
Effects of world wars, loss of great power status, economic decline, social conflict, welfare state, modern political parties, Irish problem in 20th-century Britain. (HU)

HIST 349. Revolutions in Modern European History (3-4)
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. (SS) Savage

HIST 350. (GCP 350) 19th Century Paris and the Invention of Modernity (3-4)
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. (HU) Savage

HIST 351. (GS 351) "The Gangs of New York" (4)
The course will use the Martin Scorcese film "The Gangs of New York" as a window to examine the social and economic transformations of New York City in the middle of the 19th century. Emphasis will be on immigration, slum conditions, nativism, workingclass culture, 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 the film. NOT AVAILABLE FOR PASS/FAIL. (HU) Simon

HIST 355. (GS 355) The Destruction and Reconstruction of Europe, 1870-1950 (3)
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. (SS) Baylor

HIST 356. European Cultural History (3-4)
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. (HU) Savage

HIST 357. Early Modern Germany, 1500-1850 (3-4)
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. (HU) Baylor

HIST 358. Modern Germany, 1850 to Present (3-4)
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. (HU) Baylor

HIST 359. (AAS 359) History of South Africa (3-4)
South Africa's history from its earliest human settlement to its emergence as a racist political order and transition to a nonracial democratic state. Includes comparisons with political thought and practices in the U.S. (SS) Scott

HIST 360. American Legal History (3-4)
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. (SS) Pettegrew

HIST 367. Rise and Fall of the Old South (3-4)
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-Revolutionarry contest for empire, and the rise and development of the plantation complex and slavery. (SS) LeMaster

HIST 368. Seminar in Latin American History (3-4)
Readings and individual investigation of selected topics. (SS) Saeger

HIST 370. (ANTH 370) Historical Archeology (3-4)
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. (SS) Small

HIST 371. Independent Study (1-4)
Directed readings in a topic or area of history not covered by current course offerings. For students of demonstrated ability and adequate preparation. Prerequisite: consent of department chair. May be repeated for credit with permission up to a maximum of six credits. (ND)

HIST 373. The French Revolution and Napoleon (3-4)
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. (HU) Savage

HIST 391. Honors Thesis in History (4)
Opportunity for undergraduate majors in history to pursue an extended project for senior honors.By invitation and department permission only. (ND)

HIST 392. Honors Thesis in History (2)
Continuation of History 391 available under exceptional circumstances where additional credit for honors project is warranted.Department permission only. (ND)

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 and to take History 401 and History 404 or 405.

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 PublicHistory courses.

HIST 305	Public History (3), required
HIST 306	Internship in Public History (3),required but may be waived for equivalent experience
ART 370	Special Topics in Museum Studies (1-4)
EDT 405	Website and Resource Development (3)
HIST 336	Bethlehem and the Lehigh Valley (3)
HIST 339	Managing Nonprofit Organizations(3)
HIST/ANTH 370	Historical Archeology (3)
HIST 438	Techniques in Public History (2 or 3 credits; may be repeated for up to 8 credits)

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 (404) or Readings in the History of Industrial America (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.

Graduate Courses in History

HIST 401. Historical Research (3)
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)
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)
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)
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. Smith

HIST 421. Readings in Topics in the Atlantic World (3)
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.

HIST 426. Readings in Topics in American History (3)
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.

HIST 438. Techniques in Public History (2 or 3)
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.

HIST 440. Readings in Colonial American History (3)
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.

HIST 441. Readings in Nineteenth Century American History (3)
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.

HIST 442. Readings in Twentieth Century American History (3)
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.

HIST 443. Readings in English History (3)
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.

HIST 444. Readings in Latin American History (3)
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.

HIST 445. Readings in the History of Science (3)
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.

HIST 446. Readings in the History of Technology (3)
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.

HIST 447. Readings in European History (3)
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.

HIST 448. (POLS 448) Land Use, Growth Management, and the Politics of Sprawl (3)
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. Freeman

HIST 452. Research in American History (3)
An intensive research seminar on a phase of American history.May be repeated for credit with permission of the department chair.

HIST 453. Research in English History (3)
An intensive research seminar on a phase of English history.May be repeated for credit with permission of the department chair.

HIST 454. Research in Latin American History (3)
An intensive research seminar on a phase of Latin American history.May be repeated for credit with permission of the department chair.

HIST 455. Research in History of Science and Technology (3)
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.

HIST 457. Research in European History (3)
An intensive research seminar on a phase of European history.May be repeated for credit with permission of the department chair.

HIST/WS 458. Readings in Gender History (3)
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. Cooper, LeMaster, Najar, Pettegrew

HIST 471. Special Topics in History (1-3)
Individual study under the direction of a faculty member of a topic in history.May be repeated for credit.

HIST 472. Special Topics in History (1-3)
Individual study under the direction of a faculty member of a topic in history.May be repeated for credit.

HIST 473. Special Topics in History (1-3)
Individual study under the direction of a faculty member of a topic in history.May be repeated for credit.

HIST 481. Teaching History (1)
Focuses on the practical aspects of college teaching, including teaching methods, preparation of syllabi and exams, grading papers and exams, and dealing with problems such as plagiarism.Required for teaching assistants, teaching fellows, and Ph.D. students in the Department of History.

Humanities

Eccentral Committee: M. Edurne Portela, Ph.D. (North Carolina), MLL – Spanish and Director Humanities Center; Gordon C.F. Bearn, Ph.D. (Yale), Philosophy; Seth Moglen, Ph.D. (California at Berkeley), English; Suzanne M. Edwards, Ph.D. (Chicago), English; 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. We choose a theme for each year (Creativity, The Public Intellectual, Waste, Just Globalization, New Bethlehem, Speaking Bodies 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 (1-4)
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)

Industrial and Systems Engineering

Professors. Keith M. Gardiner, Ph.D. (Manchester); Nicholas G. Odrey, Ph.D. (Penn State); Robert H. Storer, Ph.D. (Georgia Tech); Tamás Terlaky, Ph.D. (Loránd Eötvös Univ.) chair; S. David Wu, Ph.D. (Penn State); Emory W. Zimmers, Jr., Ph.D. (Lehigh).

Associate Professors. Eugene Perevalov, Ph.D. (TexasAustin); Louis J. Plebani, Ph.D. (Lehigh); Theodore K. Ralphs, Ph.D. (Cornell); Katya A. Scheinberg, Ph.D. (Columbia); Lawrence

V. Snyder (Northwestern); Aurelie Thiele, Ph.D. (MIT); Gregory L. Tonkay, Ph.D. (Penn State); George R. Wilson, Ph.D. (Penn State) associate chair.

Assistant Professors. Frank E. Curtis (Northwestern); Luis F. Zuluaga, Ph.D. (Carnegie Mellon).

Professors of Practice. Hisham Abu-Nabaa, M.S. (Wilkes); Pasquale Costa, B.S. (Penn State).

Professors Emeritus. Mikell P. Groover, Ph.D. (Lehigh); John W. Adams, Ph.D. (North Carolina).

Mission Statement

To pursue excellence and national prominence in the areas of manufacturing, operations research, information technology and related fields of industrial 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, and process control.

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 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 IE coursework. IE/computing center PC laboratories containing 54 PCs are located in the Mohler Laboratory building.

B.S. in Industrial Engineering

Industrial Engineering (IE) is concerned with the analysis, design, and implementation of integrated systems of people, materials, information, and equipment to accomplish useful work. The discipline of industrial engineering is applicable in nearly all industries, whether the industry involves manufacturing of a product or delivery of a service. Job functions performed by IEs include: systems analysis, cost estimation, capital equipment selection, engineering economy, facilities planning, production planning and scheduling, inventory control, quality control, information systems, 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 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.

Career Opportunities

IE 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 engineer is to start in an entrylevel engineering position or as a technical analyst and to progress through various management positions in the firm or institution. Significant numbers of industrial engineers ultimately become chief executive officers, chief operating officers, and chief technology officers in their respective organizations.

Program Educational Objectives

Industrial Engineering graduates will:

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 lifelong learning and professional growth as ethical and responsible members of society
5. form, lead, and participate on multidisciplinary teams that solve problems in engineering and business

IE Curriculum

The IE curriculum is designed to provide graduates with the skills and knowledge that employers expect of young industrial 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 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.

Specialized industrial engineering 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, production engineering, and metal machining analysis. The ISE department website contains a list of optional tracks and course suggestions for IE majors interested in specific fields (http://www.lehigh.edu/ise). The IE degree requires a minimum of 131 credit hours.

IE Major Requirements

See freshman year requirements, section III.

sophomore year, first semester (16 credit hours)

IE 111	Engineering Probability (3)
IE 112	Computer Graphics (1)
MATH 23	Calculus III (4)
PHY 21, 22	Introductory Physics II and Laboratory (5)
MAT 33	Engineering Materials and Processes (3)

sophomore year, second semester (17-18 credit hours)

IE 121	Applied Engineering Statistics (3)
IE 131	Work Systems and Operations Management (3)
IE 132	Work Systems Laboratory (1)
ME 104	Thermodynamics I (3)
MATH 205	Linear Methods (3)
HSS	Humanities/Social Sciences elective (3-4)*

junior year, first semester (17-18 credit hours)

IE 215	Fundamentals of Modern Manufacturing (3)
IE 216	Manufacturing Laboratory (1)
HSS	Humanities/Social Science Elective (3-4)*
ACCT 108	Fundamentals of Accounting (3)
MECH 2	Elementary Engineering Mechanics (3)
ECO 1	Principles of Economics (4)

junior year, second semester (16 credit hours)

IE 122	Software Tools (1)
IE 226	Engineering Economy and Decision Analysis (3)
IE 220	Introduction to Operations Research (3)
IE 224	Information Systems Analysis and Design (3)
ECE 83	Introduction to Electrical Engineering (3)
IE 305	Simulation (3)

summer

IE 100	Industrial Employment (0)

senior year, first semester (18 credit hours)

IE 251	Production and Inventory Control (3)
IE	elective (3)**
IE	elective (3)**
IEOR	elective (IE 316 or IE 339) (3)***
HSS	Humanities/Social Sciences elective (3)* FE free elective (3)

senior year, second semester (18 credit hours)

IE 154	Senior Project (3)
HSS	Humanities/Social Sciences elective (3)*
IE	elective (3)**
IE	elective (3)**
FE	free elective (6)

Notes:

*HSS elective credit totals must satisfy the college HSS program

**IE elective courses are chosen from the current offering of 300-level IE courses

***IEOR elective is either IE 316 or IE 339 (could be fall or spring).

Special Opportunities for IE students

The following special opportunities are available to majors in industrial engineering and information & 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 IE courses (400level) to satisfy two of their four 300level elective IE 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 IE 155 as an engineering or free elective. After IE 155, IE 156 is taken as the thesis is written. The sequence of these 2 courses can replace IE 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://www.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 engineering. It requires 16 credits.

5th Year Master of Management Science and Engineering Option

Students enrolled in the IE or ISE curricula can pursue a fifthyear Master of Management Science and Engineering program. Students in the management science program take a mixture of engineering and business courses. Admission is not guaranteed. For details see the management science and engineering section of the catalog or contact the ISE department.

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 specified 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.

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): IE 406, IE 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.

Undergraduate Courses

IE 100. Industrial Employment (0)
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. Prerequisite: Sophomore standing.

IE 111. Engineering Probability (3) fall and spring
Random variables, probability models and distributions. Poisson processes. Expected values and variance. Joint distributions, covariance and correlation. Prerequisite: MATH 22.

IE 112. Computer Graphics (1) fall
Introduction to interactive graphics and construction of multiview representations in twoand threedimensional space. Applications in industrial engineering. Prerequisites: Sophomore standing in industrial engineering, ENGR 1.

IE 121. Applied Engineering Statistics (3) spring
The application of statistical techniques to solve industrial problems. Regression and correlation, analysis of variance, quality control, and reliability. Prerequisite: IE 111 or MATH 231.

IE 122. Software Tools (1) spring
Introduction to application software tools used to solve stochastic and deterministic problems. Problem design and solution will be drawn from IE 220. Corequisite: IE 220.

IE 131 Work Systems and Operations Management (3) spring
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. Prerequisite: IE 111 or equivalent, either previously or concurrently.

IE 132. Work Systems Laboratory (1) spring
Laboratory exercises, case studies, and projects in operations analysis, methods engineering, work measurement, and plant layout design. Corequisite: IE 131.

IE 154. Senior Project (3) fall and spring
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. Prerequisite: Senior standing in industrial engineering.

IE 155. Senior Thesis I (3)
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. Prerequisite: Senior standing.

IE 156. Senior Thesis II (3)
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 IE155. Prerequisite: IE 155.

IE 168. Production Analysis (3) spring
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: MATH 21 or 51.

IE 172. Algorithms in Systems Engineering (4) spring
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. Prerequisite: CSE 17 or CSE 18.

IE 185. ISELP Honors Seminar (1)
Study of problem solving, principles of enterprise systems, and creative use of information technology in controlled environments. Emphasis on teamwork, self knowledge, and communication skills. Department permission required. May be repeated for credit.

For Advanced Undergraduates and Graduate Students

IE 215. Fundamentals of Modern Manufacturing (3) fall
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. Prerequisite: MAT 33.

IE 216. Manufacturing Laboratory (1) fall
Laboratory exercises and experiments in manufacturing processes and systems. Prerequisite or concurrent: IE215.

IE 220. Introduction to Operations Research (3) spring
Introduction to deterministic and stochastic methods in operations research. Mathematical programming, queuing theory, and other modeling techniques. Emphasis on formulation, analysis and solution of operations problems. Prerequisites: IE 111 or MATH 231 and MATH 205, Corequisite: IE 122.

IE 224. Information Systems Analysis and Design (3) spring
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) spring
Economic analysis of engineering projects; interest rate factors, methods of evaluation, depreciation, replacement, breakeven analysis, aftertax analysis. decision-making under certainty and risk. Prerequisite: IE 111 or MATH 231, either previously or concurrently.

IE 251. Production and Inventory Control (3) fall
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.

IE 275. Fundamentals of Web Applications (3)
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: either IE 224 or CSE 241 previously or concurrently.

IE 281. Leadership Project (1-3)
Application of leadership principles through team projects with industry. Written report required. (Prerequisite: IE 382 or permission of instructor).

IE 305. Simulation (3)
Applications of discrete and continuous simulation techniques in modeling industrial systems. Simulation using a highlevel simulation language. Design of simulation experiments. Prerequisite: IE 121.

IE 316. Optimization Models and Applications (3)
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. Prerequisite: IE 220 or equivalent.

IE 319. Facilities Planning and Material Handling (3)
Facilities planning including plant layout design and facility location. Material handling analysis including transport systems, storage systems, and automatic identification and data capture. Prerequisite: IE 131 or consent of department chair.

IE 321. Independent Study in Industrial & Systems Engineering (1-3)
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.

IE 324. Industrial Automation and Robotics (3)
Introduction to robotics technology and applications. Robot anatomy, controls, sensors, programming, work cell design, part handling, welding, and assembly. Laboratory exercises. Prerequisites: MECH 2, MATH205.

IE 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. Prerequisite: MATH 23 or equivalent. This course cannot be taken by IE undergraduates.

IE 332. Product Quality (3)
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. Prerequisite: IE 121.

IE 334. Organizational Planning and Control (3) fall
Design of organization and procedures for managing functions of industrial engineering. Analysis and design of resources planning and control, including introduction of change in manmachine systems; manpower management and wage administration. Prerequisite: Junior Standing.

IE 339. Stochastic Models and Applications (3)
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. Prerequisite: IE 220 or equivalent.

IE 340. Production Engineering (3) fall
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. Prerequisite: IE 215.

IE 341. Data Communication Systems Analysis and Design (3)
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. Prerequisite: IE 224 and IE 220 or equivalent.

IE 344. (MAT 344/ME 344) Metal Machining Analysis (3) spring
Intensive study of metal cutting emphasizing forces, energy, temperature, tool materials, tool life, and surface integrity. Abrasive processes. Laboratory and project work. Prerequisite: IE 215 or ME 240 or Mat 206.

IE 345. Manufacturing Information Systems (3)
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. Prerequisites: IE275.

IE 355. Optimization Algorithms and Software (3)
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. Prerequisite: IE 220 or consent of instructor

IE 356 Introduction to Systems Engineering and Decision Analysis (3)
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: IE220 or consent of the instructor

IE 358. (ECO 358). Game Theory (3)
A mathematical analysis of how people interact in strategic situations. Applications include strategic pricing, negotiations, voting, contracts and economic incentives, and environmental issues. Prerequisites: ECO 105 or 115 and MATH 21, 31 or 51.

IE 362. (MSE 362). Logistics and Supply Chain Management (3)
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. Prerequisite: IE 220 and IE 251 or equivalents, or instructor approval.

IE 372. Systems Engineering Design (3)
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, 275.

IE 382. Leadership Development (3) spring
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. (Junior or Senior)

IE 385. ISELP Honors Project Seminar (1)
Application of problem solving to real enterprise systems projects. Emphasis on leadership, teamwork, design, and communication skills. Requires a written honors project report. Department permission required. Senior standing. May be repeated for credit.

Graduate Courses

IE 404. Simulation (3)
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: IE 121 or IE 328 and IE 220 or equivalent.

IE 405. Special Topics in Industrial & Systems Engineering (3)
An intensive study of some field of industrial & systems engineering.

IE 406. Introduction to Mathematical Optimization (3)
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 408. Management of Information Systems (3)
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. Prerequisite: IE 224 or ACCT 311 or equivalent.

IE 409. Time Series Analysis (3)
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. Prerequisite: IE 121 or equivalent.

IE 410. Design of Experiments (3)
Experimental procedures for sorting out important causal variables, finding optimum conditions, continuously improving processes, and trouble shooting. Applications to laboratory, pilot plant and factory. Prerequisite: Some statistical background and experimentation in prospect, IE 121 or equivalent.

IE 411. Networks and Graphs (3)
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. Prerequisite: IE 406 or equivalent.

IE 412. Quantitative Models of Supply Chain Management (3)
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. Prerequisite: IE 316 and IE 339, or equivalent.

IE 413. Advanced Engineering Economy and Replacement Analysis (3)
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: IE 220 and IE 226, or equivalent.

IE 414. Heuristic Methods in Combinatorial Optimization (3)
Heuristic methods for solving combinatorial and discrete optimization problems such as routing, scheduling, partitioning and layout. Introduction to NPcompleteness 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)
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. Prerequisite: IE 316 or equivalent.

IE 417. Nonlinear Programming (3)
Advanced topics in mathematical programming with emphasis on modeling and analysis of nonlinear optimization problems. Convex analysis, unconstrained and constrained optimization, duality theory, Lagrangian relaxation, and methods for solving nonlinear programs, including descent methods, Newton methods, conjugate gradient methods, and penalty and barrier methods. Prerequisite: IE 406 or equivalent.

IE 418. Integer Programming (3)
Advanced topics in mathematical programming 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 integer programs, such as branch and bound. Prerequisite: IE 406 or equivalent.

IE 419 Planning and Scheduling in Manufacturing and Services (3)
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.
Prerequisites: IE 316 or equivalent

IE 422. Measurement and Inspection Systems (3)
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. Prerequisite: IE 328 or equivalent.

IE 424. Robotic Systems and Applications (3)
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. Prerequisite: IE 324 or consent of instructor.

IE 425. Advanced Inventory Theory (3)
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. Prerequisites: IE 316 and IE 339, or equivalent.

IE 426. Optimization Models and Applications (3)
Modeling and analysis of operations research problems using techniques form 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. Prerequisite: IE 220 or equivalent background.

IE 429. Stochastic Models and Applications (3)
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. Prerequisite: IE 220 or equivalent background.

IE 430. Management Science Project (3)
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)
Extensive study of selected topics in techniques and models of operations research.

IE 433. Manufacturing Engineering Special Topics (3)
Extensive study of selected topics in the research and development of manufacturing engineering techniques.

IE 437. Advanced Database Analysis and Design (3)
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. Prerequisite: IE 310 or equivalent.

IE 438. Advanced Data Communication Systems Analysis and Design (3)
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. Prerequisite: IE 341 and IE 316, or equivalent.

IE 439. Queueing Systems (3)
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. Prerequisite: IE 339 or consent of instructor.

IE 441. Financial Engineering Projects (3)
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)
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. (MSE 427) Automation and Production Systems (3)
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. Prerequisite: IE 215 or equivalent.

IE 445. Assembly Processes and Systems (3)
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. Prerequisite: IE 215 or equivalent.

IE 446. Discrete Event Dynamic Systems (3)
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. Prerequisites: Consent of instructor.

IE 447. Financial Optimization (3)
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. Prerequisite: IE 426 or equivalent.

IE 448. Industrial Control Systems for Manufacturing (3)
Techniques used to control manufacturing systems: numerical control, digital control, programmable logic controllers, and sensors.

IE 449. Advanced Computer Aided Manufacturing (3)
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. Prerequisite: IE 340 or consent of instructor.

IE 451. Intelligent Manufacturing Systems (3)
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. Prerequisite: Consent of instructor.

IE 455 Optimization Algorithms and Software (3)
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.
Prerequisite: IE 220 or consent of instructor

IE 458 (ECO 463). Topics in Game Theory (3)
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. Prerequisites: Two semesters of calculus, ECO 412 and ECO 414, or permission of the instructor.

IE 460. Engineering Project (1-3)
Intensive study of an area of industrial engineering with emphasis upon design and application. A written report is required.

IE 461. Readings (1-3)
Intensive study of some area of industrial engineering that is not covered in general courses.

IE 470. Introduction to Healthcare Systems (3)
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)
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)
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)
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 ()
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)
Intensive study of an area of healthcare systems engineering with emphasis upon design and application. Written report is required.

IE 490. Thesis (16)

IE 499. Dissertation (115)

Information and Systems Engineering

B.S. in Information and Systems Engineering

Information and systems engineering (I&SE) is a bachelor of science degree program that produces graduates who understand the complex facets of modern information systems, and the integration of these systems in industrial, service and financial organization. The degree program, offered through the Department of Industrial and Systems Engineering, constitutes a broad based curriculum focusing on three core areas: (1) Information Economics, (2) Quantitative Systems Analysis, and (3) Information Technology. The core 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. Topic areas range from fundamental theory and methodologies in systems science and engineering, to issues in complex supply networks, e-Business, electronic marketplaces, and financial engineering. Quantitative systems analysis studies operations research and computational tools for analyzing complex systems and their information components. Topic areas include mathematical programming, optimization, decision analysis, large-scale modeling and simulation, decentralized decision processes, stochastic processes, sequencing and scheduling, parallel and distributed algorithms, and algorithm design. 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 intelligent manufacturing control. The ISE department website contains a list of optional tracks and course suggestions for I&SE majors interested in specific fields (http://www.lehigh.edu/ise). The I&SE degree requires 129 credit hours.

Program Educational Objectives

Information and Systems Engineering graduates will:

1. recognize and analyze problems, design innovative solutions, and lead their implementation
2. excel as information 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

I & SE Major Requirements

See freshman year requirements, section III.

sophomore year, first semester (15 credit hours)

IE 111	Engineering Probability and Statistics (3)
MATH 23	Calculus III (4)
PHY 21, 22	Introductory Physics II and Laboratory (5)
CSE 18	Data Structures and Programming (3)

sophomore year, second semester (16 credit hours)

IE 121	Applied Engineering Statistics (3)
IE 172	Algorithms in Systems Engineering (4)
MATH 205	Linear Methods (3)
ACCT 108	Fundamentals of Accounting (3)
ECE 83	Introduction to Electrical Engineering (3)

junior year, first semester (17 credit hours)

IE 122	Software Tools (1)
IE 220	Introduction to Operations Research (3)
IE 224	Information Systems Analysis and Design (3)
ECO 1	Principles of Economics (4)
MECH 2	Elementary Engineering Mechanics (3)
or ME 104	Thermodynamics I (3)
or MAT 33	Engineering Materials Processing (3)
FE	Free Elective (3)

junior year, second semester (18-19 credit hours)

IE 226	Engineering Economy and Decision Analysis (3)
IE 275	Fundamentals of Web Applications (3)
IE 305	Simulation (3)
HSS	Humanities/Social Science Elective (6-7)*
FE	Free Elective (3)

summer

IE 100	Industrial Employment (0)

senior year, first semester (15-16 credit hours)

IE 316	Optimization Models and Applications (3)
IE 372	Systems Engineering Design (3)
TE	Technical Elective (6)**
HSS	Humanities/Social Sciences elective (3-4)*

senior year, second semester (18 credit hours)

IE 154	Senior Project (3)
IE 339	Stochastic Models and Applications (3)
TE	Technical Elective (6)**
HSS	Humanities/Social Sciences elective (3)*
FE	Free Elective (3)

Notes:

**HSS elective credit totals must satisfy the college HSS program*

***Technical Electives from approved list*

Special Opportunities for I&SE students

The following special opportunities are available to majors in information systems and 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. The minors program section of this catalog should be consulted for details.

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 the Department of Industrial and Systems Engineering can petition to take up to two graduate IE courses (400-level) to satisfy two of their five 300-level elective IE 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 IE 155 as an engineering or free elective. After IE 155, IE 156 is taken as the thesis is written. The sequence of these 2 courses can replace IE 154.

5th Year Master of Management Science and Engineering Option

Students enrolled in the ISE curricula can pursue a fifth-year Master of Management Science and Engineering program. Students in the management science and engineering program take a mixture of engineering and business courses. Admission is not guaranteed. For details see the management science and engineering section of the catalog or contact the ISE department.

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 and Business Information Systems (sgb2@lehigh.edu) and Robert H. Storer, Professor of Industrial and Manufacturing Systems Engineering (rhs2@lehigh.edu). For additional information, see the IBE Honors Program entry in Section V of this catalog or visit the IBE web site at *www.lehigh.edu/inibep/inibep.html.*

IBE 10 Integrated Business and Engineering Freshman Seminar (1) fall
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 50 Integrated Business and Engineering Freshman Workshop (3) spring
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) fall
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 250 Integrated Business and Engineering Junior Laboratory (1) fall
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 380 Integrated Business and Engineering Capstone Project I (3) spring
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) fall
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.

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 accreted 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:

Program Component	Minimum Credits	Required Courses
IDEAS core 1	12 credits	IDEA 11, 12, 111, 112, 150, 151, 210, 211
Math/Science core 2	36 credits	Math 21, 22, 23, 205; Chem 25; Physics 11, 12 plus (see #2 below)
Engineering concentration 3	36 credits	Specified by the college
Arts & Science concentration 4	36 credits	Specified by the college
A&S distribution requirements 5	16 credits	As defined by the college
Total	136 credits	

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 41, 42; Chem 51, 53; EES gateway courses; Physics 21, 22; 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 for the first two years and one in the fall of the junior and senior years.

a. These courses replace Engineering 5, English 1 & 2, the CAS college seminar, and the CAS junior year writing intensive requirement. All IDEAS core courses are writing intensive.

b. IDEA 11 and 12: 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 112: a continuation of IDEAS 11 & 12 where interest areas are integrated into themes as individual concentrations are pursued.

d. IDEA 150 and 151: the junior year courses have students working on team-based projects and preparing for the senior year thesis work.

e. IDEA 250 and 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.

1. **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*

IDEAS Courses:

IDEA 11 IDEAS Seminar I (2 credits)

IDEA 12 IDEAS Seminar II (2 credits)

IDEA 111 IDEAS Seminar III (2 credits)

IDEA 112 IDEAS Seminar IV (2 credits)

IDEA 150 IDEAS Seminar V (1 credit)

IDEA 151 IDEAS Seminar VI (1 credit)

IDEA 250 IDEAS Seminar VII (1 credit)

IDEA 251 IDEAS Seminar VIII (1 credit)

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.

Required Courses comprising the minor include:

- IPRE 001 Introductory Seminar in Real Estate (3 credit hours)
- IPRE 002 Field Laboratory (2 credit hours)
- IPRE 301 Case Studies in Real Estate Value Creation (3 credit hours)
- IPRE 302 Summer IPRE Internship (0 - 1 credit hour)
- Bus 347 Practicum in Real Estate I (2 credit hours)
- Bus 348 Practicum in Real Estate II (2 credit hours)

Recommended Courses:

1. IPRE 101 Real Estate Practicum Clerkship I (1 credit hour)
2. IPRE 102 Real Estate Practicum Clerkship II (1 credit hour)

The director of the Goodman Center for Real Estate Studies and the ***ire@l*** program is Associate Professor Stephen Thode (ire@lehigh.edu).

ire@l Minor Courses:

IPRE 001 Introductory Seminar in Real Estate (3 credit hours)
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. *Prerequisite: Freshman standing OR Sophomore standing and permission of the instructor.*

IPRE 002 Field Laboratory (2 credit hours)
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. *Prerequisite: IPRE 001 and permission of the instructor.*

IPRE 301 Case Studies in Real Estate Value Creation (3 credit hours)
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. *Prerequisite: Permission of the instructor.*

IPRE 302 Summer IPRE Internship (0 - 1 credit hour)
This course is available summers and 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. *Prerequisite: permission of the program director.* **In extraordinary circumstances and with the approval of the program director this requirement can be altered according to the director's stipulations.**

Bus 347 Practicum in Real Estate I (2 credit hours)
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. *Prerequisite: Permission of the instructor.*

Bus 348 Practicum in Real Estate II (2 credit hours)
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. Prerequisite: Permission of the instructor.

IPRE 101 Real Estate Practicum Clerkship I (1 credit hour)
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. *Prerequisite: Permission of the instructor*

IPRE 102 Real Estate Practicum Clerkship II

(1 credit hour)
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). *Prerequisite: IPERE 101 and permission of the instructor.*

International Relations

Professors. Henri J. Barkey, Ph.D. (Pennsylvania), Bernard L. and Bertha F. Cohen Professor; John Martin Gillroy, Ph.D. (Chicago); Rajan Menon, Ph.D. (Illinois), Monroe J. Rathbone Professor; Bruce E. Moon, Ph.D. (Ohio State).

Associate professors. Chaim D. Kaufmann, Ph.D. (Columbia).

Assistant professor. Kevin Narizny, Ph.D. (Princeton)

Emeritus professors. Zdenek J. Slouka, Ph.D. (Columbia), Oles M. Smolansky, Ph.D. (Columbia).

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 21st 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 10 and ECO 1 as early as possible. We recommend that IR majors fulfill the mathematics portion of their college distribution requirement with Math 12 (Basic Statistics), although this course is not required for the major.

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 (two courses, 8 credits)

IR 10	Introduction to World Politics (4)
Eco 1	Principles of Economics (4)

Core courses (four courses, one from each functional group, 16 credits)

Functional Group	Approved Course(s)
International Relations Theory	IR 105. Theories of International Relations (4)
International Political Economy	IR 125. International Political Economy (4)
International Security Studies	IR 234. Great Power Politics (4) or IR 235. International Security (4)
International Governance	IR 142. International Law (4) or IR 245. International Organization (4)

Advanced courses (two courses, 8 credits)

Any IR courses numbered 301-387 (except 307) or 393.

Electives (12 credits)

Any IR courses other than IR 19, 90, 300, 388 or 391. 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.

Departmental Honors

To graduate with Departmental honors, a major in international relations must:

3. successfully complete a two semester honors thesis (IR 388) in the senior year;
4. 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.

Minor in International Relations

The minor consists of 16 credits: IR 10, one advanced IR elective numbered 301-387(except 307) or 393, and 8 credits of free IR electives other than IR 19, 90, 300 or 391.

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 and active role in the world of the 21st 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 1

5 courses in International Relations (20 credits), as follows:

IR 10

IR 105

IR 125

Two IR advanced courses numbered 301-387 (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, Russian, French (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 in International Environmental Policy

The Minor consists of 20 credits: IR 10, one advanced IR elective numbered 301-387(except 307) and 393, and 16 credits of electives (including one advanced course) to be taken from a list of approved eligible courses within the Department of International Relations.

Minor in Peace Studies

This interdisciplinary minor is listed under *Peace Studies*. IR majors are eligible.

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.

Undergraduate Courses

IR 10 (GS 10). Introduction to World Politics (4)
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. Staff (SS)

IR 19. Current Issues in World Affairs (3)
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. Staff (SS)

IR 34. Society, Technology and War (4)
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. Kaufmann (SS)

IR 36. International Terrorism (4)
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. Kaufmann (SS)

IR 56. European International Relations (4)
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. Staff (SS)

IR 61. (ASIA 61) Pacific Asian International Relations (4)
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. Staff (SS)

IR 72. The United States in the Global Economy (4)
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. Moon (SS)

IR 74. United States Foreign Policy (4)
Major themes and trends in U.S. foreign policy, including the historical evolution of current issues and institutions. Emphasis on critical examination of the interests and values that underlie the goals of policy and the beliefs that shape decisions on how to achieve those goals. Also addresses the constitutional division of authority, bureaucratic politics and processes, civil military relations, and public opinion. Narizny (SS)

IR 82. Middle East in World Affairs Since 1945 (4)
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. Staff (SS)

IR 104 (ES 104). Political and Environmental Geography (4)
Geographic 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 impacts of borders, how people have altered patterns of climate, hydrology, land forms, soils, and biota. Staff (SS)

IR 105. Theories of International Relations (4)
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. Prerequisite: IR 10. Staff (SS)

IR 118. Issues in International Relations (1-4)
Readings on selected themes in world politics, with theme to change each semester. Offered on an occasional basis only. Staff (SS)

IR 119. Issues in International Relations (1-4)
Readings on selected themes in world politics, with theme to change each semester. Offered on an occasional basis only. Staff (SS)

IR 120. Globalization and World Politics (4)
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. Prerequisite: IR 10. Moon (SS)

IR 123. Evolution of International Order (4)
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. Narizny (SS)

IR 125. (GS 125, POLS 125) International Political Economy (4)
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: Eco 1 and IR 10. Moon (SS)

IR 127. Research in International Relations (4)
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. Prerequisite: Consent of the instructor. Moon (SS)

IR 132. Nationalism and Ethnic Conflict (4)
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. Kaufmann (SS)

IR 140. (GC140, GS 140). The United Nations (4)
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. Prerequisite: IR 10. Staff (SS)

IR 142. International Law (4)
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. Prerequisite: IR 10. Gillroy (SS)

IR 143. (ES 143). Comparative Environmental Law & Policy (4)
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. Gillroy (SS)

IR 161. (ASIA 161) China in World Affairs (4)
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. Staff (SS)

IR 163. (ASIA 163) Japan in World Affairs (4)
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. Staff (SS)

IR 169. International Relations of Russia and Eastern Europe (4)
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). Staff (SS)

IR 177. International Relations of Latin America (4)
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. Barkey (SS)

IR 181. (Rel 181). Israel: Religion, Culture and National Identity (4)
Silberstein (HU). See description under Religion Studies.

IR 222. Political Economy of North-South Relations (4)
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). Prerequisite: IR 125 or permission of instructor. Moon (SS)

IR 234. Great Power Politics (4)
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 (bio-polarity), and the post-Cold War period (uni-polarity). Prerequisite: IR 10. Narizny (SS)

IR 235. International Security (4)
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. Prerequisite: IR 10. Kaufmann (SS)

IR 245. International Organization (4)
Examines how Cooperation is achieved and sustained in world politics. Under what circumstances does Cooperation take place? What role do formal international organizations (such as the UN) play? What roles do norms, values, and ethics play? Can Cooperation last? Questions pursued theoretically and in practical terms across topical issues (e.g., human rights, poverty, the environment, international law). Prerequisite: IR 10. Staff (SS)

IR 246. (JOUR 246) International Communication (4)
Lule (SS) See description under Journalism.

IR 302. Rise and Decline of Empires (4)
An overview of the expansion, overextension, and collapse of empires. Focus on alternative theories of empires as well as historical cases. Prerequisite: IR 10 and department permission. Staff (SS)

IR 307. International Social Entrepreneurship Practicum (4)
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. Moon and Watkins (SS)

IR 321. Economic Relations of Advanced Industrial Societies (4)
Foreign economic policies of advanced industrial nations. Bilateral and multilateral economic relations; international

economic regimes and institutions; interdependence and Cooperation; managing conflict. Prerequisite: IR 125. Moon (SS)

IR 322. Poverty and Development (4)
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. Corequisite: IR 222. Moon (SS)

IR 323. Political Economy of Newly Industrializing Countries (4)
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. Prerequisite: IR 125. Barkey (SS)

IR 333 (ES 333/433). International Environmental Law and Policy (4)
Gillroy (SS) See description under Environmental Studies

IR 334. Prospects for Peace in the 21st Century (4)
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. Prerequisites: IR 10 and department permission. Kaufmann (SS)

IR 335. Intervention (4)
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. Prerequisites: IR 10 and departmental permission. Kaufmann (SS)

IR 339 (ES 339/ES 439) Global Security and the Environment (4)
Staff (SS) See description under *Environmental Studies*

IR 340 (ES 340/ES 440). International Environmental and Science Policy (4)
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. Prerequisites: IR 10 and department permission Staff (SS)

IR 343 (ES 343). Comparative Environmental Law & Policy (4)
Gillroy (SS) See description under *Environmental Studies*

IR 344. International Politics of Oil (4)
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. Department permission required. Prerequisites: IR 10 or Eco 1. Barkey (SS)

IR 345. External Dimensions of Democratization (4)
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. Prerequisites: IR 10 and department permission. Narizny. (SS)

IR 346. Contemporary Ethical Dilemmas in World Politics (4)
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. Prerequisites: IR 10 and department permission. Staff (SS)

IR 347.(GS 347). Non-State Actors in a Globalized World (4)
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.) Prerequisites: IR 10 and department permission. Staff. (SS)

IR 354. International Relations of the Middle East (4)
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. Prerequisites: IR 10 or 82 and department permission. Staff (SS)

IR 364. (ASIA 364) International Relations of Pacific Asia (4)
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. Prerequisite: IR 61 or 161 or 163 or 164. Staff (SS)

IR 367. International Relations of Russia and other Post-Soviet States (4)
Analysis of foreign relations of Russia and the other fourteen states that emerged after the collapse of the USSR.

Prerequisites: IR 10 or IR 169 and department permission. Staff (SS)

IR 388. Honors Thesis in International Relations (4)
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. Staff. (SS)

IR 390. Readings in International Relations (1-4)
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. Departmental permission required. Staff (SS)

IR 391. Internship in International Relations (1-4)
Internship in public or private agency. May be repeated for credit. Departmental permission required. Staff (SS)

IR 392. Independent Study (1-4)
This course enables students to work with faculty on individual projects and material not covered by the current course offerings. Department permission required. Staff (SS)

IR 393. Seminar in International Relations (4)
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 departmental permission required. Staff. (SS)

IR 394. Special Topics in International Relations (1-4)
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. Departmental permission required. Staff (SS)

Japanese

See Listings under Modern Languages and Literature.

Jewish Studies

Program Director: Ruth Knafo Setton, Ph.D.
610-758-4869; inber@lehigh.edu

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. Ruth K. Setton.

Students pursuing a minor in Jewish studies must fulfill 16 credit hours from the following courses. (A maximum of eight credit hours of Hebrew may be counted.)

HEBR 1	Elementary Modern Hebrew I (4)
HEBR 2	Elementary Modern Hebrew II (4)
HEBR 11	Intermediate Modern Hebrew I (4)
HEBR 12	Intermediate Modern Hebrew II (4)
HEBR 151	Hebrew Special Topics I (4)
HEBR 152	Hebrew Special Topics II (4)
IR 82	Middle East in World Affairs Since 1945 (4)
PHIL/REL 129	Jewish Philosophy (4)
PHIL 133	Medieval Philosophy (4)
REL 73	The Jewish Tradition (4)
REL 111	Jewish Scriptures/Old Testament (4)
REL 112	The Beginnings of Judaism and Jewish Origins: Jewish Diversity in the Greco-Roman World (4)
REL 120	Newish Jewish: New Forms of Judaism in North America (4)
REL 121	Sources for the Life of Jesus: Jewish and Christian Context (4)
REL 132	Hasidic Tales (4)
REL/WS 138	Women in Jewish History (4)
REL/ANTH 139	Jewish Folklore (4)
REL 150	Judaism in the Modern World (4)
REL 152	American Judaism (4)
REL 153	The Spiritual Quest in Contemporary Jewish Life (4)
REL/HIST 154	The Holocaust: History and Meaning (4)
REL 155	Responses to the Holocaust (4)
REL 156	Israel, Zionism, and the Renewal of

	Judaism (4)
REL/WS 158	Sex and Gender in Judaism (4)
REL 174	Contemporary Theology (4)
REL/IR 181	Israel: Religion, Culture, National Identity (4)
REL 186	Judaism in Israel and the United States (4)
REL 230	Kabbalah: The Jewish Mystical Tradition (4)
REL 231	Classic Jewish Texts (4)
REL 371	Directed Readings (1-4)

Journalism and Communication

Professors. Sharon M. Friedman, M.A. (Penn State), director of science and environmental writing program; Jack Lule, Ph.D. (Georgia) chair

Associate Professors. Walter W. Trimble, M.A. (Ohio State); Kathy Olson, Ph.D. (University of North Carolina)

Assistant Professor. John Jirik, Ph.D (University of Texas); Jeremy Littau, Ph.D. (University of Missouri)

Lecturer. Nancy S. Ross, M.A.T. (Cincinnati).

Adjunct Professors. Kenneth Friedman, Ph.D. (Penn State); Glenn Kranzley, B.A. (Penn State); William White, M.A. (Ohio State); James Harper, M.A. (Northwestern); Charles Butler, M.A. (Columbia).

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 communication is offered for students interested in developing oral communication skills and a better understanding of how people share meaning through persuasive use of rhetoric, logic and symbols in public, one-to-one and small group communication.

Career opportunities are numerous for graduates of the department. Students find work in traditional journalism organiza

tions, 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 communication will be useful to students interested in organizational and written communication, law, business, philosophy, government, marketing, teaching, telecommunication or other careers where successful communication is important.

Required Math Course. Understanding statistical information has become extremely important in modern society. MATH 12, Basic Statistics, is required for students taking a journalism or science and environmental writing major. Students should take MATH 12 to fulfill the college's distribution requirement. ECO 145, 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 1	Brown and White (1)
JOUR 2	Brown and White (1)
JOUR 3	Brown and White (1)

JOUR 4	Brown and White (1)
COMM 30	Media and Society (4)
JOUR 21	Writing for the Media (4)
JOUR 23	Editing and Critical Thinking (4)
JOUR 24	Visual Communication (4)
JOUR 122	Media Ethics and Law (4)

Advanced Courses

JOUR 211	Reporting (4) *
Or JOUR 212	Feature Writing (4)*
Or JOUR 218	Freelance Writing (4)*
JOUR 361	Internship (4)

Senior Seminar: Journalism or Communication course at 300 level (4)

** (JOUR 211, JOUR 212 and JOUR 218 fulfill junior writing intensive requirement)*

Required Elective

One additional 4-credit Journalism or Communication course. (4)

NOTE: Students must consult an adviser in choosing the elective course as not all courses with JOUR or COMM designations can be used

Total credits: (40)

Collateral Requirements

Students must also complete a second major, OR a minor outside of the Department of Journalism and Communication with a minimum of 15 credits.

Journalism/Science and Environmental Writing Major

Core Courses

JOUR 1	Brown and White (1)
JOUR 2	Brown and White (1) or
JOUR 231	Science Writing Practicum (1)
JOUR 123 or 311	Basic Science and Technical Writing (4) or
JOUR 21	Writing for the Media (4)
JOUR 23	Editing and Critical Thinking (4)
JOUR 24	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

One additional 4-credit Journalism or Communication course. (4)

NOTE: Students must consult an adviser in choosing the elective course as not all courses with JOUR or COMM designations can be used.

Total credits: (38)

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 1	Brown and White (1) or
JOUR 231	Science Writing Practicum (1)
JOUR 21	Writing for the Media (4) or
JOUR 123	Basic Science and Technical Writing (4)
JOUR 124	Politics of Science (4)
JOUR 125	Environment, the Public and the Mass Media (4)
JOUR 323	Controversies (4)

Total credits: (17)

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.

Required core course:

COMM 30	Media and Society (4)

Plus three 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.

Course Listings

JOUR 1. Brown and White (1) every semester
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 1 is for students with freshman or sophomore standing; juniors only with consent of department chair. Trimble (ND)

JOUR 2-JOUR 8. Brown and White (1) every semester
Enrollment constitutes continued membership on the staff of the semiweekly undergraduate newspaper. These courses are taken consecutively after a student has completed JOUR 1. For a second semester on the newspaper, a student registers for JOUR 2. For a third semester, JOUR 3. For a fourth semester, JOUR 4. And so on. Prerequisite: JOUR 1. Trimble (ND)

JOUR 9. Brown and White photography (1) every semester
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. Trimble (ND)

JOUR 10 Brown and White (12) every semester
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. Prerequisites: JOUR 1 and permission of the department chair. Trimble

JOUR 12. Brown and White Videography (1) every semester
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. Littau, Trimble (ND)

JOUR 21. Writing for the Media (4) every semester
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. White. (ND)

JOUR 23. Editing (4) every semester
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. Prerequisite: Jour 21. Trimble, Olson (ND)

JOUR 24 Visual Communication (4) every semester
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. Prerequisite: Jour 21. Trimble (ND)

JOUR 101. Media, Sports and Society (4) summer
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. Lule (SS)

JOUR 111. Sportswriting (4) summer
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. Lule (ND)

JOUR 114. Technical Communication (4) summer
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. K Friedman (ND)

JOUR 115 (ES 115). Communicating About the Environment (4)
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. (SS)

JOUR 116 (ES 116) (HMS 116). Environmental Health Risks and the Media (4) summer
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. S. Friedman (SS)

JOUR 122. Media Ethics and Law (4) fall
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. Olson (SS)

JOUR 123. Basic Science and Technical Writing (4)
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. K. Friedman (SS)

JOUR 124. (STS 124) Politics of Science (4) fall
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. S. Friedman (SS)

JOUR 125 (ES125). Environment, the Public and the Mass Media (4) fall
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. S. Friedman (SS)

JOUR 141. Photojournalism (4) summer
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. Trimble (ND)

JOUR 166. Beyond Google – Internet Research: Principles and Practice (4) summer
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. Lule (SS)

JOUR 211 Reporting (4) every semester
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: JOUR 23 and JOUR 24. Staff (SS)

JOUR 212. Feature Writing (4) fall
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: JOUR 23 and JOUR 24. Staff (ND)

JOUR 218. Freelance Writing (4) spring
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: JOUR 23 and JOUR 24. Butler. (ND)

JOUR 230 Multimedia Storytelling (4)
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. Prerequisite: Jour 211, 212 or 218. Littau (ND)

JOUR 231. Science Writing Practicum (1-4) spring
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. Prerequisites: JOUR 21 or JOUR 123 or JOUR 311, junior standing, and consent of the instructor. S. Friedman (ND)

JOUR 232. Journalism Practicum (1-4) every semester
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. Prerequisites: Eight hours of journalism credits or consent of the instructor. Lule (ND)

JOUR 246. (IR 246) International Communication (4) summer
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. (SS) Lule

JOUR 311. Science and Technical Writing (3-4) every semester
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). K. Friedman (SS) 4 credits for upperclassmen and 3 for graduate students

JOUR 312. Advanced Science Writing (3-4)
Further practice, on individual basis, in science writing techniques. Prerequisite: JOUR 123 or 311. S. Friedman (ND)

JOUR 313. Special Topics in Science Communication (1-4)
Research or writing involving a topic, medium or issue in science, environmental or technical communication not covered in other courses. Prerequisite: Eight hours in science or environmental writing or consent of the instructor. S. Friedman (SS)

JOUR 314. Technical Communication (3-4) summer
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. K. Friedman (ND)

JOUR 323 (STS 323) (HMS 323). Health and Environmental Controversies (4) spring
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. S. Friedman (SS)

JOUR 324 (SSP 324). Health Communication and the Internet (4) spring
This interdisciplinary class examines the role of the Internet in changing the way lay people, the mass media and medical organizations think and behave regarding health and medical care. It explores the nature of traditional and online health communication, and highlights online health issues such as access, quality of information, economics, privacy, and ethics. S. Friedman and J. Lasker (SS)

JOUR 325. Seminar in Journalism and Communication Issues (3-4)
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. Prerequisite: nine hours in journalism or communication or consent of the instructor. (ND)

JOUR 330 Critical Studies in Journalism (4)
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: JOUR 23 and JOUR 24 or consent of the instructor. Jirik (ND)

JOUR 361. Internship (4) every semester
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. Prerequisite: Senior standing and declared major in journalism or science writing. S. Friedman (ND)

JOUR 389. College Scholar Project (1-8)
Opportunity for college scholars to pursue an extended project. May be repeated for credit. Collegewide course designation. Transcript will identify department in which project was completed. Prerequisite: consent of the instructor. Staff (ND)

JOUR 390. Honors Thesis (1-4)
Directed undergraduate research thesis required of students who apply for and qualify for graduation with departmental honors. Staff (ND)

JOUR 391. Special Topics in Journalism and Communication (1-4)
Directed research or writing involving a subject or issue in journalism not covered in other courses. May be repeated for credit. Prerequisite: 12 hours in journalism or consent of the instructor. Staff (ND)

Communication Courses

COMM 30: Media and Society (4)
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. Littau (ND)

COMM 130. Public Speaking (4) every semester
Applying the principles of public speaking to making informative and persuasive presentations effectively. Emphasis on speech composition and effective oral communication skills. Ross (HU)

COMM 143. Persuasion and Influence (4)
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. Staff. (SS)

COMM 160. Public Speaking (for IBE Students) (4) every semester
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. Ross (HU)

COMM 220 Public Relations (4) fall
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: JOUR 23 and JOUR 24. Harper. (ND)

COMM 248 (GS 248) Global Communication (4)
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. Jirik. (SS)

Languages

Courses are listed alphabetically under Modern Languages and Literature and Classical Studies.

Latin American Studies

Program Director: Dr. Antonio Prieto, Associate Professor of Modern Languages and Literature and Director of Latin American Studies; 529 Maginnes Hall; ap01@lehigh.edu; 610-758-3088

The minor in Latin American studies is designed for students who wish to develop an understanding of a neighboring region that is of vital importance to the United States. Courses in archeology, foreign policy, history, language and literature, and politics, along with independent studies in the visual arts and museum studies, allow students to explore various aspects of Latin American cultures and societies from different disciplinary perspectives. 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 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.

For further information or to coordinate their minor program, students should contact Dr. Antonio Prieto, Director, Latin American Studies Program. For minor declaration forms, please go to the Office of Interdisciplinary Programs, 490 Maginnes Hall.

Requirements (8 credits).

A. History/Culture (4 credits).

Choose one of the following:

HIST 49	History of Latin America (4)
HIST 50	History of Latin America (4)
SPAN/LAS 152	The Cultural Evolution of Latin America (taught in Spanish) (4)

B. Language (4 credits).

SPAN 12	Intermediate Spanish II (4)

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.

ART 273	Special Topics in Studio Practice (1)
ART 370	Special Topics in Museum or Curatorial Studies (1-4)
ART 375	Museum Internship (1-4)
ARTS 196	Sustainable Development: The Costa Rican Experience (3-4)
AAS 148	Cultural Diversity in the Caribbean (4)
ANTH 178	Mesoamerican Archeology (4)
ART 269	Special Topics in Art History (1)
HIST 49	History of Latin America (4)
HIST 50	History of Latin America (4)
HIST 341	Mexico and Central America (3-4)
HIST 342	Argentina, Brazil, and Chile (3-4)
HIST 368	Seminar in Latin American History (3-4)
IR 177	International Relations of Latin America (4)
IR 222	Political Economy of North South Relations (4)
IR 323	Political Economy of Newly Industrializing Countries (4)
LAS/AAS/SSP 106	Race & Ethnicity in Latin America and the Spanish Speaking Caribbean (4)
LAS/AAS/MLL/FREN/HIST/POLS 133	Lehigh in Martinique: Globalization and Local Identity (4)
LAS/AAS/SSP 155	Afro-Latino Social Movements in Latin America & the Caribbean (4)
LAS/AAS/SSP 177	Cuba: Race, Revolution and Culture (4)
LAS/SPAN 213	Approaches to Reading Cultural Productions in Spanish (4)
LAS/SPAN 263	The Spanish American Short Story (4)
LAS/SPAN 265	Spanish and Latin American Cinema (4)
LAS/SPAN/WS 275	Introduction to Hispanic Women Writers (4)
LAS/SPAN 276	Contemporary Literature of the Southern Cone (4)
LAS/SPAN 320	Literature of the Spanish Caribbean (4)
LAS/SPAN 321	Children and Adolescents in Contemporary Spanish American Literature (4)

LAS/SPAN 322	The Short Novel in Contemporary Spanish American Literature (4)
LAS/SPAN 323	Literature and Revolution in Contemporary Cuba (4)
LAS/SPAN 325	Hispanic Literature of the United States (4)
LAS/SPAN/WS 326	Tradition and Resistance: Women Writers of Latin America (4)
LAS/SSP 328	Society, Democracy and Revolution in Latin America (4)
LAS/SPAN 342	The New Narrative in Spanish American Literature (4)
LAS/SPAN 345	Testimonial Writing in the Hispanic World (4)
LAS/SPAN 346 (WS 346)	Contemporary Hispanic Women Writers: The Novelists (4)
MLL 51	Contemporary Hispanic-American Literature (4)
MLL 53	The Hispanic World and Its Culture (4)
POLS 335	Latin American Political Systems (4)
POLS 336	US Foreign Policy and Latin America (4)
POLS 337	Religion and Politics in Latin America (4)
POLS/GS/WS 342	Gender and Third World Development (4)
SPAN 211	Business Spanish (4)

Law

Professors. Matthew A. Melone, J.D. (Pennsylvania), C.P.A.; George A. Nation III, J.D. (Villanova).

Adjunct professors. Patrick F. McCormick, J.D. (Ohio Northern); Nancy Schneiderman, J.D. (Harvard).

The following undergraduate law courses are offered through the Perella Department of Finance:

Undergraduate Courses

LAW 101. Introduction to Law (3)
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)
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. Prerequisite: ECO 1

LAW 202. Business Law (3)
The law of agency, business organizations, secured transactions, bankruptcy and negotiable instruments. Prerequisite: LAW 201.

LAW 371. Directed Readings (1-3)
Readings in various fields of law, designed for students who have a special interest in a field of law. Prerequisite: consent of sponsoring instructor.

LAW 372. Special Topics (3)
Special problems and issues in commercial law.

Course descriptions for the College of Business and Economics graduate courses can be found in this section (Section V) under the heading of Business and Economics Graduate Courses. Prerequisite: consent of sponsoring instructor.

Management

Professors. Nada Sanders, Ph.D. (Ohio State) Iacocca Chair; Susan A. Sherer, Ph.D. (Pennsylvania), Kenan Professor of Information Technology Management, Robert J. Trent, Ph.D. (Michigan State).

Associate professors. Catherine Ridings, Ph.D. (Drexel); Michael D. Santoro, Ph.D. (Rutgers); Andrew Ward, Ph.D. (Pennsylvania); Yuliang Yao, Ph.D. (Maryland)

Assistant professors. Luiba Belkin, Ph.D. (Rutgers); Jill Brown, Ph.D. (University of Georgia); William Forster, Ph.D. (University of Virginia); Mei Li, Ph.D. (Arizona State); Lin Lin, Ph.D. (Arizona); Robert C. Giambatista, Ph.D. (Wisconsin); Douglas Mahony, Ph.D. (Rutgers); Corinne Post, Ph.D. (Rutgers); Timothy Quigley, Ph.D. (Pennsylvania State); Naomi Rothman, Ph.D. (New York University); Zachary Zacharia, Ph.D. (Tennessee).

Adjunct professors. Sandra Holsonbach, Ph.D. (Lehigh); Dennis Praedin, B.A. (Muhlenberg); Joel Sutherland, M.B.A. (Pepperdine).

Professors of practice. Robert Kuchta, M.S. (New Jersey Institute of Technology); Christopher McDemus (Widener)

Lecturer: Chitra Nayar, M.B.A. (Iowa)

Active emeriti. Richard W. Barsness, Ph.D. (Minnesota)

The Management major introduces management practices to students who may desire to work in management consulting (with specialties in supply chain processes or systems management), human resource management, and small businesses or non profit organizations or entry level managerial jobs.

While the management major offers a choice of four distinctive tracks, they all emphasize managerial skills that are sought out by employers, such as conflict resolution, negotiation, decision-making, and leadership. All tracks in the major also include at least one semester-long hands-on project management experience.

There are four distinct tracks to the major.

- Managing People: This track prepares students to work as human resource professionals or in management consulting organizations or to broaden their interpersonal skills.
- Systems Management Consulting: This track prepares students to work as management consultants with a focus on information systems projects.

- Supply Chain Process Management: This track prepares students to work as management consultants with a special emphasis on supply chain projects.
- 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.

The management major is comprised of 5 courses (15 credits). All management majors are required to take an Organizational Dynamics Workshop as well as a capstone Project Management course. Each track requires 3 additional courses as indicated below.

All Management majors will take the following two courses. MGT 321 Organizational Dynamics Workshop MGT 350 Project Management

In addition Management majors will choose one of the following four tracks.

Managing People

MGT 333	Human Resource Management

Plus 2 courses chosen from the following:

PSYC 121	Social Psychology
WS/SSP 128	Race, Gender, Work
ECO 234	LaborManagement Relations
ECO 235	Labor Economics
MGT/SCM 328	Negotiations and Conflict Management

Systems Management Consulting

BIS 311	Managing Information Systems Analysis and Design
BIS 324	Business Data Management

Plus 1 from the following IS application courses:

BIS 335	Web Application Development
BIS 342	eBusiness Enterprise Applications

Supply Chain Processes Management

Choose 3 from the following courses:

MGT/SCM 328	Negotiations and Conflict Management
SCM 342	eBusiness Enterprise Applications
SCM 309	Supply and Cost Management
SCM 354	Integrated Logistics and Supply Chain Management
SCM 340	Demand and Supply Chain Planning

Small Business and Non-Profit Management

MGT 311	LUMAC Management Assistance Counseling
MGT 306	Decision Making in Small Business and Non-Profits

Plus 1 of the following courses:

MGT/SCM 328	Negotiations and Conflict Management
FIN 328	Corporate Financial Policy
MGT 333	Human Resource Management
BIS 335	Web Application Development
MKT 319	Development and Marketing of New Products

Management Courses

For Advanced Undergraduates and Graduate Students

MGT 243. Managing and Leading People in Organizations (3)
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.

MGT 301. Strategic Management (3) fall, spring
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. Prerequisites: Senior standing in the College of Business and Economics, and completion of the college core.

MGT 306. Decision Making in Small Business and Non Profit Enterprises (3)
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: Fin 125; Mkt 111

MGT 311. LUMAC Management Assistance Counseling (3) fall, spring
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. Prerequisites: junior standing in the College of Business and Economics.

MGT 321. Organizational Dynamics Workshop (3)
Individual and group dynamics explored through role playing, problem solving, group simulations, and case analysis. Topics include decision making, communications, teams, diversity, negotiation, ethics, consensus, conflict, creativity, and leadership. Prerequisite: MGT 243 or equivalent or consent of instructor.

MGT 328. Negotiations and Conflict Management (3) (cross list with SCM 328)
This course covers the theory and processes of negotiation in a variety of settings including facetoface, virtual and crosscultural business environments. Students will learn negotiating skills by preparing and simulating a broad mixture of negotiations, ranging from oneonone, to

threeperson, 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)
Analysis and resolution of personnel problems in organizations. Human resource planning, recruitment, selection, orientation, training, appraisal, compensation, and development. Prerequisite: MGT 243 or equivalent or consent of instructor.

MGT 350. Project Management (3)
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. Prerequisites: completion of all other courses in either BIS or Management major.

MGT 371. Directed Readings (13)
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. Prerequisite: consent of the department chair. May be repeated.

MGT 372. Special Topics (13)
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. Prerequisite: consent of the department chair. May be repeated.

MGT 373. Management Internship (13) summer
A sponsoring faculty member shall direct readings, projects, and other assignments including a comprehensive final report in conjunction with an industrysponsored 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. Prerequisite: junior standing in the College of Business and Economics and Management major declaration.

Course descriptions for the College of Business and Economics graduate courses can be found in this section (Section V) under the heading of Business and Economics Graduate Courses.

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.

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. At least 6 credits must be IE courses.

IE 358 (ECO 358), IE 404, IE 409, IE 410, IE 414, IE 416, IE 419, IE 412, IE 426, IE 429, IE 439, IE 447, IE 458 (ECO 463), MATH 311, MATH 312, MATH 334, MATH 338 (STAT 438), MATH 467, MATH 468, ECO 412, ECO 415.

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.

Manufacturing Systems Engineering

Program director. Keith M. Gardiner, Ph.D. (Manchester, England), *professor of industrial and systems engineering.*

Program faculty. John P. Coulter, Ph.D. (Delaware), associate professor of mechanical engineering and mechanics; Steven L. Goldman, Ph.D. (Boston), Andrew W. Mellon distinguished professor in the humanities; Mikell P. Groover, Ph.D. (Lehigh), professor of industrial and systems engineering; Parveen P. Gupta, Ph.D. (Penn State), associate professor of accounting; Jacob Y. Kazakia, Ph.D. (Lehigh), professor of engineering mathematics; Roger N. Nagel, Ph.D. (Maryland), Harvey Wagner Professor of computer science and engineering; John B. Ochs, Ph.D. (Penn State), professor of mechanical engineering and mechanics; Robert J. Trent, Ph.D. (Michigan State), Eugene Mercy Professor of management; George R. Wilson, Ph.D. (Penn State), associate 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.

Graduate Courses

MSE 362. (IE 362) Logistics and Supply Chain Management (3)
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. Prerequisite: IE 220 and IE 251 or equivalent, or instructor approval.

MSE 401. (ME 401) Integrated Product Development (3)
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. Ochs.

MSE 431. Marketing & the Invention to Innovation Process (3)
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 433. Technology and the Factory of the Future (3)
Engineering and technological issues affecting future developments in manufacturing. Flexible automation systems, integration of design and production through the factory data network, intelligent machines, the man-machine interface, and the manufacturing management information system.

MSE 438. Agile Organizations & Manufacturing Systems (3)
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. (IE 443) Automation and Production Systems (3)
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)
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 456/MSE 356. Micromanufacturing Systems & Technologies (3)
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. Pre-requisite MAT33 or equivalent, instructor permission. note: *300 level course may not be repeated at the 400 level for credit.*

MSE 481. (GBUS 481) Technology, Operations & Competitive Strategy (3)
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
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 451. Manufacturing Systems Engineering Project (1-3)

MSE 490. Manufacturing Systems Engineering Thesis (1-6)

Marketing

Marketing Department Web page: www.lehigh.edu/cbemarketing

Professors: K. Sivakumar, Ph.D. (Syracuse), Arthur C. Tauck Jr. Professor of International Marketing and Logistics and Chairperson, Department of Marketing.

Associate Professors: Ravindra Chitturi, Ph.D. (Texas); James M. Maskulka, D.B.A. (Kent State).

Assistant Professors: Deepa Chandrasekaran, Ph.D. (Southern California); Beibei Dong, Ph.D. (Missouri); Reetika Gupta, Ph.D. (CUNY), Nevena Koukova, Ph.D. (Maryland).

Professors of Practice: Beth Gallant, MBA (Columbia); Steve Savino, M.B.A. (Wake Forest).

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.

The marketing major offered by the Department of Marketing consists of 18 credit hours from the following courses:

Required courses

MKT 311	Consumer Behavior
MKT 312	Marketing Research
MKT 387	Marketing Strategy

Elective courses

Two courses (6 credit hours) from the following list of courses, and one additional marketing elective course (3 credit hours) required, either from the following, or any course approved by the academic advisor.

MKT 313	Integrated Marketing Communications
MKT 319	Development & Marketing of New Products
MKT 320	Global Marketing Strategies
MKT 321	Business-to-Business Marketing
MKT 325	Quantitative Marketing Analysis
MKT 331	Electronic Commerce
MKT 332	Sales Management
MKT 348	Management of Marketing Channels
MKT 360	Marketing Practicum
MKT 366	Marketing of Services
MKT 371	Directed Readings
MKT 372	Special Topics

Undergraduate Courses

MKT 111. Principles of Marketing (3)
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. Prerequisite: ECO 1.

MKT 311. Consumer Behavior (3)
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. Prerequisite: MKT 111 or MKT 211.

MKT 312. Marketing Research (3)
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: ECO 045 and MKT 111 or MKT 211.

MKT 313. Integrated Marketing Communications (3)
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. Prerequisite: MKT 211 or MKT 111.

MKT 319. Development and Marketing of New Products (3)
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. Prerequisite: MKT 211 or MKT 111.

MKT 320. (GCP 320) Global Marketing (3)
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. Prerequisite: MKT 211 or MKT 111.

MKT 321. Business-to-Business Marketing (3)
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. Prerequisite: MKT 211 or MKT 111.

MKT 325 (ECO 325). Quantitative Marketing Analysis (3)
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: MKT 211 or MKT 111, ECO 045, ECO 105 or ECO 146, and MATH 21, 31, 51.

MKT 331. Electronic Commerce (3)
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: MKT 211 or MKT 111, or consent of the instructor.

MKT 332. Sales Management (3)
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. Prerequisite: MKT 211 or MKT 111.

MKT 348. Management of Marketing Channels (3)
This course focuses on the design, elements, and management of marketing channels. For our purposes, a marketing channel is viewed as an interdependent, inter-organizational system involved in the task of making goods, services, and concepts available for consumption. The main emphasis of this course is on the initial design of such systems and the on-going management of relationships between system participants. Economic, social, and structural aspects of channels will be analyzed. Illustrative topics include how channel systems should be formed; an investigation of a variety of channel intermediaries, including franchise systems, distributors, retailers, intermediary "market makers," and gray channels; the role of technology in channel relationships; the interpersonal dimensions of channel relationship management such as conflict management, minority issues, and ethics; and sales-force management, including selection, motivation, and compensation. Prerequisite: MKT 211 or MKT 111.

MKT 360. Marketing Practicum (3)
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: MKT 211 or MKT 111, MKT 311 and MKT 312.

MKT 366. Marketing of Services (3)
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. Prerequisite: MKT 211 or MKT 111.

MKT 371. Directed Readings (1-3)
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. Prerequisite: consent of the department chair. May be repeated.

MKT 372. Special Topics (1-3)
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. Prerequisite: consent of the department chair. May be repeated.

MKT 373. Marketing Internship (1)
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. Prerequisites: MKT 211 or MKT 111, declaration of a marketing major, junior standing, and department approval. May be repeated once.

MKT 387. Marketing Strategy (3)
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. Prerequisite: MKT 311, 312 and senior standing.

Graduate Courses

Course descriptions for the College of Business and Economics graduate courses can be found in this section (Section V) under the heading of Business and Economics Graduate Courses.

Materials Science and Engineering

Professors. Helen M. Chan, Ph.D. (Imperial College of Science and Technology, England), chair and New Jersey Zinc Professor; Charles E. Lyman, Ph.D. (M.I.T.), associate chair; John N. DuPont, Ph.D. (Lehigh), Stout Chair; Martin P. Harmer, Ph.D. (Leeds, England), Alcoa Professor, director of Center for Advanced Materials and Nanotechnology; Himanshu Jain, Sci. D. (Columbia), Diamond Chair; Chris Kiely, Ph.D. (Bristol); Wojciech Misiolek, Sc.D (U. of Mining and Metallurgy, Krakow, Poland), Loewy Chair; Raymond A. Pearson, Ph.D. (Michigan); Jeffrey M. Rickman, Ph.D. (Carnegie-Mellon); Richard P. Vinci, Ph.D. (Stanford).

Associate Professors. Masashi Watanabe, Ph.D. (Kyushu).

Assistant Professors. Xuanhong Cheng, Ph.D. (U. of Washington); Sabrina S. Jedlicka, Ph.D. (Purdue).

Adjunct Professors. Walter L. Brown, Ph.D. (Harvard); Carol Kiely, Ph.D. (University of Newcastle Upon Tyne, United Kingdom); Lloyd Robeson, Ph.D. (U. of Maryland).

Emeritus Professors. Betzalel Avitzur, Ph.D. (Michigan); Sidney R. Butler, Ph.D. (Penn State); G. Slade Cargill, III, Ph.D. (Harvard); Ye T. Chou, Ph.D. (Carnegie Mellon); Alwyn Eades, Ph.D. (Cambridge); Richard W. Hertzberg, Ph.D. (Lehigh); Ralph J. Jaccodine, Ph.D. (Notre Dame); Arnold R. Marder, Ph.D. (Lehigh); Michael R. Notis, Ph.D. (Lehigh); Alan W. Pense, Ph.D. (Lehigh); Donald M. Smyth, Ph.D. (M.I.T); Leslie H. Sperling, Ph.D. (Duke); Robert D. Stout, Ph.D. (Lehigh); S. Kenneth Tarby, Ph.D. (Carnegie-Mellon); David A. Thomas, Sc.D. (M.I.T.).

Research scientists. Robert Keyse and Samuel J. Lawrence.

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, electrical machinery, 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.

B.S. in Materials Science and Engineering

The undergraduate program is designed to train graduates for research, development, operations, management, and sales careers in industry or for graduate study in various specialties of the field, including the manufacture and application of 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 other, related fields, including other areas of engineering or science, by choosing to concentrate elective courses in one of these areas. Requirements for adding a Minor include 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 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 one required course (MAT 33, 3 credits) and four other three-credit courses for a total of 15 credit hours. The four courses may be chosen from a long list of 200 and 300 level courses relevant to various engineering disciplines.

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 credits), a course on crystallography and band theory, and additional electives for a total of 15 credits.

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 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.

Program Outcomes

The MS&E undergraduate Program Outcomes declare that graduates should:

1. have a firm base of knowledge in areas of mathematics, physics, and chemistry relevant to materials science and engineering, and be able to apply and extend this knowledge;
2. understand relationships among materials structure, properties, processing, and performance for metals, ceramics, polymers, composites, and electronic materials; be able to extend this knowledge; and be able to apply it in materials analysis, development, selection, and design;
3. be able to function effectively on problem-solving teams and to coordinate and provide leadership for teams, including multidisciplinary teams;
4. be knowledgeable and experienced in using basic laboratory tools, computers, and databases for materials analysis, development, and selection;
5. be able to define and solve materials-related problems, including design problems, within economic, environmental, and time deadline constraints;
6. develop skills in writing, speaking, reading, and listening, needed to communicate logically and effectively;
7. understand and accept professional and ethical responsibilities, including responsibilities for public safety and workplace safety;
8. gain background in history, economics, world cultures, and current events to provide a realistic context for their professional activities.

Major Requirements

The recommended sequence of courses is shown below. The standard freshman engineering year is shown in section III. A total of 132 credits or more is required to graduate.

sophomore year, first semester (18 credits)

MAT 33	Engineering Materials and Processes (3)*
MAT 10	Materials Laboratory (2)
MATH 23	Analytic Geometry & Calculus III (4)
PHY 21, 22	Introductory Physics and Laboratory (5)
ECO 1	Economics (4)

sophomore year, second semester (18 –19 credits)

MAT 20	Computational Methods in Materials Science (3)
MAT 203	Materials Structure at the Nanoscale (3)
MAT 205	Thermodynamics of Macro/Nanoscale Materials (3)
MATH 205	Linear Methods (3)
MECH 3	Fundamentals of Engineering Mechanics (3)

HSS Humanities/Social Sciences Elective (3 or 4)

junior year, first semester (18 credits)

MAT 201	Physical Properties of Materials (3)
MAT 216	Diffusion and Phase Transformations (3)
MAT 218	Mechanical Behavior of Macro/Nanoscale Materials (3)
MAT 101	Professional Development (2)
HSS	Humanities/Social Sciences Elective (4)

Elect Free Elective (3)

junior year, second semester (1819 credits)

MAT 204	Processing and Properties of Polymeric Materials (3)
MAT 206	Processing and Properties of Metals (3)
MAT 211 (ENG 211)	Integrated Product Development Projects I (3)
MAT 214	Processing and Properties of Ceramic Materials (3)

HSS Humanities/Social Sciences Elective (3 or 4)

Elect Free Elective (3)

senior year, first semester (15 credits)

MAT 212 (ENG 212)	Integrated Product Development Projects II (2)
MAT 302	Electronic Properties of Materials (3)

Engr Sci Elect Engineering Science Elective (3)

Engr Sci Elect Engineering Science Elective (3)

HSS Humanitites/Social Sciences Elective (4)

senior year, second semester (16 credits)

MAT 338	Materials Selection and Failure Analysis (3)
CHE 60	Unit Operations Survey (3)
ECE 83	Introduction to Electrical Engineering (3)
ECE 162	Electrical Laboratory (1)

Appr Elect Approved Elective (3)

Elect Free Elective (3)

*MAT 33 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. Three days 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.

Undergraduate Courses

MAT 10. Materials Laboratory (2) fall
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. Prerequisite: MAT 33 previously or concurrently. DuPont

MAT 20. Computational Methods in Materials Science (3) spring
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. Prerequisite: ENGR. 1 or equivalent. Rickman

MAT 33. Engineering Materials and Processes (3) fall/spring
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. Kiely or Chan and Staff

MAT 101. Professional Development (2) fall
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. Prerequisite: junior standing. Lyman

MAT 107. Special Topics in Materials (13)
A study of selected topics in materials science and engineering not covered in other formal courses.

MAT 196. Education Option (3)
Selected students may create and use educational modules for disseminating concepts in materials science and engineering.

For Advanced Undergraduates and Graduate Students

MAT 201. Physical Properties of Materials (3) fall
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: Phys 21, MAT 33, MATH 205. Jain

MAT 203. Materials Structure at the Nanoscale (3) spring
The structure of metals, ceramics, semiconductors and polymers at the atomic scale. Materials structures at the nanoscale and macroscale. Crystalline, semicrystalline, liquid crystalline, and amorphous (glassy) states. Crystal structures and fundamental aspects of formal crystallography. Point, line, and planar crystal defects. Materials characterization by xray diffraction, light and electron microscopy, and other techniques. Prerequisites: CHEM 30; MAT 33 previously or concurrently; MAT 10 or permission of instructor. Lyman

MAT 204. Processing and Properties of Polymeric Materials (3) spring
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. Prerequisite: MAT 33. Pearson

MAT 205. Thermodynamics of Macro/Nanoscale Materials (3) spring
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: MATH 23 and MAT 33, previously or concurrently. Vinci

MAT 206. Processing and Properties of Metals (3) spring
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: MAT 216, MAT 218. Misiolek

MAT 211 (ENGR 211; BUS 211). Integrated Product Development (IPD) I (3) spring
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. Prerequisite: junior standing in engineering, business or arts and science.

MAT 212 (ENGR 212; BUS 212) Integrated Product Development II (2) fall
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 I. 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. Prerequisite: MAT 211.

MAT 214. Processing and Properties of Ceramic Materials (3) spring
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. Prerequisite: MAT 33. Harmer

MAT 216. Diffusion and Phase Transformations (3) fall
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: MAT 203, MAT 205. DuPont

MAT 218. Mechanical Behavior of Macro/Nanoscale Materials (3) fall
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: MECH 3, MAT 33; MAT 10 or permission of instructor. Vinci

MAT 221. (STS 221) Materials in the Development of Man (3) fall
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) fall
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) spring
Application of research techniques to a project in materials science and engineering selected in consultation with the faculty. Normally preceded by MAT 240.

MAT 302. Electronic Properties of Materials (3) fall
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: MAT 201, MAT 203. Cheng

MAT 309 (ME 309). Composite Materials (3)
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. Prerequisite: MAT 33 or equivalent, MECH 3. Pearson

MAT 310. Independent Study in Materials (1-3)
Provides an opportunity for advanced, independent study of selected topics in materials science and engineering not covered in other formal courses.

MAT 312. (CHE 312, CHEM 312) Fundamentals of Corrosion (3)
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. Prerequisite: MAT 205, CHEM 187, or equivalent of either.

MAT 314. Metal Forming Processes (3)
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. Prerequisite: MAT 206 or consent of instructor. Misiolek

MAT 315. Physical Properties of Structural and Electronic Ceramics (3)
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: MAT 214 or consent of instructor. Harmer

MAT 317. Imperfections in Crystals (3)
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. Prerequisite: MAT 203 or consent of instructor. Rickman

MAT 319. Current Topics in Materials Science (3)
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. Prerequisite: Consent of department chair.

MAT 320. Analytical Methods in Materials Science (3)
Selected topics in modern analysis and their application to materials problems in such areas as thermodynamics, crystallography, deformation and fracture, diffusion. Prerequisite: MATH 231 or 205. Rickman

MAT 324 (BioE 324). Introduction to Organic Biomaterials
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: BioE 110 or MAT 204 and consent of instructor. Cheng

MAT 325 (BioE 325). Inorganic Biomaterials (3)
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, nanoporous ceramic filters for kidney dialysis). Prerequisites BioE 110 or MAT 33, or consent of instructor. Misiolek

MAT 327. Industrial Project (4)
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. Misiolek

MAT 329. Industrial Project (4)
To be taken concurrently with MAT 327. Course material is the same as MAT 327. Misiolek

MAT 332. Basics of Materials Science and Engineering (3) fall
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. Prerequisites: Graduate student status and permission of department chair. Not available to students who have taken MAT 33 or equivalent.

MAT 333. (EES 337, CHM 337) Crystallography and Diffraction (3)
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: MAT 203 or EES 133 or senior standing in chemistry.

MAT 334. (CHE 334) Electron Microscopy and Microanalysis (4) fall
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. Prerequisite: consent of the department chair. Lyman and Kiely

MAT 338. Failure Analysis Reports (3) spring
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. Prerequisites: Senior standing and MAT 204, MAT 206, MAT 214, and MAT302.

MAT 339. Light Metals (3)
Designing mechanical properties of light metals such as aluminum, beryllium, magnesium and titanium through alloying and processing. In depth analysis of strengthening mechanisms and resulting physical properties. Review of typical casting, deformation, powder metallurgy and machining processes applied to these materials. Recent commercial applications in the construction, packaging, aerospace and automotive industries. Prerequisite: MAT 206 or consent of the instructor. Misiolek

MAT 342. Inorganic Glasses (3)
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. Prerequisite: MAT 33. Jain

MAT 344. (IE 344) (ME 344) Metal Machining Analysis (3) spring
Intensive study of metal cutting emphasizing forces, energy, temperature, tool materials, tool life, and surface integrity. Abrasive processes. Laboratory and project work. Prerequisite: IE 215 or ME 240 or MAT 206. Misiolek

MAT 345. Powder Metallurgy (3)
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. Prerequisite: MAT 206 or consent of instructor. Misiolek

MAT 346. Physical Metallurgy of Welding (3)
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: MAT216. DuPont

MAT 348. Materials Science for Electronic Applications (3)
Materials technology for integrated circuit packaging systems. Dielectric, thermal and mechanical considerations; joining methods; resistor and ceramic capacitor materials and incorporation of active devices into packaging systems; multilayer package design and processing. Individualized semester project involving forensic examination of failures using scanning electron microscopy and microprobe analysis. Prerequisite: MAT 201, and MAT 33.

MAT 355. Materials for Nanotechnology (3)
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. Kiely

MAT 356. Strategies for Nanocharacterization (3)
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. Lyman and Jedlicka

MAT 359. Thin Film Processing and Mechanical Behavior (3)
Metallic, ceramic and glassy films, with thickness less than approximately 1 B5m, formed by gas phase deposition. Thin film applications, vacuum fundamentals, PVD and CVD, models for general thin film growth, epitaxial growth, sources of stress, deformation mechanisms, and mechanical characterization techniques such as substrate curvature and nanoindentation. Prerequisite: MAT 33. Also recommended, but not required, is some experience with mechanics of materials. Vinci

MAT 388. (CHE 388, CHM 388) Polymer Synthesis and Characterization Laboratory (3)
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. Prerequisite: Senior level standing in chemical engineering, chemistry, or materials science and engineering, or permission of the instructor.

MAT 393. (CHE 393, CHM 393) Physical Polymer Science (3)
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. Prerequisite: Senior level standing in chemical engineering, chemistry, or materials science and engineering, or permission of the instructor.

MAT 396. (CHEM 396) Chemistry of Nonmetallic Solids (3)
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. Prerequisite: CHEM 187 or MAT 205 or equivalent.

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 15credit 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 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 above 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 per formance 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.

GraduateLevel Courses

MAT 401. Thermodynamics and Kinetics (4) fall
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 (ME 402). Advanced Manufacturing Science (3) spring
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) spring
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)
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. Prerequisite: consent of the department chair. DuPont

MAT 409. Current Topics in Materials (3)
Recent practical and theoretical developments in materials. This course may be repeated for credit if new material is covered. Prerequisite: consent of the department chair.

MAT 415. Mechanical Behavior of Ceramic Solids (3)
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. Prerequisite: MAT 218 or consent of the department chair.

MAT 423. Advanced Transmission Electron Microscopy (4)
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. Prerequisite: MAT 334 or equivalent. Kiely, Watanabe

MAT 427. Advanced Scanning Electron Microscopy (4)
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. Prerequisite: MAT 334 or equivalent. Lyman

MAT 430. Glass Science (3)
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. Prerequisite: MAT 315 or equivalent. Jain

MAT 431. Sintering Theory and Practice (3)
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. Prerequisite: MAT 214 or equivalent. Harmer

MAT 435 Photonic Materials (3)
Scope of photonics, especially in communications. Characteristics of light. Optical properties of metals, semiconductors and insulators. Nonlinear optical properties. Materials for fibers, lasers, detectors, modulators, amplifiers and other components. Prerequisites: MAT 302 or consent of instructor. Jain

MAT 443. (CHEM 443) Solid-State Chemistry (3)
Crystal structure, diffraction in crystals and on surfaces, bonding and energy spectra in solids, dielectrics, surface states and surface fields in crystals. Prerequisites: one course in linear algebra and one course in quantum mechanics. Klier

MAT 455. Materials for Nanotechnology (3)
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. Kiely

MAT 456. Strategies for Nanocharacterization (3)
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. Lyman and Jedlicka

MAT 460. Engineering Project (13)
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.

MAT 461. Advanced Materials Research Techniques (3)
Study of the theory and application of selected advanced techniques for investigating the structure and properties of materials. May be repeated for credit with the approval of the department chair.

MAT 482. (CHM 482, CHE 482) Engineering Behavior of Polymers (3) spring
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. Pearson

MAT 485. (CHM 485, CHE 485) Polymer Blends and Composites (3) fall
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. Prerequisite: any introductory polymer course or equivalent. Sperling

MAT 490. Thesis. (1-6)

MAT 492. (CHM 492, CHE 492) Topics in Polymer Science (3)
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. Prerequisite: CHEM 392 or equivalent.

MAT 499. Dissertation (1‑15)

Mathematics

Professors. HuaiDong Cao, Ph.D. (Princeton), A. Everett Pitcher Professor; Donald M. Davis, Ph.D. (Stanford); Vladimir Dobric, Ph.D. (Zagreb, Croatia); Bennett Eisenberg, Ph.D. (M.I.T); WeiMin Huang, Ph.D. (Rochester), chair; Garth Isaak, Ph.D. (Rutgers); Terrence Napier, Ph.D. (Chicago); Eric P. Salathe, Ph.D. (Brown), director of the Institute for Biomedical Engineering and Mathematical Biology; Lee J. Stanley, Ph.D. (Berkeley); Steven H. Weintraub, Ph.D. (Princeton); Joseph E. Yukich, Ph.D. (M.I.T.).

Associate professors. Bruce A. Dodson, Ph.D. (S.U.N.Y. at Stony Brook); David L. Johnson, Ph.D. (M.I.T.); Mark A. Skandera, Ph.D. (M.I.T.); Susan Szczepanski, Ph.D. (Rutgers); Ramamirthan Venkataraman, Ph.D. (Brown); Linghai Zhang, Ph.D. (Ohio State).

Assistant professors. Soutir Bandyopadhyay, Ph.D. (Texas A& M); Robert Neel, Ph.D. (Harvard); Xiaofeng Sun, Ph.D. (Stanford); PingShi Wu, Ph.D. (Davis).

Adjunct professor. Howard Fegan, Ph.D. (Oxford).

Emeriti. Theodore Hailperin, Ph.D. (Cornell); Samir A. Khabbaz, Ph.D. (Kansas); Jerry P. King, Ph.D. (Kentucky); Clifford S. Queen, Ph.D. (Ohio State); Murray Schechter, Ph.D. (N.Y.U.); Andrew Snyder, Ph.D. (Lehigh); Albert Wilansky, Ph.D. (Brown).

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 21, 22, 23; MATH 31, 32, 33; MATH 51, 52.

The MATH 21, 22, 23 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 31, 32, 33 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 51, 52 sequence is a survey of calculus. Math 81 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 21, 22 instead.

MATH 75, 76 is a two-semester sequence that substitutes for MATH 21, covering the same material but at a slower pace.

The MATH 31, 32, 33 sequence will be accepted in place of the other two sequences. MATH 21, 22 will be accepted in place of MATH 51, 52. Credit will be awarded for only one course in each of the following groups: 21, 75/76, 31, 51 and 81; 22, 32, and 52; 23 and 33. 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.

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)

Core Mathematics Requirements (32-35 credits)

Calculus	(12 cr)	MATH 21, 22, 23 or MATH 31, 32, 33
Introductory Seminar	(3 cr)	MATH 163
Statistics/Probability	(3-4 cr)	MATH 12 or MATH 231
Linear Algebra	(4 cr)	MATH 242
Differential Equations	(3-4 cr)	MATH 205 or MATH 320
Analysis	(4 cr)	MATH 301
Complex Analysis	(34 cr)	MATH 208 or MATH 316
Major Requirements	(10 credits)	
Algebra	(4 cr)	MATH 243
Electives	(6 cr)	Two courses (at least 6 credits) at or above the200-level chosen in consultation with the major advisor. At most one course may be taken outside the department.
General Electives		(41-47 credits)

Chosen in consultation with faculty advisor.

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)

Core Mathematics Requirements (32-34 credits)

Calculus	(12 cr)	MATH 21, 22, 23, or MATH 31, 32, 33
Introductory Seminar	(3 cr)	MATH 163
Statistics/Probability	(3 cr)	MATH 231 or MATH 309
Linear Algebra	(4 cr)	MATH 242
Differential Equations	(3-4 cr)	MATH 205 or MATH 320
Analysis	(4 cr)	MATH 301
Complex Analysis	(3-4 cr)	MATH 208 or MATH 316
Major Requirements	(24-25 cr)	
Algebra	(4 cr)	MATH 243
Electives	(1-4 cr)	Four courses (at least 14 credits) at or above the 200 level. At most two courses may be taken outside the department.
Computer Science	(6-7 cr)	Two courses: ENGR 1 and one approved CSE course or two approved CSE courses.
General Electives	(27-33 cr)	Chosen in consultation with faculty advisor.

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 (32-34 credits)

Calculus	(12 cr)	MATH 21, 22,23 or MATH 31, 32, 33
Introductory Seminar	(3 cr)	MATH 163
Statistics/Probability	(3 cr)	MATH 231 or MATH 309
Linear Algebra	(4 cr)	MATH 242
Differential Equations	(3-4 cr)	MATH 205 or MATH 320
Analysis	(4 cr)	MATH 301
Complex Analysis	(3-4 cr)	MATH 208 or

		MATH 316
Major Requirements	(23-24 credits)	
Electives	(17 cr)	Five 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.
Computer Science	(6-7 cr)	Two courses: ENGR 1 and one approved CSE course or two Approved CSE courses.
General Electives	(28-33 cr)	Chosen in consultation with faculty advisor

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, MATH 322 and MATH 341

Concentration in Discrete Mathematics and Theoretical Computer Science:
Electives must include at least three courses selected from MATH 305, MATH 311, MATH 329, MATH 340

Concentration in Probability and Statistics:
Electives must include at least three courses selected from MATH 309, MATH 310, MATH 312, MATH 334, MATH 338

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 and university requirements excluding Mathematics (3134 credit hours)

Required Major courses (45-47 credit hours)

MATH 21, 22, 23/ 31, 32, 33	Calculus I, II, III (12) or Honors Calculus I, II, III (12)
MATH 12/231	Basic Statistics (4) or Probability and Statistics (3)
MATH 43/205/242	Survey of Linear Algebra (3) or Linear Methods (3) or Linear Algebra (4)
MATH 309	Theory of Probability (3)
MATH 310	Random Processes and Applications (3)
MATH 312	Statistical Computing and Applications (3)
MATH 334	Mathematical Statistics (4)
MATH 338	Linear Models in Statistics with Applications (4)
MATH 374	Statistical Project (3)

Two approved computing science courses or one approved computer science course and Engineering 1 (6) or (7).

Major Electives (12 credit hours)
At least three courses with specific mathematical or statistical content chosen with the approval of the faculty advisor.

Professional Electives (21 credit hours)
Courses selected from two or three fields of application of statistics and probability.

Free Electives (6-11 credits)

This program requires a total of 120 credit hours.

A student must achieve an average of 2.0 or higher in major courses.

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 23 or 33 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, 243, 301

MATH 302 or 303 or 307 or 316 or 342

Minor in Applied Mathematics

Three of MATH 205, 208, 230, 231, 242, 320, 322, 323

MATH 341

Minor in Probability and Statistics

MATH 12 or 231

MATH 309

Two of MATH 310, 312, 334, 338

Minor in Actuarial Science

MATH 309, 310 and one of Math 202, 203

ECON 029

ACCT 108 or 151

For information on examinations of actuarial societies, students may consult their minor advisor.

Undergraduate Courses

MATH 0. Preparation for Calculus (2) summer-fall
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. Prerequisite: department permission.

MATH 5. Introduction to Mathematical Thought (3) spring
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. (MA)

MATH 9. Introduction to Finite Mathematics (4)
Systems of linear equations, matrices, introduction to linear programming. Sets, counting methods, probability, random variables, introduction to Markov chains. (MA)

MATH 12. Basic Statistics (4) fall/spring
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, twoway tables, correlation and regression; random sampling, rules of probability, probability distributions and parameters, parameter estimation, confidence intervals, hypothesis testing, statistical significance. (MA) Note: Students may not receive credit for both MATH 12 & ECO 045.

MATH 21. Calculus I (4) fall/spring
Functions and graphs; limits and continuity; derivative, differential, and applications; indefinite and definite integrals; trigonometric, logarithmic, exponential, and hyperbolic functions. (MA)

MATH 22. Calculus II (4) fall/spring
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. Prerequisite: MATH 21 or MATH 31. (MA)

MATH 23. Calculus III (4) fall/spring
Vectors in space; partial derivatives; Lagrange multipliers; multiple integrals; vector analysis; line integrals; Green's Theorem, Gauss's Theorem. Prerequisite: MATH 22 or MATH 32. (MA)

MATH 31. Honors Calculus I (4) fall
Same topics as in MATH 21, but taught from a more thorough and rigorous point of view. (MA)

MATH 32. Honors Calculus II (4) fall/spring
Same topics as in MATH 22, but taught from a more thorough and rigorous point of view. Prerequisite: MATH 31. (MA)

MATH 33. Honors Calculus III (4) fall/spring
Same topics as in MATH 23, but taught from a more thorough and rigorous point of view. Prerequisite: MATH 32. (MA)

MATH 43. Survey of Linear Algebra (3) fall
Matrices, vectors, vector spaces and mathematical systems, special kinds of matrices, elementary matrix transformations, systems of linear equations, convex sets, introduction to linear programming. (MA).

MATH 51. Survey of Calculus I (4) fall
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. (MA)

MATH 52. Survey of Calculus II (3) spring
Techniques of integration. Differential equations. Probability and calculus. Partial derivatives and extrema. Multiple integrals and applications. Prerequisite: MATH 21 or 31 or 51 or 81. (MA)

MATH 75. Calculus I, Part A (2) fall
Covers the same material as the first half of MATH 21. Meets three hours per week, allowing more class time for each topic than does MATH 21. (MA)

MATH 76. Calculus I, Part B (2) spring
Continuation of MATH 75, covering the second half of MATH 21. Meets three hours per week. Final exam for this course is similar to the MATH 21 final. Prerequisite: MATH 75. (MA)

MATH 81. Calculus with Business Applications (4) fall-spring
Limits and continuity; exponential, logarithmic and trigonometric functions; derivatives; extrema; approximations; indefinite and definite integrals. Applications with emphasis on business and economics. (MA)

MATH 130. Biostatistics (4)
Elements of statistics and probability with emphasis on biological applications. Statistical analysis of experimental and observational data. Prerequisite: MATH 22 or MATH 52. (ND)

MATH 163. Introductory Seminar (3) spring
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. (MA)

MATH 171. Readings (1-3) fall/spring
Study of a topic in mathematics under individual supervision. Intended for students with specific interests in areas not covered in the listed courses. Prerequisite: permission of the department chair. (MA)

For Advanced Undergraduates and Graduate Students
Courses listed as (3-4) are 3 credits for graduate students and 4 credits for undergraduates. The extra credit will frequently involve some extra workshops or projects.

MATH 201. Problem Solving (1) fall
Practice in solving problems from mathematical contests using a variety of elementary techniques. (MA)

MATH 202. Actuarial Exam I (1) spring
Preparation for the first actuarial exam – probability. Problems in calculus and probability with insurance applications. Prerequisites: MATH 23 and 231. (MA)

MATH 203. Actuarial Exam II – Financial Mathematics (1) spring
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. Prerequisite: Math 22. (MA)

MATH 205. Linear Methods (3) fall/spring
Linear differential equations and applications; matrices and systems of linear equations; vector spaces; eigenvalues and application to linear systems of differential equations. Prerequisite: MATH 22 or 32. (MA)

MATH 208. Complex Variables (3) fall/spring
Functions of a complex variable; calculus of residues; contour integration; applications to conformal mapping and Laplace transforms. Prerequisite: MATH 23 or MATH 33. (MA)

MATH 214 (PHIL 214). Topics in Philosophical Logic (4)
The course materials are drawn from the many topics and figures in philosophical logic, widely construed, that are not covered by the other logic courses. Examples of such topics are the many systems of nonclassical logic, truth theory, the impact of incompleteness and undecidability results on philosophy, and the foundational projects of many philosophers/mathematicians. The topic may also concern the work of a certain important figure in the history of philosophical logic. Prerequisite: Permission of the instructor. (MA)

MATH 229. Geometry (3-4)
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. Prerequisite: Math 205 or Math 242 or permission of instructor. (MA)

MATH 230. Numerical Methods (3)
Representation of numbers and rounding error; numerical solution of equations; quadrature; polynomial and spline interpolation; numerical solution of initial and boundary value problems. Prerequisites: MATH 205 (previously or concurrently) and knowledge of either FORTRAN or PASCAL. (MA)

MATH 231. Probability and Statistics (3) fall/spring
Probability and distribution of random variables; populations and random sampling; chisquare and t distributions; estimation and tests of hypotheses; correlation and regression theory of two variables. Prerequisite: MATH 22 or MATH 32 or MATH 52. (MA)

MATH 234. Fractal Geometry (3-4)
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. Prerequisite: MATH 23 or MATH 33. (MA)

MATH 242. Linear Algebra (3-4) fall
Solution of systems of linear equations, matrices, vector spaces, bases, linear transformations, eigenvalues, eigenvectors, additional topics as time permits. Prerequisite: MATH 22 or MATH 32 or permission of instructor. (MA)

MATH 243. Algebra (3-4) spring
Introduction to basic concepts of modern algebra: groups, rings, and fields. (MA)

MATH 261. (CSE 261) Discrete Structures (3) fall-spring
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. Prerequisite: MATH 21. (MA)

MATH 271. Readings (13) fall/spring
Study of a topic in mathematics under individual supervision. Intended for students with specific interests in areas not covered in the listed courses. Prerequisite: permission of the department chair. May be repeated for credit. (MA)

MATH 301. Principles of Analysis I (3-4) fall
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. Prerequisite: MATH 23 or MATH 33. (MA)

MATH 302. Principles of Analysis II (3-4) spring
Continuation of MATH 301. Functions of several variables; the implicit function theorem, and further topics with applications to analysis and geometry. Prerequisite: MATH 301. (MA)

MATH 303. (Phil 303) Mathematical Logic (3-4) fall
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. Prerequisite: Permission of instructor. (MA)

MATH 304 (PHIL 304). Axiomatic Set Theory (3-4) fall
A development of set theory from axioms; relations and functions; ordinal and cardinal arithmetic; recursion theorem; axiom of choice; independence questions. Prerequisite: permission of instructor. (MA)

MATH 305. Enumerative Combinatorics (3)
An introduction to basic theoretical results and techniques of enumerative combinatorics such as combinatorial identities, generating functions, inclusionexclusion, recurrence relations, bijective proofs and permutations. Additional topics will be covered as time permits. Prerequisite: MATH 163 or MATH/CSE 261 or MATH 205 or permission of instructor. (MA)

MATH 306. (CHE 306) Introduction to Biomedical Engineering and Mathematical Biology (3)
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: MATH 205. (MA)

MATH 307. General Topology I (3-4) fall
An introductory study of topological spaces, including metric spaces, separation and countability axioms, connectedness, compactness, product spaces, quotient spaces, function spaces. Prerequisite: MATH 301. (MA)

MATH 309. Theory of Probability (3) fall
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. Prerequisite: MATH 23 or MATH 33 or MATH 52. (MA)

MATH 310. Random Processes and Applications (3-4) spring
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. Prerequisite: MATH 309 or MATH 231. (MA)

MATH 311. Graph Theory (3)
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. Prerequisite: MATH 163 or MATH/CSE 261 or MATH 205 or permission of instructor. (MA)

MATH 312. Statistical Computing and Applications (3-4)
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. Prerequisite: MATH 12 or 231. (MA)

MATH 316. Complex Analysis (3-4)
Concept of analytic function from the points of view of the CauchyRiemann equations, power series, complex integration, and conformal mapping. Prerequisite: MATH 301. (MA)

MATH 320. Ordinary Differential Equations (3-4)
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. Prerequisite: MATH 205 or Math 242 and one of Math 23 or Math 33. (MA)

MATH 321. Topics in Discrete Mathematics (3)
Selected topics in areas of discrete mathematics. May be repeated for credit. Prerequisite: permission of the department chair. (MA)

MATH 322. Methods of Applied Analysis I (3) fall
Fourier series, eigenfunction expansions, SturmLiouville 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. Prerequisite: MATH 205 or permission of instructor. (MA)

MATH 323. Methods of Applied Analysis II (3) spring
Green's functions; integral equations; variational methods; asymptotic expansions, method of saddle points; calculus of vector fields, exterior differential calculus. Prerequisite: MATH 322. (MA)

MATH 327. Groups and Rings (3-4) fall
An intensive study of the concepts of group theory including the Sylow theorems, and of ring theory including unique factorization domains and polynomial rings. Prerequisite: MATH 243 or permission of instructor. (MA)

MATH 329. Computability Theory (3-4) spring
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. (MA)

MATH 331. Differential Geometry of Curves and Surfaces (3)
Local and global differential geometry of curves and sufaces in Euclidean 3space. Frenet formulas for curves, isoperimetric inequality, 4vertex theorem; regular surfaces, first fundamental form, Gauss map, second fundamental form; curvatures for curves and surfaces and their relations; The GaussBonnet theorem. Prerequisites: MATH 23 or MATH 33 and MATH 205, or permission of instructor. (MA)

MATH 334. Mathematical Statistics (3-4) spring
Populations and random sampling; sampling distributions; theory of statistical estimation; criteria and methods of point and interval estimation; theory of testing statistical hypotheses. Prerequisite: MATH 231 or MATH 309. (MA)

MATH 338 (Stat 438). Linear Models in Statistics with Applications (3-4) spring
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. Prerequisite: MATH 12 or 231. (MA)

MATH 340. (CSE 340) Design and Analysis of Algorithms (3) spring
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-andconquer, 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: MATH 22 and CSE 261 (MATH 261).

MATH 341. Mathematical Models and Their Formulation (3) spring
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. Prerequisite: MATH 205. (MA)

MATH 342. Number Theory (3-4)
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. Prerequisite: permission of instructor. (MA)

MATH 343. Introduction to Cryptography (3-4)
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. Prerequisite: permission of instructor. (MA)

MATH 350. Special Topics (3) fall/spring
A course covering special topics not sufficiently covered in listed courses. Prerequisite: permission of the department chair. May be repeated for credit. (MA)

MATH 371. Readings (13) fall/spring
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. Prerequisite: permission of the department chair. May be repeated for credit (MA)

MATH 374. Statistical Project (3)
Supervised field project or independent reading in statistics or probability. Prerequisite: permission of the department chair. (MA)

MATH 391. Senior Honors Thesis (3) fall/spring
Independent research under faculty supervision, culminating in a thesis presented for departmental honors. May be repeated once for credit. Prerequisite: permission of the department chair. (MA)

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. The statistics track has recommended courses MATH 309, STAT 412, 434, and 462; electives STAT 410, 438, and 461; and other possible electives STAT 408 and 409, EDUC 411, I.E. 332, 409, and 410, ECO 460 and 463, CSE 411, and MECH 445. The stochastic modeling track has recommended courses MATH 309 and 401, and STAT 410 and 463; electives MATH 341 and STAT 434, 438, and 464; and other possible electives STAT 408 and 409, MATH 402, 430, 467, and 468, ECO 463, CSE 411, MECH 445, and I.E. 316, 339, 409, 416, and 439.

Ph.D. in Mathematics

The plan of work toward the doctor of philosophy degree will include a comprehensive examination and a qualifying examination. A language exam may be required at the discretion of the thesis committee. The latter tests the student's command of three areas. The combination of areas must be approved by the department. Recent exam areas include algebra, analysis, differential equations, differential geometry, discrete structures, functional analysis, logic and set theory, probability, mathematical statistics, and topology. Other areas of mathematics may be proposed by the candidate and approved by the department. A general examination, a foreign language examination, and 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, 410, and 499.

Ph.D. in Applied Mathematics

The plan of work toward the doctor of philosophy degree will include a comprehensive examination and a qualifying examination. The latter tests the student's command of three areas. The combination of areas must be approved by the department. Recent exam areas include analysis, applied probability, differential equations, discrete structures, financial mathematics, mathematical biology, mathematical statistics, numerical methods, and statistical methods. Other areas of mathematical and physical sciences may be proposed by the candidate and approved by the department. A general examination, a foreign language examination, and 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, 410, and 499.

Graduate Courses

MATH 401. Real Analysis I (3) fall
Set theory, real numbers; introduction to measures, Lebesgue measure; integration, general convergence theorems; differentiation, functions of bounded variation, absolute continuity; Lp spaces. Prerequisites: MATH 302 or permission of instructor.

MATH 402. Real Analysis II (3) spring
Metric spaces; introduction to Banach and Hilbert space theory; Fourier series and Fejer operators; general measure and integration theory, RadonNikodym and Riesz representation and theorems; LebesgueStieljtes integral. Prerequisites: MATH 307 and MATH 401.

MATH 403. Topics in Real Analysis (3)
Intensive study of topics in analysis with emphasis on recent developments. Prerequisite: permission of the department chair. May be repeated for credit.

MATH 404. Topics in Mathematical Logic (3)
Intensive study of topics in mathematical logic. Prerequisite: permission of instructor. May be repeated for credit.

MATH 405. Partial Differential Equations I (3) fall
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. Prerequisite: MATH 302 or its equivalent.

MATH 406. Partial Differential Equations II (3) spring
Continuation of MATH 405. Emphasis on second order equations with variable coefficients and systems of first order partial differential equations. Prerequisite: MATH 405.

MATH 408. Algebraic Topology I (3)
Polyhedra; fundamental groups; simplicial and singular homology.

MATH 409. (STAT 409) Mathematics Seminar (16) fall
An intensive study of some field of mathematics not offered in another course. Prerequisite: permission of the department chair.

MATH 410. (STAT 408) Mathematics Seminar (16) spring
Continuation of the field of study in MATH 409 or the intensive study of a different field. Prerequisite: permission of the department chair.

MATH 416. Complex Function Theory (3)
Continuation of MATH 316. Prerequisite: MATH 316 or permission of instructor.

MATH 421. Introduction to Wavelets (3)
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. Prerequisite: ECE 108, MATH 205, or permission of instructor.

MATH 423. Differential Geometry I (3)
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. Prerequisite: MATH 301, 302, or MATH 243 or MATH 205 with permission of instructor.

MATH 424. Differential Geometry II (3)
Curves and surfaces in Euclidean space; mean and Gaussian curvatures, covariant differentiation, parallelism, geodesics, GaussBonnet formula. Riemannian metrics, connections, sectional curvature, generalized GaussBonnet theorem. Further topics. Prerequisite: MATH 423.

MATH 428. Fields and Modules (3) spring
Field theory, including an introduction to Galois theory; the theory of modules, including tensor products and classical algebras. Prerequisite: MATH 327.

MATH 430. Numerical Analysis (3)
Multistep methods for ordinary differential equations; finite difference methods for partial differential equations; numerical approximation of functions. Use of computer required. Prerequisite: MATH 230 or permission of instructor.

MATH 431. Calculus of Variations (3)
Existence of a relative minimum for single and multiple integral problems; variational inequalities of elliptic and parabolic types and methods of approximating a solution. Prerequisite: MATH 302 or its equivalent.

MATH 435. Functional Analysis I (3)
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. Prerequisites: MATH 307 and MATH 401.

MATH 441 (CSE 441). Advanced Algorithms (3) spring
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)
Continuation of MATH 408. Cohomology theory, products, duality. Prerequisite: MATH 408.

MATH 445. Topics in Algebraic Topology (3)
Selected topics reflecting the interests of the professor and the students. Prerequisite: MATH 444.

MATH 449. Topics in Algebra (3)
Intensive study of topics in algebra with emphasis on recent developments. Prerequisite: consent of the department chairman. May be repeated for credit with the permission of the department chair.

MATH 450. Special Topics (3) fall/spring
Intensive study of some field of the mathematical sciences not covered in listed courses. Prerequisite: consent of the department chair. May be repeated for credit with the permission of the department chair.

MATH 455. Topics in Number Theory (3)
Selected topics in algebraic and/or analytic number theory. Prerequisite: permission of instructor. May be repeated for credit with permission of the department chair.

MATH 461. (STAT 461) Topics in Mathematical Statistics (3)
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. Prerequisites: MATH 334 and MATH 401. May be repeated for credit with permission of the department chair.

MATH 462. (STAT 462) Modern Nonparametric Methods in Statistics (3)
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; KolmogorovSmirnov 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. Prerequisites: MATH 334 (STAT 334) and MATH 338 (STAT 338) or equivalent classes or permission of instructor.

MATH 463. (STAT 463) Advanced Probability (3)
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. Prerequisites: MATH 309 and MATH 401.

MATH 464. (STAT 464) Advanced Stochastic Processes (3)
Theory of stochastic processes; stopping times; martingales; Markov processes; Brownian motion; stochastic calculus; Brownian bridge, laws of suprema; Gaussian processes. Prerequisites: MATH 309 and MATH 401.

MATH 465. Topics in Probability (3)
Selected topics in probability. Prerequisite: permission of the department chair. May be repeated for credit with permission of the department chair.

MATH 467. Financial Calculus I (3) fall
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 BlackScholes 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. Prerequisites: Math 231 or Math 309 or permission of instructor.

MATH 468. Financial Calculus II (3) spring
Models and mathematical concepts behind the interest rates markets. HeathJarrowMorton 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, swapoptions. Development of multidimensional stochastic calculus and applications to multiple stock models, quantos, and foreign currency interestrate models. Prerequisites: Math 467.

MATH 470. Proseminar (3)
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. Prerequisite: permission of the department chair.

MATH 471. Homological Algebra (3)
Modules, tensor products, categories and functors, homology functors, projective and injective modules. Prerequisite: MATH 428.

MATH 472. Group Representations (3)
Linear representations and character theory with emphasis on the finite and compact cases. Prerequisite: MATH 428 or permission of the department chair.

MATH 475. Topics in Geometry (3)
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. Prerequisite: permission of the department chair. May be repeated for credit with permission of the department chair.

MATH 485. Topics in Financial Mathematics (3)
Selected topics in financial mathematics. Prerequisite: permission of the department chair. May be repeated for credit with permission of the department chair.

MATH 490. Thesis MATH 499. Dissertation

Statistics

STAT 408. (MATH 410) Seminar in Statistics and Probability (16) spring
Intensive study of some field of statistics or probability not offered in another course. Prerequisite: permission of the department chair.

STAT 409 (MATH 409) Seminar in Statistics and Probability (16) fall
Intensive study of some field of statistics or probability not offered in another course. Prerequisite: permission of the department chair.

STAT 410. Random Processes and Applications (3) spring
See MATH 310.

STAT 412. Statistical Computing and Applications (3)
See MATH 312.

STAT 434. Mathematical Statistics (3) spring
See MATH 334.

STAT 438 (MATH 338). Linear Models in Statistics with Applications (3) spring
See MATH 338

STAT 461 (MATH 461). Topics in Mathematical Statistics (3)
See MATH 461.

STAT 462 (MATH 462). Nonparametric Statistics (3)
See MATH 462.

STAT 463 (MATH 463). Advanced Probability (3)
See MATH 463.

STAT 464 (MATH 464). Advanced Stochastic Processes (3)
See MATH 464.

Mechanical Engineering and Mechanics

Professors. D. Gary Harlow, Ph.D. (Cornell), *chair*; Philip A. Blythe, Ph.D. (Manchester, England); John P. Coulter, Ph.D. (Delaware); John N. DuPont, Ph.D. (Lehigh); Patrick V. Farrell, Ph.D. (University of Michigan); Joachim L. Grenestedt, Ph.D. (KTH, Royal Inst. of Tech., Stockholm, Sweden), Class of '61 Professor; Jacob Y. Kazakia, Ph.D. (Lehigh); Edward K. Levy, Sc.D. (M.I.T.), Director, Energy Research Center; Alistair K. Macpherson, Ph.D. (Sydney, Australia); Wojciech Misiolek, Sc.D. (University of Mining and Metallurgy, Krakow, Poland), Loewy Chair; Sudhakar Neti, Ph.D. (Kentucky); Herman F. Nied, Ph.D. (Lehigh); John Ochs, Ph.D. (Penn State); Tulga M. Ozsoy, Ph.D. (Istanbul, Turkey); Donald O. Rockwell, Ph.D. (Lehigh), *Paul B. Reinhold Professor*; Eric Varley, Ph.D. (Brown); Arkady Voloshin, Ph.D. (Tel-Aviv, Israel).

Associate professors. Robert A. Lucas, Ph.D. (Lehigh), *associate chair*; Meng-Sang Chew, Ph.D. (Columbia); Alparslan Öztekin, Ph.D. (Illinois); N. Duke Perreira, Ph.D. (California, Los Angeles); Eugenio Schuster, Ph.D. (California, San Diego); Edmund Webb, III, Ph.D. (Rutgers University).

Assistant Professors. Yaling Liu, Ph.D. (Northwestern); Xiaohui (Frank) Zhang, Ph.D. (University of Miami).

Professors of Practice. David C. Angstadt, Ph.D. (Lehigh);Terry J. Hart, D. Engr.- Honorary (Lehigh); Murat Öztürk, Ph.D. (Lehigh)

Emeritus professors. Russell E. Benner, Ph.D. (Lehigh); Forbes T. Brown, Sc.D. (M.I.T.); Terry J. Delph, Ph.D. (Stanford); Fazil Erdogan, Ph.D. (Lehigh); Ronald J. Hartranft, Ph.D. (Lehigh); Stanley H. Johnson, Ph.D. (Berkeley), G. Whitney Snyder Professor; Arturs Kalnins, Ph.D. (Michigan); Jerzy A. Owczarek, Ph.D. (London, England); Richard Roberts, Ph.D. (Lehigh); Robert G. Sarubbi, Ph.D. (Lehigh); Kenneth N. Sawyers, Ph.D. (Brown); George C.M. Sih, Ph.D. (Lehigh); Charles R. Smith, Ph.D. (Stanford); Gerald F. Smith, Ph.D. (Brown); Theodore A. Terry, Ph.D. (Lehigh); Dean P. Updike, Ph.D. (Brown); Robert P. Wei, Ph.D. (Princeton), *Paul B. Reinhold Professor*.

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, which are to educate engineers who:

- Model, formulate and creatively synthesize (i.e. design) realistic and practical systems, products, and environments;
- Naturally incorporate basic sciences and the art of mathematics as part of their thinking and problem-solving processes;
- Design, conduct, and analyze experimental tests of practical systems and products;
- Understand and appreciate the technical diversity required to develop new products/processes, and use this understanding to work effectively in multidisciplinary teams;
- Develop an appreciation of the contemporary world, and be able to contribute to it in a professional and ethical manner;
- Learn how to learn, so that lifelong learning becomes second nature.

The undergraduate program in mechanical engineering focuses principally on the first five of these objectives, and is configured to prepare our students for employment, and continued professional development and growth. 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. Because of 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, consistent with the sixth educational objective for lifelong learning.

Achievement of the six educational objectives 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. 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.

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

freshman year (see Engineering, freshman year, Section III)

sophomore year, first semester (16-17 credit hours)

ME 10	Graphics for Engineering Design (3)
MECH 3	Fundamentals of Engineering Mechanics (3)
MAT 33	Engineering Materials and Processes (3)
MATH 23	Analytical Geometry & Calculus III (4)
	elective (3-4)

sophomore year, second semester (17-18 credit hours)*

ME 104	Thermodynamics I (3)
MECH 12	Strength of Materials (3)
PHY 21,22	Introductory Physics II and Laboratory (5)
MATH 205	Linear Methods (3)
	Elective (3-4)

**Co-op students must take ME 21 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 (34) during the summer after the sophomore year (12-13 credit hrs.). See Co-op program for details*

junior year, first semester (16-18 credit hours)

ME 21	Mechanical Engineering Lab I (1)
ME 231	Fluid Mechanics (3)
MECH 102	Dynamics (3)
ME 215	Engineering Reliability (3) or
MATH 208	Complex Variables (3) or
MATH 230	Numerical Methods (3) or
MATH 231	Probability and Statistics (3)
	elective (68)

junior year, second semester (17 credit hours)

ME 121	Mechanical Engineering Lab II (1)
ME 211	Mechanical Engineering Design I (3)
ME 240	Manufacturing (3)
ME 242	Mechanical Engineering Systems (3) or
ME 245	Engineering Vibrations (3)
ME 252	Mechanical Elements (3)

ECE 83	Fundamentals of Electrical Engineering (3)
ECE 162	Electrical Laboratory (1)

Senior Year (30-34 credit hours)

ME 111	Professional Development (1) [*Fall only*]
ME 212	Integrated Product Development II (2) [*Fall only*]
ME 207	Mechanical Engineering Laboratory III (2)
ME 321	Introduction to Heat Transfer (3)
	electives (22-26)

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

a. Humanities/Social Sciences: A total of 17 credits of electives in humanities and social science, which must include ECO 1. (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.

b. ENGR. Elective A: One, 3credit course selected from the following: MECH 302, MECH 305, ME 304, ME 322, ME 331, or ME 343

c. ENGR. Elective B: One, 3credit course selected from any ME 300 or MECH 300-level course, excluding ME 310

d. 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. ME 310 may be taken once to satisfy this requirement.

e. Free electives: 6 credit hours in any subject area are required.

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

freshman year (see Engineering, freshman year, Section III)

sophomore year, first semester (16-17 credit hours)

ME 10	Graphics for Engineering Design (3)
MECH 3	Fundamentals of Engineering Mechanics (3)
MAT 33	Engineering Materials and Processes (3)
MATH 23	Analytical geometry & Calculus III (4)
	elective (3-4)

sophomore year, second semester (17-18 credit hours)*

ME 104	Thermodynamics I (3)
MECH 12	Strength of Materials (3)
PHY 21, 22	Introductory Physics II and Laboratory (5)
MATH 205	Linear Methods (3)
	elective (3-4)

**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 (68) during the summer after the sophomore year (12-14 credit hours). See Co-op program for details.*

junior year, first semester (16-18 credit hours)

ME 21	Mechanical Engineering Lab I (1)
ME 231	Fluid Mechanics (3)
MECH 102	Dynamics (3)
MATH 230	Numerical Methods (3)
	elective (68)

junior year, second semester (17-18 credit hours)

ME 121	Mechanical Engineering Lab II (1)
ME 240	Manufacturing (3)
ME 242	Mechanical Engineering Systems (3) or
ME 245	Engineering Vibrations (3)
MATH 208	Complex Variables (3)
ECE 83	Fundamentals of Electrical Engineering (3)
ECE 162	Electrical Laboratory (1) electives (34)

senior year (27-32 credit hours)

ME 111	Professional Development (1) [Fall only]
ME 207	Mechanical Engineering Laboratory III (2)
ME 321	Introduction to Heat Transfer (3) electives (21-26)

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

a. Humanities/Social Sciences: A total of 17 credits of electives in humanities and social science, which must include ECO 1. (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.

b. ENGR. Elective A: Two, 3 credit courses selected from the following: MECH 302, MECH 305, ME 304, ME 322, ME 331, or ME 343

c. ENGR. Elective B: Four, 3credit courses selected from any ME 300/MECH 300-level course or an engineering/science/ mathematics course, as approved by the Department Chair, excluding ME 310.

d. Free electives: 6 credit hours of any subject area are required.

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 Materials (3)
PHY 31	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 Eng. (3)
MECH 326	Aerodynamics (3)
MECH 328	Fundamentals of Aircraft Design (3)

Elective Courses

ME 309	Composite Materials (3)
ME 322	Gas Dynamics (3)
ME 331	Advanced Fluid Mechanics (3)
ME 333	Propulsion Systems (3)

ME 343	Control Systems (3)
ME 348	Computer-Aided Design (3)
MECH 305	Advanced Mechanics of Materials (3)
MECH 312	Finite Element Analysis (3)

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)

Elective Energy Courses:

Choose at least three courses from the below four

ME 360	Nuclear Energy (3)
ME 362	Nuclear Fusion and Radiation Protection (3)
ME 364	Renewable Energy (3)
ME 366	Engineering Principles of Clean Coal Technology (3)

Additional Electives:

ChE 373	Fundamentals of Air Pollution (3)
ChE/ME 376	Energy: Issues and Technology (3)
ChE 386	Process Control (3)
ME 322	Gas Dynamics (3)
ME 331	Advanced Fluid Mechanics (3)
ME 343	Control System (3)

OR other Energy related 300 level courses with the approval of the ME Dept. Chair.

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 3	Fundamentals of Engineering Mechanics (3)
MECH 12	Strength of Materials (3)

Electives

ME 10	Graphics for Engineering Design (3)
ME 215	Engineering Reliability (3)
ME 240	Manufacturing (3)
ME 252	Mechanical Elements (3)
ME 344/MAT 344/IE 344	Metal Machining Analysis (3)
ME 385	Polymer Product Manufacturing (3)
MECH 102	Dynamics (3)
MECH 305	Advanced Mechanics of Materials (3)
MECH 312	Finite Element Analysis (3)
MECH 313	Fracture Mechanics (3)

**This cross-listed course ME 344 counts as an elective.*

Undergraduate Courses in Mechanical Engineering

ME 10. Graphics for Engineering Design (3) fall
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 21. Mechanical Engineering Laboratory I (1) fall
Experimental methods in mechanical engineering and mechanics. Analysis of experimental error and error propagation. Introduction to elementary instrumentation. Introduction to digital data acquisition. Prerequisite: MECH 12, previously or concurrently. (ES 1), (ED 0)

ME 104. Thermodynamics I (3) spring
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)

ME 111. Professional Development (1) fall
Examination of ethical and professional choices facing mechanical engineers. Written and oral communications. Prerequisite: senior standing in Mechanical Engineering and Mechanics

ME 121. Mechanical Engineering Laboratory II (1) spring
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: ME 21, ME 104, and co-requisite: ME 231. (ES 1), (ED 0)

ME 207. Mechanical Engineering Laboratory III (2) fall, spring
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. Prerequisite: ME 121.

ME 211. Integrated Product Development I (3) spring
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: ME 10, MECH 12, ME 104. (ES 0), (ED 3)

ME 212. Integrated Product Development II (2) fall
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: ME 211, ME 252, (ME 252 may be taken concurrently). (ES 0) (ED 2)

ME 215. Engineering Reliability (3) fall
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: MATH 23 or 33; MECH 12, previously or concurrently.

ME 231. Fluid Mechanics (3) fall
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. Prerequisite: MATH 205. (ES 2.5), (ED 0.5)

ME 240. Manufacturing (3) spring
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: ME 10, MECH 12. (ES 1.5), (ED 1.5)

ME 242. Mechanical Engineering Systems (3) fall or spring
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: MECH 102 and MATH 205; ME 231 previously or concurrently.

ME 245. Engineering Vibrations (3) fall or spring
Physical modeling of vibrating systems. Free and forced single and multiple degree of freedom systems. Computer simulations. Engineering applications. Prerequisites: MECH 102 and Math 205. (ES2), (ED1).

ME 252. Mechanical Elements (3) spring
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: MECH 12, ME 10 and MECH 102. (ES 1.5), (ED 1.5)

ME 255 – Introduction to Aerospace Engineering (3)
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: PHY 11 and ME 104, and Co-requisite or Prerequisite ME 231.

For Advanced Undergraduates and Graduate Students

ME 304. Thermodynamics II (3)
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. Prerequisite: ME104. (ES 2), (ED 1)

ME 309 (Mat 309) – Composite Materials (3)
Principles and technology of composite materials. Processing, properties, and structural applications of composites, with emphasis on fiber-reinforced polymers. Prerequisites: MAT 33 or equivalent, MECH 3.

ME 310. Directed Study (13) fall, spring
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. Prerequisite: Department permission required. (ES 1), (ED 2)

ME 312. Analysis and Synthesis of Mechanisms (3) fall
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. Prerequisite: MECH 102. Chew. (ES1), (ED2)

ME 315 (BIOE 315). Bioengineering Statistics (3) spring
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: MATH 231 or equivalent.

ME 321. Introduction to Heat Transfer (3)
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: ME 104, ME 231. Neti, Blythe, MacPherson. (ES 2), (ED 1)

ME 322. Gas Dynamics (3)
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: ME 231, ME 104, MATH 205. Blythe. (ES 2.5), (ED 0.5)

ME 323. Reciprocating and Centrifugal Engines (3)
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. Prerequisite: ME 104. (ES 2.5), (ED 0.5)

ME 331. Advanced Fluid Mechanics (3)
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. Prerequisite: ME 231 or equivalent. Varley. (ES 2.5), (ED 0.5)

ME 333. Propulsion Systems (3)
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. Prerequisite: ME 104 Thermodynamics and either MECH 326 Aerodynamics or ME 322 Gas Dynamics.

ME 340. Advanced Mechanical Design (3)
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. Prerequisite: MATH 231 or consent of instructor. Harlow. (ES 2), (ED 1)

ME 341. Mechanical Systems (3)
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. Prerequisite: ME 252. Lucas. (ES 1.5), (ED 1.5)

ME 342. Dynamics of Engineering Systems (3)
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. Prerequisite: ME 242. (ES 2), (ED 1)

ME 343. Control Systems (3)
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. Prerequisite: ME 242, or ME 245, or ECE 125. (ES 2), (ED 1)

ME 344 (IE 344, MAT 344) Metal Machining Analysis (3)
Intensive study of metal cutting emphasizing forces, energy, temperature, tool materials, tool life, and surface integrity. Abrasive processes. Laboratory and project work. Prerequisite: ME 240 or IE 215 or MAT 206.

ME 348. Computer-Aided Design (3)
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: MATH 205, ME 10, MECH 12, MECH102.

ME 350. Special Topics (1-4)
A study of some field of mechanical engineering not covered elsewhere. Prerequisite: consent of the department chair. (ES 1), (ED 2)

ME 360. (CHE 360) Nuclear Reactor Engineering (3)
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. Prerequisite: Senior standing in engineering or physical science. Neti. (ES 2), (ED 1)

ME 362. Nuclear Fusion and Radiation Protection (3)
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. Prerequisites: Senior standing in engineering or physical science.

ME 364. Renewable Energy (3)
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: Math 205, ME 104, ME 231 and/or senior standing in Engineering .

ME 366. Engineering Principles of Clean Coal Technology (3)
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. Prerequisites: ME 104 or equivalent and Junior standing in engineering or physical science.

ME 373. Mechatronics (3)
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. Prerequisites: ECE 83 or equivalent; ME 374 concurrently.

ME 374. Mechatronics Laboratory (3)
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. Prerequisites: ECE 83 or equivalent; ME 373 concurrently.

ME 376 (ChE 376) Energy: Issues & Technology (3)
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. Prerequisites: college-level introductory courses in chemistry, physics and mathematics and instructor approval.

ME 385. Polymer Product Manufacturing (3)
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. Prerequisites: Senior level standing in engineering or science. Credit not given for both ME 385 and ME 485.

ME 387. (CHE 387, ECE 387) Digital Control (3)
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). Prerequisite: CHE 386 or ECE 212 or ME 343 or consent of instructor. Luyben.(ES 3), (ED 0)

ME 389. (ECE 389, CHE 389) Control Systems Laboratory (2)
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: Either CHE 386, ME 343, or ECE 212. (ES 1), (ED 1)

Undergraduate Courses in Engineering Mechanics

MECH 2. Elementary Engineering Mechanics (3) fall
Static equilibrium of particles and rigid bodies. Elementary analysis of simple truss and frame structures, internal forces, stress, and strain. Prerequisites: Phys. 11; MATH 22 previously or concurrently.

MECH 3. Fundamentals of Engineering Mechanics (3) fall, spring
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. Prerequisites: Phys. 11; MATH 22 previously or concurrently. Course is intended as a prerequisite for MECH 12. Credit not given for both Mech 2 and Mech 3. (ES 2.5, ED 0.5)

MECH 12. Strength of Materials (3) spring
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: MECH 3; MATH 23 may be taken previously or concurrently. (ES 2), (ED 1)

MECH 102. Dynamics (3) fall
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: MECH 2 or MECH 3, and MATH 23. (ES 3), (ED 0)

MECH 103. Principles of Mechanics (4)
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: MATH 23 and Phys 11. (ES 4), (ED 0)

For Advanced Undergraduates and Graduate Students

MECH 302. Advanced Dynamics (3)
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: MECH 102 or 103; MATH 205. Perreira (ES 3), (ED 0)

MECH 305. Advanced Mechanics of Materials (3)
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: MECH 12, MATH205. Nied. (ES 2.5), (ED 0.5)

MECH 307. Mechanics of Continua (3)
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. Prerequisite: MECH 305. Varley. (ES 3), (ED 0)

MECH 312. Finite Element Analysis (3)
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. Prerequisite: MECH 12. (ES 1.5), (ED 1.5)

MECH 313. Fracture Mechanics (3)
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: MECH 12, MATH 205, or approval of department. Nied, Wei. (ES 2), (ED 1)

MECH 326. Aerodynamics (3)
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: ME 231 and MATH208. Blythe, Varley. (ES 2.5), (ED 0.5)

MECH 328. Fundamentals of Aircraft Design (3)
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. Prerequisite: MECH 12. Grenestedt.

MECH 350. Special Topics (3)
A study of some field of engineering mechanics not covered elsewhere. Prerequisite: consent of the department chair.

Graduate Programs

The department offers programs of study leading to the degrees of master of science, master of engineering, and doctor of philosophy 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. 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; and either ME 453, Mathematical Methods in Engineering II or ME 413, Numerical Methods in Mechanical Engineering. In addition, three of the following courses must be taken: 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; and either ME 401, Product Development, or ME 402, Manufacturing.

Master of Engineering in Mechanical Engineering

The M.Eng. 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 300or 400-level. No course in mechanical engineering and mechanics below the 300-level may be used towards the M.Eng., but two courses (6 credits) outside the department that are below the 300-level may apply, 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 the following three required courses:

Mathematical Methods I & II	ME 452 & ME 453
Numerical Methods	ME 413

In addition they must take two of the four MEM core courses:

Heat and Mass Transfer	ME 423
Advanced Fluid Mechanics	ME 430
Fundamentals of Solid Mechanics	MECH 406
Analyt. Meth. In Dynamics & Vibs.	MECH 425

The remaining 15 credits may be taken from any of the graduate courses in MEM and other approved electives. Both thesis and non-thesis options are available.

Doctor of Philosophy in Mechanical Engineering

The Ph.D. program in Mechanical Engineering 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). Students are admitted to Ph.D. candidacy in mechanical engineering upon attainment of a minimum GPA of 3.35 in five core courses (see core course requirements for Master of Science in Mechanical Engineering) and completion of a General Examination, which is based on assessment and presentation of a research topic. 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 the required core courses:

Mathematical Methods I & II	ME 452 & 453
Numerical Methods	ME 413

They must also take two core courses from the supplemental list given below:

Asymptotic Methods	MECH 419
Finite Element Methods	MECH 418
Nondeterministic Models in Engr.	MECH 445
Mechanical Reliability	ME 446
Heat and Mass Transfer	ME 423*
Advanced Fluid Mechanics	ME 430*
Fundamentals of Solid Mechanics	MECH 406*
Analyt. Meth. in Dynamics & Vibs.	MECH 425*

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.

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 * in the above list. If desired, these starred courses may be used as part of the Computational and engineering mechanics core, and hence count towards the core GPA requirement.

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 Mechanical Engineering

Except for core courses, graduate courses are generally offered every third semester. Several courses are offered each year as ME 450 Special Topics. For details, contact the graduate office of the department.

ME 401. Integrated Product Development (IPD) (3) fall
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 with international partners. Ochs. ME402.

ME 402. (MAT 402) Advanced Manufacturing Science (3) spring
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. Coulter/Nied

ME 411. Boundary-Layer Theory (3)
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)
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)
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. Rockwell

ME 420. Advanced Thermodynamics (3)
Critical review of thermodynamics systems. Criteria for equilibrium. Applications to electromagnetic systems. Statistical thermodynamics. Irreversible thermodynamics. Thermoelectric phenomena. Levy

ME 421. Topics in Thermodynamics (3)
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. Staff

ME 423. Heat and Mass Transfer (3) spring
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. Neti, Öztekin

ME 424. Unstable and Turbulent Flow (3)
Stability of laminar flow; transition to turbulence. Navier-Stokes equations with turbulence. Bounded turbulent shear flows; free shear flows; statistical description of turbulence. Prerequisite: ME 331. Rockwell

ME 426. Radiative and Conductive Heat Transfer (3)
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. Prerequisite: ME 321 or CHE 421. Varley

ME 428. Boundary Layers and Convective Heat Transfer (3)
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. Prerequisite: ME 331 or ME 321. Levy

ME 430. Advanced Fluid Mechanics (3) fall
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. Smith, Rockwell

ME 431. Advanced Gas Dynamics (3)
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. Prerequisite: ME 322. Blythe

ME 433. (CHE 433, ECE 433) State Space Control (3)
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. Prerequisite: ME 343 or ECE 212 or CHE 386 or consent of instructor.

ME 434. (CHE 434, ECE 434) Multivariable Process Control (3)
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. Prerequisite: CHE 433 or ME 433 or ECE 433 or consent of instructor.

ME 436. (CHE 436, ECE 436) Systems Identification (3)
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-imbedding techniques for nonlinear system parameter identification included. Prerequisite: CHE 433 or ME 433 or ECE 433 or consent of instructor.

ME 437. (CHE 437, ECE 437) Stochastic Control (3)
Linear and nonlinear models for stochastic systems. Controllability and observability. Minimum variance state estimation. Linear quadratic Gausian control problem. Computational considerations. Nonlinear control problem in stochastic systems. Prerequisite: CHE 433 or ME 433 or ECE 433 or consent of instructor. Staff

ME 444. Experimental Stress Analysis in Design (3)
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. Voloshin

ME 446. Mechanical Reliability (3)
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. Prerequisite: MATH 231 or MATH 309. Harlow

ME 450. Special Topics (3)
An intensive study of some field of mechanical engineering not covered in more general courses.

ME 451. Seminar (1-3)
Critical discussion of recent advances in mechanical engineering.

ME 452 (CHE 452, ENGR 452). Mathematical Methods in Engineering I (3) fall
Analytical techniques relevant to the engineering sciences are described. Vector spaces; eigenvalues, eigenvectors. Linear ordinary differential equations; diagonalizable and non-diagonizable systems. Inhomogeneous linear systems; variation of parameters. Nonlinear 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 Fournier transforms; planar, cylindrical, and spherical geometries.

ME 453. Mathematical Methods in Engineering II (3) spring
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)
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 (16)
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. Prerequisite: consent of the department chair.

ME 461. IPD: Design (3)
Industry sponsored Integrated Product Development Project (IPD) projects. The student works with an industry sponsor to do a technical and economic feasibility study of new product development. 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 and posters. Prerequisites: Consent of the department chair and faculty project advisor.

ME 462. IPD: Manufacturing (3)
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. Prerequisites: Consent of the department chair and faculty project advisor.

ME 464. Computer-Aided Geometric Modeling (3)
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. Prerequisite: ME 348 or consent of instructor. Ozsoy

ME 466. Fundamentals of Acoustics (3)
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. Ochs

ME 485. Polymer Product Manufacturing (3)
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. Prerequisites: Graduate level standing in engineering or science.

ME 490. Thesis

ME 499. Dissertation

Graduate Courses in Engineering Mechanics

Except for core courses, graduate courses are generally offered every third semester.

MECH 404 (CEE 404). Mechanics and Behavior of Structural Members (3)
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. Prerequisite: CEE 259 or equivalent.

MECH 406 (CEE 406). Fundamentals of Solid Mechanics (3)
An introductory graduate course in the mechanics of solids. Topics to be addressed include: tensor analysis, analysis of strain and nonlinear kinematics, stress, work conjugate stress-strain measures, conservation laws and energy theorems. Hamilton's principle, variational calculus, isotropic and anistropic linear elasticity, boundary value problems, beam and plate theories. Prerequisite: MATH 205 or equivalent.

MECH 408. Introduction to Elasticity (3) fall
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. Staff

MECH 410. Theory of Elasticity II (3)
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. Prerequisites: MECH 408, MATH 208, or consent of the department chair.

MECH 411. (PHY 471) Continuum Mechanics (3)
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. Staff

MECH 413. Fracture Mechanics (3)
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. Prerequisites: MATH 205, MECH 305 or equivalent course in advanced mechanics of materials. Nied, Wei

MECH 415. (CE 468) Stability of Elastic Structures (3)
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. Prerequisite: MATH 205.

MECH 418. Finite Element Methods (3)
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. Prerequisite: knowledge of a high-level programming language. Delph

MECH 419. (CHE 419) Asymptotic Methods in the Engineering Sciences (3)
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. Blythe

MECH 424. Unsteady Fluid Flows (3)
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. Varley

MECH 425. Analytical Methods in Dynamics and Vibrations (3) spring
This course is a first graduate course in dynamics and vibrations. It treats three-dimensional rigid body motion by vector methods and multi-degree of freedom systems by variational principles. Discrete modal analysis and continuous modal analysis of one-dimensional systems plus finite-element formulation of numerical problems constitutes about one-third of the course. There is a brief treatment of advanced impact. Use of symbolic computer codes is encouraged.

MECH 432 (CEE 432). Inelastic Behavior of Materials (3)
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. Prerequisite: MECH 406. Delph.

MECH 445. Nondeterministic Models in Engineering (3)
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. Prerequisites: advanced calculus and some exposure to probability and statistics. Harlow

MECH 450. Special Problems (3)
An intensive study of some field of applied mechanics not covered in more general courses.

MECH 454. Mechanics and Design of Composites (3)
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. Prerequisite: MECH 305 or equivalent course in advanced mechanics of materials. Voloshin

MECH 490. Thesis

MECH 499. Dissertation

Graduate Courses in Engineering Mathematics

EMA 425. Variational Methods in Science and Engineering (3)
Variational problems with one independent variable; Euler-Lagrange equations; methods of solution; space and time dependent fields; null Lagrangians and inhomogeneous Dirichlet data; problems with constraints; symmetries and conservation laws; variational approximation methods, Rayleigh-Ritz, Galerkin, finite element, and collocation. Problems and examples will be drawn from the mechanics of solids, fluids, and related fields. Prerequisite: consent of chair. Staff

EMA 450. Special Topics (3)
An intensive study of some field of engineering mathematics not covered in other courses.

EMA 490. Thesis

EMA 499. Dissertation

Military Science

Professor. LTC Erik J. Walker, M.A. Penn State University, B.A. WV University

Instructors. MAJ Jeff Boers, MAJ Deron Haught, MSG Jimmy Soles

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.

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, field trips, role playing, 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 completes either the basic course or the four-week Leaders Training Course; or has received basic course credit for previous military experience; or is a nursing student and is accepted for enrollment by the university and the Department of Military Science.

Note: The Advanced course is a requirement for Scholarship and contracted cadets only and is not offered to participating students.

Uniforms and Equipment. All uniforms and equipment needed by the student for military science courses are supplied by the department. Students are charged only for those items not returned when they leave 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.

Obligation After Graduation. Upon graduation a student will receive a commission as a Second Lieutenant in either the Active Army or the Reserve Forces. If offered active duty, scholarship students serve four years while non-scholarship students serve three. If offered reserve duty, students normally serve six to 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. Delay does not lengthen the active service obligation unless the degree is obtained at government expense. The three major areas of concentration are medical school, law school, and all other categories.

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 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 are 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. Applications may be obtained by calling 1-800-USA-ROTC. 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 are 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 field training exercises and weapons familiarization during the two annual weekend field exercises. Gettysburg National Park is also visited each year.

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). 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 (13)

MIL 101	Adaptive Team Leadership I (3)
MIL102	Adaptive Team Leadership II (3)
MIL 113	Developing Adaptive Leaders (3)
MIL 114	Leadership in a Complex World (3)
HIST 110	American Military History (3)

International Relations (3-4))

International Relations

Political Science

Written Communications (3)

(Select one course from one of the following categories)

Creative Writing

Scientific Writing

Writing for Mass Communications

English Composition

Human Behavior (3)

(Select one course from one of the following categories)

General Psychology

Sociology

Anthropology

Ethics

Computer Literacy (3)

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 on three Saturdays or Sundays per semester. The Leadership Laboratory provides students the opportunity to demonstrate an understanding of the leadership process and develop fundamental military skills.

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.

MIL 15. Foundation of Officership (MS101) (1) fall
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 16. Basic Leadership (MS102) (1) spring
Role of individual and leader within the group, leadership skills and characteristics. Emphasis on problem solving and application. Includes laboratory and FTX.

MIL 23. Individual Leadership Studies (MS201) (2) fall
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 24. Leadership and Teamwork (MS202) (2) spring
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 (MS 301) (3) fall
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. Prerequisite: permission of department chair.

MIL 102. Adaptive Team Leadership II (MS 302) (3) spring
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. Prerequisite: permission of department chair.

MIL 113. Developing Adaptive Leaders (MS 401) (3) fall
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. Prerequisite: permission of department chair.

MIL 114. Leadership in a Complex World (MS 402) (3) spring
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. Prerequisite: permission of department chair.

Leadership Development and Assessment Course (LDAC)
This is a five-week training program normally conducted at Fort Lewis, WA. Prerequisites are completion of the basic military science courses or their equivalent and MS 101 and 102. The summer camp experience, in coordination with respective engineering curricula, may be used to fulfill the industrial employment requirements of the engineering courses, CE 100, IE 100, and MAT 100

Modern Languages and Literatures

Professors. Marie-Hélène Chabut, Ph.D. (U.C., San Diego), Chair, French; Constance Cook, Ph.D. (Berkeley), Chinese; David W. Pankenier, Ph.D. (Stanford), Chinese.

Associate Professors. Marie-Sophie Armstrong, Ph.D. (Oregon), French; Kiri Lee, Ph.D. (Harvard), Japanese; Linda S. Lefkowitz, Ph.D. (Princeton), Spanish; Mary A. Nicholas, Ph.D. (Pennsylvania), Russian; Miren Edurne Portela, Ph.D. (North Carolina-Chapel Hill), Spanish; Antonio Prieto, Ph.D. (Princeton), Spanish; Vera S. Stegmann, Ph.D. (Indiana), German.

Assistant Professors. Taïeb Berrada, Ph.D. (Northwestern), French and Francophone Studies; Matthew Bush, Ph.D. (Colorado-Boulder), Spanish.

Professors of Practice. Christine Kalleeny, Ph.D. (Emory), Comparative Literature; Limei Shan, M.A. (East China Normal University), Education Administration.

Lecturers. Diego Argibay, M.A. (North Carolina-Chapel Hill), Spanish; Stephanie Katz, B.A. (California-Pomona College), Spanish.

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.

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

A minimum of 32 credits beyond German 12, of which 4 credits must be a junior year writing course in the German section or in another major. Emphasis should be upon 200 and 300 level courses For specific course requirements, see the language major adviser. Language students may count one MLL course taught in English toward the major in German.

Requirements for the departmental honors major

Same as for the major plus eight additional hours of advanced courses at the 300 level, dissertation or comprehensive examination (written or oral), and a 3.20 average in the major.

Major in French and Francophone Studies

1. 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)

2. 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 when taught by a French faculty member.
3. Collateral requisites:

6-8 credits from a list of approved courses taken in other programs and departments.

These courses have to 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 cr):

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.

Major in Spanish and Hispanic Studies

1. 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)

2. Advanced course work: 12 credits, or three courses at the 300 level.
3. Electives: 8 credits at the 100 or 200 level.
4. Collateral requisites

6-8 credits from a list of approved courses taken in other programs and departments.

These courses have to 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 21st 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, 200or 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.

Study Abroad Awards

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 scholarships 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)

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 advisers. For course descriptions, see under each language area below.

MLL 006. (GS 006) Globalization and Cultures (4)
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. (HU/GC)

MLL 023. Lehigh in Russia (1-8)
A summer program in Russia, taught in English. (HU)

MLL 027. Russian Classics (4)
Russian classics in translation. May be repeated for credit. (HU)

MLL 051. Contemporary Hispanic-American Literature (4)
Reading and discussion of distinguished Latin American writers: Borges, García Márquez, Cortázar, and Vargas Llosa. (HU)

MLL 053. This Hispanic World and its Culture (4)
Characteristics and values of the people of Spain and Latin America in literary works and other material. Hispanic cultural contributions to Western civilization. (HU)

MLL 068. (ASIA 068) Japanese Language: Past and Present (4)
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. Prerequisite JPNS 001. (HU)

MLL 073. (ASIA 073, GCP 073 WS 073) Film, Fiction, and Gender in Modern China (4)
Study of the struggle for an individual "modern" entity 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. (HU)

MLL 074. (ASIA 074) Chinese Cultural Program (1-8)
A summer program in China, taught in English. (HU)

MLL 075. (ASIA 075, HIST 075) Chinese Civilization (4)
The development of traditional Chinese thought, beliefs, technology, and institutions from a historical perspective, from earliest times to China's encounter with the West. (H/S)

MLL 076. (ASIA 076, HIST 076) Understanding Contemporary China (4)
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. (SS)

MLL 078. (ASIA 078) Asian American Studies (4)
A survey of issues concerning Asians living in the United States from the perspectives of history, language, literature, and film. (HU)

MLL 079. (ASIA 079, DES 079) Digital Bridges (2)
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. (HU)

MLL 100. Introduction to International Film (4)
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. (HU)

MLL 124. Negotiating Across Cultures (4)
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. (ASIA 125) Immortal Images: Traditional Chinese Literature in Translation (4)
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. (HU)

MLL 127. (ASIA 127, GCP 127) ORIENTations: Approaches to Modern Asia (4)
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. (AAS 133, FREN 133, HIST 133, LAS 133, POLS 133) Lehigh in Martinique: Globalization and Local Identity (3-4)
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. (HU)

MLL 140. (ANTH 140, COGS 140, PSYC 140) Introduction to Linguistics (4)
Relationship between language and mind; formal properties of language; language and society; how languages change over time. (SS)

MLL 165. (ASIA 165, GCP 165) Love and Revolution in Shanghai (4)
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 area. Written research papers on aspects of historical or modern Shanghai, and class presentations. Blackboard and in-class discussions of assigned readings and films. (HU)

MLL 177. (ASIA 177, HIST 177) China Enters the Modern Age (4)
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. (HU)

MLL 211. (GERM 211, THTR 211) German Drama (4)
Drama as a literary genre; plays from various periods of German literature. (HU)

MLL 218. (GERM 218, THTR 218) Goethe's "Faust" (4)
Study of Goethe's play with an introduction to the Faust tradition and Faustian themes in modern literature. (HU)

MLL 231. (GERM 231, GCP 231) New German Cinema (4)
Viewing, discussion, and written analysis of selected German films. (HU)

MLL 260. (GERM 260, GCP 260) Multicultural Germany (4)
A look at Germany from the perspective of its "others"--the immigrants. Literary and cultural texts, and films on ethnic diversity and integration. (HU)

MLL 303. (GERM 303, WS 303) GRIMMS' FAIRY TALES: FOLKLORE, FEMINISM, FILM (4)
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. Stegmann (HU)

MLL 319. (4). Second Language Acquisition (SLA) Theory
This course will introduce theories of second language acquisition of English as a second language as well as other languages. Various theories of communication and language

acquisition will be covered. Prerequisite: consent of instructor. (HU)

MLL 321. (GCP 321, GS 321) (4) Intercultural Communication
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. (HU)

MLL 403. (WS 403) GRIMMS' FAIRY TALES: FOLKLORE, FEMINISM, FILM (3)
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. Stegmann (HU)

MLL 419. Second Language Acquisition (SLA) Theory (3)
This course will introduce theories of second language acquisition of English as a second language as well as other languages. Various theories of communication and language acquisition will be covered. Prerequisite: consent of instructor. (HU/ED)

MLL 421. Intercultural Communication (3)
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. (HU/ED)

Arabic

Undergraduate Courses

ARAB 001. Elementary Arabic I (4)
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. (HU)

ARAB 002. Elementary Arabic II (4)
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. Prerequisite: ARAB 001 or equivalent. (HU)

ARAB 011. Intermediate Arabic I (4)
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. Prerequisite: ARAB 002 or equivalent. (HU)

ARAB 012. Intermediate Arabic II (4)
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. Prerequisite: ARAB 011 or equivalent. (HU)

ARAB 190. Arabic Special Topics I (1-4)
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. Prerequisite: ARAB 012 or equivalent. (HU)

ARAB 191. Arabic Special Topics II (1-4)
Continuation of ARAB 190. Literary and linguistic topics not covered in regular classes. Prerequisite: ARAB 190 or equivalent. (HU)

Chinese

Undergraduate Courses in Chinese

CHIN 001. Beginning Chinese Reading and Writing I (2)
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. Staff. (HU)

CHIN 002. Beginning Chinese Reading and Writing II (2)
Continuation of CHIN 001: continued character acquisition, reading practice in pinyin and simple character texts. (Spring) 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. Prerequisite: CHIN 001 or permission of the instructor. Staff (HU)

CHIN 003. Beginning Spoken Chinese I (2)
Introduction to Mandarin Chinese pronunciation, the pinyin transcription system, and modern colloquial Chinese; emphasis on oral proficiency. Not open to native speakers. (Fall) Students are strongly encouraged to take Reading and Writing course of the same level during the same semester as this Spoken course. Prerequisite: CHIN 002 or permission of the instructor. (HU)

CHIN 004. Beginning Spoken Chinese II (2)
Continuation of CHIN 003: further practice with text based dialogues in modern colloquial Chinese; emphasis on oral proficiency. Not open to native speakers. (Spring) Students are strongly encouraged to take Reading and Writing course of the same level during the same semester as this Spoken course. Prerequisite: CHIN 003 or permission of the instructor. Staff (HU)

CHIN 011. Intermediate Chinese Reading and Writing I (2)
Continued focus on vocabulary/character acquisition and text-based reading and writing exercises using Chinese characters. (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. Prerequisite: CHIN 002 or permission of the instructor. Staff (HU)

CHIN 012. Intermediate Chinese Reading and Writing II (2)
Continuation of CHIN 011: vocabulary/character acquisition and text-based reading and writing exercises using Chinese characters. (Spring). 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. Prerequisite: CHIN 011 or permission of the instructor. Staff (HU)

CHIN 013. Intermediate Spoken Chinese I (2)
Further development of communicative skills in Chinese using situational dialogues and class discussion; emphasis on oral proficiency. Not open to native speakers. (Fall) Students are strongly encouraged to take Reading and Writing course of the same level during the same semester as this Spoken course. Prerequisite: CHIN 004 or permission of the instructor. Staff. (HU)

CHIN 014. Intermediate Spoken Chinese II (2)
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. (Fall) Students are strongly encouraged to take Reading and Writing course of the same level during the same semester as this Spoken course. Prerequisite: CHIN 013, or permission of the instructor. Staff. (HU)

CHIN 111. Advanced Chinese Reading & Writing I (2)
Reading, translation, and writing practice using text-based exercises, short stories, essays, and other selected materials. (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. Prerequisite: CHIN 011 or permission of the instructor. Staff. (HU)

CHIN 112. Advanced Chinese Reading & Writing II (2)
Continuation of CHIN 111: reading, translation, writing exercises using text-based exercises, short stories, essays, and other selected materials. (Spring) 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. Prerequisite: CHIN 111 or permission of the instructor. Staff. (HU)

CHIN 113. Advanced Spoken Chinese I (2)
Topical discussions and oral presentations in Chinese. (Fall) Students are strongly encouraged to take Reading and Writing course of the same level during the same semester as this Spoken course. Prerequisite: CHIN 014 or permission of the instructor. Staff. (HU)

CHIN 114. Advanced Spoken Chinese II (2)
Continuation of CHIN 113: topical discussions and oral presentations in Chinese. (Fall) Students are strongly encouraged to take Reading and Writing course of the same level during the same semester as this Spoken course. Prerequisite: CHIN 113 or permission of the instructor. Staff. (HU)

CHIN 251. Chinese Special Topics (1-4)
Literary and linguistics topics not covered in regular courses. May be repeated for credit. Prerequisite: consent of the instructor. (HU)

CHIN 252. Business Chinese (12)
Directed readings on the Chinese business environment and business terminology. Emphasis on reading comprehension and translation. May be repeated for credit. Prerequisite: CHIN 112, CHIN 114, or permission of the instructor. Staff. (HU)

CHIN 253. Chinese Fiction (12)
Students read modern Chinese short stories or a novel. Emphasis on reading comprehension and translation. May be repeated for credit. Prerequisite: CHIN 112, CHIN 114, or permission of instructor. Staff. (HU)

CHIN 254. Intensive Chinese Conversation (12)
Conversational practice based on topical readings. For advanced speakers only. May be repeated for credit. Prerequisite: CHIN 112, CHIN 114, or permission of the instructor. Staff. (HU)

CHIN 255. Newspaper Readings in Chinese (12)
Newspaper readings in Chinese. Emphasis on reading comprehension and translation. May be repeated for credit. Prerequisite: CHIN 112, CHIN 114, or permission of the instructor. Staff. (HU)

CHIN 371. Advanced Readings in Chinese (1-4)
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. Prerequisite: consent of the instructor. (HU)

Courses Taught in English (see descriptions under MLL courses)

MLL 073. (ASIA 073, GCP 73, WS 073) Film, Fiction, and Gender in Modern China (4)

MLL 074. (ASIA 074) Chinese Cultural Program (1-8)

MLL 075. (ASIA 075, HIST 075) Chinese Civilization (4)

MLL 076. (ASIA 076, HIST 076) Understanding Contemporary China (4)

MLL 079. (ASIA 079, DES 079) Digital Bridges (2)

MLL 078. (ASIA 078) Asian-American Studies (4)

MLL 125. (ASIA 125) Immortal Images: Traditional Chinese Literature in Translation (4)

MLL 127. (ASIA 127, GCP 127) ORIENTations Approaches to Modern Asia (4)

MLL 165. (ASIA 165, GCP 165) Love and Revolution in Shanghai (4)

MLL 177. (ASIA 177, HIST 177) China Enters the Modern Age (4)

French

Undergraduate Courses in French

FREN 1. Elementary French I (4) fall
Multimedia approach to the study of French. Introduction to French conversation, grammar, and culture. (HU)

FREN 2. Elementary French II (4) spring
Continuation of FREN 1. Prerequisite: FREN 001 or appropriate achievement test score before entrance, or consent of instructor. (HU)

FREN 11. Intermediate French I (4) fall
Further acquisition of the fundamentals of French conversation, writing, and culture. Multimedia approach. Prerequisite: FREN 002 or appropriate achievement test score before entrance, or consent of instructor. (HU)

FREN 12. Intermediate French II (4) spring
Continuation of FREN 011. Prerequisite: FREN 011 or appropriate achievement test score before entrance, or consent of instructor. (HU)

FREN 133. (AAS 133, HIST 133, LAS 133, MLL 133, POLS 133) Lehigh in Martinique: Globalization and Local Identity (3-4)
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. (HU)

FREN 143. Advanced Written French (4)
Intensive practice in written French and introduction to literary criticism. Prerequisite: FREN 012, or achievement test score of 590, or consent of instructor. (HU)

FREN 144. Advanced Oral French (4)
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. Prerequisite: FREN 143 or equivalent. Staff. (HU)

FREN 251. Postcolonizing France: North African Immigration (4)
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. Berrada. (HU)

FREN 252. Introduction to Literary Analysis (4)
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. (HU)

FREN 259. Contemporary France (3-4)
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. Prerequisite: FREN 143, 144, or consent of instructor. (HU)

FREN 271. French Readings (4)
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. (HU)

FREN 272. French Culture of Business (4)
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. Prerequisite: FREN 143 or 144 or equivalent. (HU)

FREN 281. French Cultural Program (16)
A program in a French-speaking country offering formal language courses and cultural opportunities. (HU)

FREN 311. French Classicism (4)
French classical theater, novel, and criticism, with emphasis on Corneille, Racine, Moliere, Pascal, Lafayette, Malherbe, and Boileau. Chabut. (HU)

FREN 312. (AAS 312) Modernity in the Maghreb (4)
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. Berrada. (HU)

FREN 313. The Age of Enlightenment (4)
The Philosophes and Encyclopédistes of the eighteenth century, with emphasis on Voltaire, Rousseau, Montesquieu, and Diderot. Chabut. (HU)

FREN 316. Nineteenth Century French Literature (4)
Study of major nineteenth century novelists and poets. Armstrong. (HU)

FREN 318. (THTR 318) French Drama in the Twentieth Century (4)
Contemporary French drama with an analysis of its origins and movements. Armstrong. (HU)

FREN 320. Contemporary French Fiction (4)
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. Armstrong. (HU)

FREN 321. Twentieth-Century French Short Fiction (4)
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. Armstrong (HU)

FREN 322. Contemporary French Films (4)
French Films from the late 1950s to the present. Introduction to cinematograhic 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. Armstrong (HU)

FREN 324. The Outsider in French Fiction (4)
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. Chabut. (HU)

FREN 327. (WS 327) Women Writing in French (4)
Reading and discussion of works written by women in French. The emphasis is on 19thand 20thcentury writers, such as G. Sand, Colette S. de Beauvoir, M. Duras, and Andrée Chédid. Chabut (HU)

FREN 369. French Readings (4)
Advanced study of an author, period, or theme. Topics vary. May be repeated once for credit. Prerequisite: consent of instructor. (HU)

FREN 370. French Internship (1-8)
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. Prerequisite: consent of instructor. (HU)

FREN 371. French Independent Study (1-8)
Special topics under faculty guidance, including honors thesis. May be repeated once for credit. Prerequisite: consent of instructor. (HU)

German

Undergraduate Courses in German

GERM 001. Elementary German I (4)
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. (HU)

GERM 002. Elementary German II (4)
Continuation of GERM 1, including reading of more advanced texts. Three class hours plus one laboratory or drill hour each week. Prerequisite: GERM 001 or equivalent. (HU)

GERM 011. Intermediate German I (4)
Review of grammar, composition, reading of intermediate texts, vocabulary building. Prerequisite: GERM 002, or four units of entrance German or consent of instructor. (HU)

GERM 012. Intermediate German II (4)
Continuation of GERM 011. Prerequisite: GERM 011 or consent of instructor; one hour of lab. (HU)

GERM 163. German Civilization and Culture (4)
Cultural, historical, and political evolution of Germany and German-speaking countries in Europe. Prerequisite: GERM 012 or equivalent, or consent of instructor. (HU)

GERM 167. German Conversation and Composition (4)
Intensive practice in spoken and written German. Prerequisite: GERM 012 or equivalent, or consent of instructor. (HU)

GERM 169. Business German (4)
German in business, the professions, international, and social relations. Letter writing, comprehension of technical texts, specialized vocabulary, and grammar review. Prerequisite: GERM 012 or equivalent, or consent of instructor. (HU)

GERM 181. German Cultural Program (1-8)
Summer program abroad. Formal instruction in the language and the culture of a German-speaking country. (HU)

GERM 211. (MLL 211, THTR 211) German Drama (4)
Drama as a literary genre; plays from various periods of German literature. (HU)

GERM 218. (MLL 218, THTR 218) Goethe's "Faust" (4)
Study of Goethe's play with an introduction to the Faust tradition and Faustian themes in modern literature. (HU)

GERM 231. (GCP 231, MLL 231). New German Cinema (4)
Viewing, discussion, and written analysis of selected German films. (HU)

GERM 240. Contemporary Germany (4)
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. (HU)

GERM 250. German Special Topics (1-4)
Literary and linguistic topics not covered in regular courses. May be repeated for credit. (HU)

GERM 260. (MLL 260, GCP 260) Multicultural Germany (4)
A look at Germany from the perspective of its "others"--the immigrants. Literary and cultural texts, and films on ethnic diversity and integration. (HU)

GERM 267. Advanced German Conversation and Composition (4)
A continuation of Germ 167. Practice of speaking and writing skills in German through readings of more complex texts. (HU)

GERM 269. Advanced Professional German (4)
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". (HU)

GERM 281. German Cultural Program (1-8)
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. Prerequisites: consent of German study abroad adviser. (HU)

GERM 301. Survey of German Literature (4)
An overview of German literary traditions through the nineteenth century, focusing on the Middle Ages, Renaissance, Reformation, Baroque, Enlightenment, Classicism, Romanticism, Realism, and Naturalism. (HU)

GERM 303. (MLL 303) Grimms' Fairy Tales: Folklore, Feminism, Film (4)
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. Stegmann (HU)

GERM 305. Modern German Literature (4)
Topics in German literature of the twentieth and twenty-first century. (HU)

GERM 320. Berlin: Transformations of a Metropolis (4)
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. (HU)

GERM 345. German Short Stories (4)
Readings of short prose texts in German. (HU)

GERM 350. German Special Topics (1-4)
Literary or linguistic topics not covered in regular courses. May be repeated for credit. Prerequisite: consent of instructor. (HU)

GERM 370. German Internship (1-8)
Designed to give advanced qualified students the chance to acquire field experience and training with selected firms and governmental agencies in German-speaking countries. Assigned readings, written reports, and employer performance evaluations are required. Prerequisite: GERM 167 or consent of the instructor. (HU)

Courses Taught in English (see descriptions under MLL courses)

MLL 211 (GERM 211, THTR 211). German Drama (4)

MLL 218. (GERM 218, THTR 218) Goethe's "Faust" (4)

MLL 231. (GCP 231, GERM 231). New German Cinema (4)

MLL 260. (GERM 260, GCP 260) Multicultural Germany (4)

MLL 303. (GERM 303, GCP 303, WS 303) Grimms' Fairy Tales: Folklore, Feminism, Film (4)

MLL 403. (WS 403) Grimms' Fairy Tales: Folklore, Feminism, Film (3)

Hebrew

The department offers courses both separately and in the context of the Jewish studies minor (Section III).

HEBR 001. Elementary Modern Hebrew I (4) fall
Classroom and laboratory instruction to develop hearing, speaking, reading, and writing the language. Cultural, ethnic, and religious dimensions of Israeli society. Tapes, textural materials, short stories. No previous study of Hebrew required. (HU)

HEBR 002. Elementary Modern Hebrew II (4) spring
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. Prerequisite: HEBR 001 or its equivalent. (HU)

HEBR 011. Intermediate Modern Hebrew I (4) fall
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. Prerequisite: HEBR 002 or consent of instructor. (HU)

HEBR 012. Intermediate Modern Hebrew II (4) spring
Continuation of Hebrew 011. Reading of texts, including selected short stories, outside reading and supplementary material; increased emphasis on oral presentation. Prerequisite: HEBR 011 or consent of instructor. (HU)

HEBR 151 Hebrew Special Topics I (4)
Literary or linguistic topics not covered in regular courses. May be repeated for credit. Prerequisite: consent of instructor. Taught in Hebrew. (HU)

HEBR 152 Hebrew Special Topics II (4)
Continuation of HEBR 151. Literary or linguistic topics not covered in regular courses. May be repeated for credit. Prerequisite: consent of instructor. Taught in Hebrew. (HU)

Japanese

See Asian Studies major and minor.

JPNS 001. Elementary Japanese I (4) fall
This course introduces the basic grammatical structures commonly found in daily situations in Japan. All four aspects of language skills are introduced. Hirangana, Katakana, and approximately 50 Kanji are introduced. (HU)

JPNS 002. Elementary Japanese II (4) spring
Continuation of JPNS 001. Approximately 100 Kanji are introduced. Prerequisite: JPNS 001 or equivalent. (HU)

JPNS 011. Intermediate Japanese I (4) fall
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. Prerequisite: JPNS 002 or equivalent. (HU)

JPNS 012. Intermediate Japanese II (4) spring
Continuation of JPNS 011. Prerequisite: Japanese 011 or equivalent. (HU)

JPNS 141. Advanced Japanese I (4) fall
This course emphasizes advanced reading comprehension on topics related to Japan. Approximately 100 Kanji are introduced. Prerequisite: JPNS 012 or equivalent. (HU)

JPNS 142. Advanced Japanese II (4) spring
Continuation of JPNS 141. Prerequisite: JPNS 141 or equivalent. (HU)

JPNS 145. Advanced Japanese Conversation and Culture I (4)
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. Prerequisite: JPNS 012 or consent of instructor. (HU)

JPNS 146. Advanced Japanese Conversation and Culture II (4)
Continuation of JPNS 145. Emphasis on advanced oral and writing skills, and knowledge of the culture. Prerequisite: JPNS 145 or consent of instructor. (HU)

JPNS 290. Japanese Special Topics (1-4)
Literary or linguistics topics not covered in regular courses. May be repeated for credit. Prerequisite: consent of instructor. (HU)

JPNS 291. Advanced Japanese and Culture Abroad (1-8)
(HU)

JPNS 390. Japanese Special Topics (1-4)
Literary or linguistics topics not covered in regular courses. May be repeated for credit. Prerequisite: consent of instructor. (HU)

Courses Taught in English (See descriptions under MLL courses)

MLL 068. (ASIA 68) Japanese Language: Past and Present (4)

Russian

RUSS 001. Elementary Russian I (4) fall
Classroom and laboratory, audio, and video introduction to the fundamentals of conversational and grammatical patterns; practice in pronunciation, simple conversation, reading, and writing. (HU)

RUSS 002. Elementary Russian II (4) spring
Continuation of RUSS 001. Prerequisite: RUSS 1 or equivalent. (HU)

RUSS 011. Intermediate Russian I (4) fall
Classroom and laboratory practice in conversation. Development of reading and writing skills. Prerequisite: RUSS 002 or equivalent. (HU)

RUSS 012. Intermediate Russian II (4) spring
Continuation of RUSS 011. Prerequisite: RUSS 002 or 011, or equivalent. (HU)

RUSS 141. Russian Conversation and Composition I (4) fall
Intensive practice in oral and written Russian and oral comprehension. Readings and discussions on Russian literature and culture. Prerequisite: RUSS 012 or equivalent. (HU)

RUSS 142. Russian Conversation and Composition II (4) spring
Continuation of RUSS 141. Prerequisite: RUSS 141 or equivalent. (HU)

RUSS 215. Russian Classics: Russian Literature with Variable Topic and Credit (1-4)
May be repeated for credit. (HU)

RUSS 231. Russian in the Real World I (4)
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. (HU)

RUSS 232. Russian in the Real World II (4)
A continuation of RUSS 231. (HU)

RUSS 251. Russian Special Topics (1-4) fall
Intensive study of literary or linguistic topics. Prerequisite: RUSS 142 or equivalent. May be repeated for credit. Nicholas (HU)

RUSS 252. Russian Special Topics (1-4) spring
Intensive study of literary or linguistic topics. Prerequisite: RUSS 142 or 251 or equivalent. May be repeated for credit. Nicholas (HU)

RUSS 370. Russian Internship (1-8)
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. Prerequisites: RUSS 141 or 142 and approval of faculty committee on internship. (HU)

RUSS 391. Russian Special Topics (1-4)
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. Prerequisites: consent of instructor. Nicholas (HU)

Courses Taught in English (see descriptions under MLL courses)

MLL 023. Lehigh in Russia (1-8) MLL 027. Russian Classics (4)

Spanish

Undergraduate Courses

SPAN 001. Elementary Spanish I (4)
Basic conversational Spanish illustrating essential grammatical principles. Reading of simple texts and writing. Lab required. (HU)

SPAN 002. Elementary Spanish II (4)
Continuation of SPAN 1. Lab required. Prerequisite: SPAN 001 or equivalent. (HU)

SPAN 011. Intermediate Spanish I (4)
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. Prerequisite: SPAN 002 or equivalent. (HU)

SPAN 012. Intermediate Spanish II (4)
Prerequisite: SPAN 011 or equivalent. (HU)

SPAN 133. Spanish Phonetics and Pronunciation (4)
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. Prerequisite: SPAN 002. (HU)

SPAN 141. Advanced Spanish Grammar (4)
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. Prerequisite: SPAN 012 or equivalent. (HU)

SPAN 142. Advanced Conversational Spanish (4)
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. Prerequisite: SPAN 141 or equivalent. (HU)

SPAN 151. Cultural Evolution of Spain (4)
The historical and cultural evolution of Spain. Discussion of major literary works in their cultural and historical contexts. Prerequisite: SPAN 141 or consent of instructor. Lefkowitz. (HU)

SPAN 152. (LAS 152) Cultural Evolution of Latin America (4)
The historical and cultural evolution of Latin America. Discussion of representative literary works in their cultural and historical contexts. Prerequisite: SPAN 141 or consent of instructor. (HU)

SPAN 199. Spanish Special Topics (34)
For students who take a course, not offered at Lehigh, at another institution. May be repeated once for credit. Prerequisite: consent of instructor. (HU)

SPAN 211. Business Spanish (4)
An introduction to business concepts and vocabulary in Spanish. Letter writing, specialized professional vocabulary, and review of grammar. Prerequisite: SPAN 141 or equivalent. (HU)

SPAN 212. Spanish Writing Skills (4)
Improving writing proficiency through practice in composition and translation. Prerequisite: SPAN 141 or equivalent. (HU)

SPAN 213. (LAS 213) Introduction to Hispanic Literature and Film (4)
An introduction to the analysis of Latin American and Spanish cultural productions (mainly literature and film). Prerequisites: Span 151 or 152, Span 141. (HU)

SPAN 263. (LAS 263) The Spanish American Short Story (4)
Comparative study of representative works by major writers such as Quiroga, Borges, and Cortazar, among others. Prerequisite: SPAN 152 or equivalent. Prieto. (HU)

SPAN 265. (LAS 265) Spanish and Latin American Cinema (4)
An introduction to cinema in the Spanish-speaking world. Oral discussion and written analysis of selected films. Students view films independently. Prerequisite: SPAN 141 or equivalent. (HU)

SPAN 270. Communicating in Spanish for Medical Personnel (4)
For prospective medical personnel communicating with Spanish-speaking patients. Dialogues, healthcare vocabulary. Review of grammar. Prerequisite: SPAN 141 or equivalent. Lefkowitz. (HU)

SPAN 275. (LAS 275, WS 275) Introduction to Hispanic Women Writers (4)
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. Portela. (HU)

SPAN 276. (LAS 276) Contemporary Literature of the Southern Cone (4)
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. Portela. (HU)

SPAN 290. Spanish Special Topics (24)
Study of an author or theme, or completion of a special project. Topics may vary. May be repeated once for credit. Prerequisites: SPAN 151 or 152, and consent of instructor. (HU)

SPAN 303. Don Quixote (4)
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. Prerequisite: SPAN 151 or equivalent. Lefkowitz. (HU)

SPAN 305. Spanish Literature of the Middle Ages (4)
Reading and discussion of outstanding works such as El Cid, El Libro de Buen Amor and La Celestina. Topics vary. Prerequisite: SPAN 151. Lefkowitz. (HU)

SPAN 308. The Spanish Novel Since 1939 (4)
The evolution of the novel from post civil war to the present. Reading of Cela, Laforet, Delibes, Rodoreda, and Marsé, among others. Prerequisite: SPAN 151 or equivalent. (HU)

SPAN 320. (LAS 320) Literature of the Spanish Caribbean (4)
Study of representative works with emphasis on Cuba and Puerto Rico. Writers include Barnet, Carpentier, Sánchez, and Rodriguez Juliá. Prerequisite: SPAN 152 or equivalent. Prieto. (HU)

SPAN 321. (LAS 321) Children and Adolescents in Contemporary Spanish American Literature (4)
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. Prerequisite: SPAN 152 or equivalent. Prieto. (HU)

SPAN 322. (LAS 322) The Short Novel in Contemporary Spanish American Literature (4)
Reading and discussion of representative works by García Márquez, Onetti, Rulfo, and Bioy Casares, among others. Prerequisite: SPAN 152 or equivalent. Prieto. (HU)

SPAN 323. (LAS 323) Literature and Revolution in Contemporary Cuba (4)
Study of works written after 1959 by dissident, nondissident, and exiled authors (Desnoes, Norberto Fuentes, Benítez Rojo, and Pedro Juan Gutiérrez, among others). Prerequisite: SPAN 152 or equivalent. Prieto. (HU)

SPAN 325. (LAS 325) Hispanic Literature of the United States (4)
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. Prerequisite: SPAN 152 or equivalent. Prieto. (HU)

SPAN 326. (LAS 326, WS 326) Tradition and Resistance: Women Writers of Latin America (4)
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. Prerequisite: SPAN 152 or equivalent. (HU)

SPAN 342. (LAS 342) The New Narrative in Spanish American Literature (4)
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. Prerequisite: SPAN 152 or equivalent. (HU)

SPAN 345. (LAS 345) Testimonial Writing of the Hispanic World (4)
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 *testimonio*s from the Hispanic world, as well as on theoretical issues concerning discourses of truth. Portela. (HU)

SPAN 346. (LAS 346, WS 346) Contemporary Hispanic Women Writers: The Novelists (4)
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 cannon 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. Portela. (HU)

SPAN 379. Spanish Internship (24)
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. Prerequisites: SPAN 141 and approval of faculty. (HU)

SPAN 390. Spanish Special Topics (24)
Study of an author, theme or period. Topics vary. May be repeated once for credit. Prerequisites: SPAN 151 or 152 and consent of instructor. (HU)

Courses Taught in English (see descriptions under MLL courses)

MLL 051. Contemporary Hispanic-American Literature (4)

MLL 053. This Hispanic World and its Culture (4)

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 MLL 90 or 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 090 or 124) or 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.

Music

Professors. Paul Salerni, Ph.D. (Harvard) (NEH Distinguished Chair in the Humanties); Steven Sametz, D.M.A. (Wisconsin) (Ronald J. Ulrich Chair in Music); Nadine Sine, Ph.D. (N.Y.U.), Chair.

Associate Professors. Eugene Albulescu, M.M. (Indiana) (Ronald J. Ulrich Chair in Orchestral Studies); William Warfield, M.M. (Manhattan).

Professors of Practice. Debra Field, M.M. (Temple); Timothy Schwarz, D.M.A. (Temple).

Lecturer. David Diggs, M.M. (SUNY Stony Brook)

Adjunct Professors: Helen Beedle, M.M. (New England); Linda Ganus, M.M. (Michigan), M.F.A. (Vermont College of Fine Arts); William Holmes (School for Recording Arts and Sciences); Albert Neumeyer, M.M. (Trenton); Gene Perla, B.A. (Thomas Edison); Dave Riekenberg, M.M.E. (N. Texas State)

Private Instructors: Bass: John Gaffney, Gene Perla; Bassoon: Kim Seifert; Clarinet: Deborah Andrus; Flute: Linda Ganus; Robin Kani; French Horn: Daniel Braden; Guitar: (electric) Bob De Vos, Tom Guarna, Vic Juris; Harp: Andrea Wittchen; Oboe: David Diggs; Organ: Tim Harrell; Piano: Eugene Albulescu, Helen Beedle, Tim Harrison (jazz), Emi Kagawa, Donna McHugh, Pat O'Connell, Irmgard Pursell; Percussion: Steven Mathiesen, Scott Neumann; Saxophone: Dave Riekenberg; Trombone: Tim Sessions; Trumpet: Joseph Mosello; Tuba: Scott Force; Viola and Violin: James Finegan, Sandya Murthy, Tim Schwarz; Violoncello: Kate Dillingham; Voice: Stephen Caldwell, Debra Field, Jane Hagness, Margaret Hanegraaf.

The study of music develops skills which will serve the student well in any career: selfdiscipline, 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, 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 also offers significant performance experiences in instrumental and vocal ensembles, large and small, and in private instruction. The Zoellner Arts Center 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 1000seat 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.

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 (36credit 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.

Thirteen credits in theory and musicianship skills: MUS 11, 2, 82, 3, 7, 83, 4, 8. Nine credits of music history (any 2 from MUS 233, 234, 235, 236) and MUS 336; eleven credits in lessons, ensembles and recitals, and three credits in music electives. 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/~inmsc/

History Concentration.

Thirteen credits in theory and musicianship skills: MUS 11, 2, 82, 3, 7, 83, 4, 8. Fifteen credits of music history (MUS 233, 234, 235, 236, 336) and eleven credits in electives, lessons, and ensembles, of which at least three must be in performance, plus a variable number for MUS 350: Senior Project. The students must produce a major research project during the senior year.

Composition and Theory Concentration.

Eighteen credits in theory: MUS 82, 3, 7, 83, 4, 8, 243, 245. Six credits in music history (MUS 336 plus any one from MUS 233, 234, 235, 236) and eight in composition (MUS 253, 254), plus four in lessons or ensembles. 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

Thirteen credits in music theory and musicianship skills: MUS 11, 2, 82, 3, 7, 83, 4, 8 plus three credits in Jazz Theory, MUS 139. Six credits in Jazz History: MUS 128, 129 or 130 (Jazz Masters) plus MUS 236. A minimum of four credits in small jazz groups, MUS 49 and six in jazz performance: MUS 24, 25. The student must undertake a senior project under faculty direction (MUS 350 for variable credit).

Conducting Concentration

Thirteen credits in music theory and musicianship skills: MUS 11, 2, 82, 3, 7, 83, 4, 8. Nine credits in music history (MUS 336, plus 2 from 233, 234, 235, 236). Four credits in conducting: MUS 321, 322 plus at least two Conducting Internships (MUS 311), of which one must be in orchestra. Six credits of performance electives (lessons and ensembles). 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 54credit minimum. Twenty-five credits in music theory: MUS 82, 3, 7, 83, 4, 8, 139, 243, 245, 331. Nine credits in music history: MUS 236, MUS 336 plus one from MUS 129, 233, 234, 235. Fourteen credits in composition: MUS 253, 254, two semesters of MUS 353. One semester of conducting, MUS 321 (2 credits) and four credits of music electives. 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 90. The program is designed to be flexible but must include MUS 11, 2, 82, 3, and 7, one history or literature course, and two performance courses (MUS 2279). The student may choose the remaining four credits from department offerings.

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, 164, 261, 10 or 11, plus MUS 361: Music Internship; and either Acct 108 or 151 for a minimum of 17 credits.

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. 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.

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 10 or 11 and are open to anyone with basic knowledge of musical terminology.

MUS 2. Keyboard Harmony I (1) spring
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. (HU)

MUS 3. Keyboard Harmony II (1) fall
Continuation of MUS 2. Diatonic progressions in major and minor and more advanced sight reading. Students may test out upon examination. Co-requisite: MUS 82. Prerequisite: MUS 2. (HU)

MUS 4. Keyboard Harmony III (1) spring
Additional keyboard skills, including progressions with secondary chords, modulations, and sight reading. Students may test out upon examination. Co-requisite: MUS 83. Prerequisite: MUS 3 (HU)

MUS 7. Aural Skills (1) fall
Sight singing, rhythm exercises, and ear training through dictation exercises. Co-requisite: MUS 82. Prerequisite: MUS 11 or equivalent. (HU)

MUS 8. Aural Skills II (1) spring
Continuation of MUS 7. Co-requisite: MUS 83. Prerequisite: MUS 7. (HU)

MUS 10. Basic Skills in Music (2) fall
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. (HU)

MUS 11. Basic Musicianship (2) spring
For intended majors and minors. Development of basic skills in using notation, sight singing and ear training. Co-requisite: MUS 2. (HU)

MUS 12. Surveys in Music (3) fall or spring
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. Staff (HU)

Applied Music and Performances Courses.
Music 21-61, 71-79, 84 may be repeated for credit. Up to six credits may be used for graduation credit in CEAS and CBE. Prerequisite: Admission to MUS 22, 24, 25, 31, 22, 34, 35, 48, 49, 61 by audition. Music 21, 23, and 32 have no auditions. MUS 65-79, 84, 170 have fees.
MUS 21. Marching Band (1) fall. (ND) No Audition

MUS 22. Wind Ensemble (1) fall/spring (HU)
MUS 23. Symphonic Band (1) spring (HU) No Audition

MUS 24. Jazz Ensemble (1) fall/spring (HU)

MUS 25. Jazz Band (1) fall/spring (HU)

MUS 31. University Choir (1) fall/spring (HU)
MUS 32. Choral Union (1) fall/spring (HU) No Audition

MUS 33. Glee Club (1) fall/spring. Co-requisite: MUS 31 (HU)

MUS 34 Freshman Lab Choir (0) fall. Co-requisite: MUS 31 (HU)

MU 35 Dolce Women's Choir (1) fall/spring. Co-requisite: MUS 31 (HU)

MUS 48. Chamber Music Collegium (1) fall/spring. Department Permission. (HU)

MUS 49. Small Jazz Ensembles (1) fall/spring. Department Permission. (HU)

MUS 61. Lehigh University Philharmonic (1) fall/spring (HU)

MUS 65. Class Guitar for Beginners (1) fall/spring
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. (HU)

MUS 66. Class Voice for Beginners (1) fall/spring
Group instruction for beginning students of voice, including breathing and vocal production techniques; diction; beginning solo pieces. (HU)

MUS 67. Class Drum Set for Beginners (1) fall/spring
Rudiments of drum set playing for students with less than a year of drum instruction. (HU)

MUS 68. Class Piano for Beginners I (1) fall/spring
Instruction for beginning piano students, including rudiments of musical notation in relation to the keyboard; beginning pieces for solo piano and the group. (HU)

MUS 69. Class Piano for Beginners II (1) fall/spring
A continuation of MUS 68. After a second semester of class piano, the student should be ready to benefit from private lesson instruction. (HU)

MUS 71. Private Piano Study (1) fall-spring (HU)

MUS 72. Private Vocal Study (1) fall-spring (HU)

MUS 73. Private String Study (1) fall-spring (HU)

MUS 74. Private Woodwind Study (1) fall/spring (HU)

MUS 75. Private Brass Study (1) fall/spring (HU)

MUS 76. Private Percussion Study (1) fall/spring (HU)

MUS 77. Private Organ Study (1) fall/spring (HU)

MUS 79. Private Electric Guitar Study (1) fall/spring (HU)

MUS 82. Harmony I (3) fall
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: MUS 11 or equivalent. Diggs (HU)

MUS 83. Harmony II (3) spring
Continuation of MUS 82 including modulation, chromatic chords, analysis. MUS 4 and 8 must be taken concurrently. Prerequisites: MUS 82, and 7 or equivalent. Diggs (HU)

MUS 84. Private Drumset Study (1) fall/spring

MUS 100. Concert Requirement (0) fall, spring
Three concerts approved by the department (for majors and minors)

MUS 128. (AAS 128) Jazz History I (3) fall
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. Warfield (HU)

MUS 129. (AAS 129) Jazz History II (3) spring
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. Warfield (HU)

MUS 130. Jazz Masters (3)
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. Warfield (HU)

MUS 132. Composer and Era (3) fall or spring
Life and development of a composer's style viewed in historical context, such as: Bach, Beethoven, Mozart, etc. May be repeated for credit as title varies. Prerequisite: MUS 10 or 11 or equivalent. Staff (HU)

MUS 139. Jazz Theory (3) spring
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: MUS 82. (HU)

MUS 151. Vocal Diction (1) fall or spring
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. Field (HU)

MUS 161. Production and Marketing of Sound Recordings (3) fall/spring
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. Perla (ND)

MUS 164. Management of Careers in Performing Arts (3) fall/spring
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. Perla (ND)

MUS 170. Private Instruction for Performance Concentrators (2)
Lesson fees apply. Repeatable for credit. Restricted to music majors concentrating in performance. (HU)

MUS 171. Accompanying (1) fall/spring
Introduction to ensemble performance including sight-reading techniques, application of chord progressions and beginning improvisation techniques at the keyboard. May be repeated for credit. (HU)

MUS 233. Medieval and Renaissance Music (WI) (3) fall, odd
Development of musical style from early Christian chant to the sacred and secular forms of the late 16th century, viewed in cultural contexts. Sine (HU)

MUS 234. Baroque and Classical Music (WI) (3) spring, even
The major genres and composers of the 17th and 18th centuries studied in their cultural context. Sine (HU)

MUS 235. Romantic Music (WI) (3) fall, even
Study of the major composers and their works from late Beethoven to Mahler and Strauss. Sine (HU)

MUS 236. Music Since 1900 (WI) (3) spring, odd
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. Sine (HU)

MUS 237. Advanced Violin Technique (1)
To teach advanced violin or viola students execution of various bow strokes, left-hand technique, complex rhythms and ensemble skills. (ND)

MUS 243. Counterpoint (4) fall
Writing and analyzing pieces in Renaissance and Baroque contrapuntal styles. Prerequisites: MUS 83, 4, and 8 or equivalent. Salerni (ND).

MUS 245. Classical and Romantic Forms (4) spring
Analyzing and writing pieces in classical and romantic forms. Exercises in chromatic harmony. Prerequisite: MUS 83, 4, and 8 or equivalent. Salerni. (ND)

MUS 251. Special Topics (13)
Study of musical topics in history or composition not covered in regular courses. May be repeated for credit as title varies. Prerequisite: consent of the instructor. Salerni (HU)

MUS 253. Composition I (4) fall
Writing for acoustic and electronic instruments based on 20thcentury models. Acoustic orchestration, digital synthesis, effects processing. Use of the computer for score preparation and as a compositional tool. Prerequisite: MUS 83, 4, and 8 or permission of instructor. Salerni (ND)

MUS 254. Composition II (4) spring
Continuation of MUS 253. Prerequisite: 253. Salerni (ND)

MUS 261. Recording Techniques I (3) fall
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. Holmes (ND)

MUS 262. Recording Techniques II (3) spring
Continuation of Recording Techniques I. Prerequisite: MUS 261. Holmes (ND)

MUS 271. Repertoire (2) fall or spring
Survey of literature in a given medium: e.g., piano, vocal, orchestral, choral repertoire. Particular emphasis on performance issues. May be repeated for credit as title varies. (HU)

MUS 291. Independent Study (13)
Individually supervised work in history or composition, or continuation of projects begun in regular courses. May be repeated for credit. Prerequisite: consent of department chair. (HU)

MUS 300. Apprentice Teaching (13) (ND)

MUS 311. Conducting Internship (2)
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. Prerequisites: MUS 322 or permission. Repeatable for credit. Staff (HU)

MUS 312/412: Advanced Choral Composition (2) Summer
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. Sametz

MUS 321. Conducting I (2) fall
Beginning study of conducting techniques, including score reading and preparation, analysis, conducting patterns and gestures. Prerequisite: MUS 83 or permission of the instructor. Sametz (HU)

MUS 322. Conducting II (2) spring
Continuation of MUS 321. Prerequisite: MUS 321. Sametz (HU)

MUS 331. Advanced Analysis (4) spring
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. Prerequisites: MUS 243 and 245 or permission. Staff (HU)

MUS 336. Seminar in the History of Musical Style (3) spring
Study and analysis of the development of musical language and genre from the middle ages to the present. Prerequisite: MUS 83. Sine (ND)

MUS 350. Senior Project (16) (ND)

MUS 353. Composition Seminar (3) fall/spring
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. Prerequisites: MUS 254. Salerni, Sametz, Warfield. Repeatable for credit. Staff (HU)

MUS 361. Music Internship (3)

MUS 370. Recital (12) fall/spring
Department permission. Repeatable for credit. (HU)

MUS 412/312. Advanced Choral Composition (2) summer.
Same as MUS 312 description above.

Peace Studies Minor

Advisor. Chaim Kaufmann (International Relations).

The Minor in Peace Studies aims to educate students about the history, theory, and practice of peace advocacy, social justice movements, and nonviolent direct action as employed by such leaders as Gandhi and King among many others. It also investigates the political structures and processes which peace advocates must confront in order to be politically effective, including those that produce armed conflict as well as those that contribute to de-escalation of hostilities. A central course (PS 180) introduces key concepts by which practitioners, using both these approaches, seek to create peace in a violent world. Guest lectures dealing with the second component will be offered by the program's Advisor (Chaim Kaufmann, International Relations) as well as by other social science and humanities faculty who contribute on a volunteer basis.

Requirements for Completion of the Minor

Four 4-credit courses, including PS 180. Introduction to Peace Advocacy.

3 courses from the two lists below, including at least one from the nonviolence/peace advocacy list and at least one from the conflict/policy process list below;

Nonviolence/peace advocacy/practice of advocacy

History 339	Managing Nonprofit Organizations.
PS 182	Internship in Peace Studies*
IR 346	Ethics in International Relations.
IR 391	U.N. or other IGO/NGO internship approved by program advisor.*
MLL 124	Negotiating Across Cultures.
Religion 3 (Philosophy 3)	Religion, Ethics and Society.
Religion 68	Practical Justice: From Social Systems to Responsible Community.
Religion 167	Engaged Buddhism.
POLS 100	Introduction to Political Thought
POLS 108	Global Citizenship and its Discontents.
POLS 230	Movements and Legacies of the 1960s.
POLS 326	Democracy Workshop.
POLS 370	The Citizen Versus the Administrative State.

Conflict/policy process/foreign policy

History 349	Revolutions in Modern European History.
IR 34	Society, Technology and War.
IR 36	International Terrorism.
IR 74	American Foreign Policy.
IR 120	Globalization.
IR 132	Nationalism and Ethnic Conflict.
IR. 235	International Security.
IR 242	International Law.
IR 334	Prospects for Peace in the 21st Century.
IR 347	Nonstate Actors in a Globalizing World.
POLS 306	Public Policy Process.
POLS 329	Propaganda, Media, and American Politics.
POLS 331	Community Politics Internship.*
SSP 105	Social Origins of Terrorism.

**No more than one internship can be counted toward the minor.*

Course Descriptions

PS 180. Introduction to Peace Studies (4)
Required for students minoring in Peace Studies. Offers an overview of the field from the perspective of various disciplines in the humanities and social sciences. Among issues to be explored are the contested concepts of "peace," "war," and "violence" (overt and systemic); methods for establishing "negative" and "positive" peace; the theory and evolution of "direct action" as a means to nonviolent social change as practiced by Gandhi, King, and others; the causes of international conflict; methods for reducing, through diplomacy, the tensions that lead to war, for de-escalating hostilities and restoring peace; the validity of Just War theory and challenges to it. Since any attempt to establish peace must take into account the political and social environment in which advocates must operate, guest lectures by faculty from International Relations and other departments will be included. Bross (HU)

PS 182. Internship in Peace Studies (4)
Supervised practical work with Lehigh-Pocono Committee of Concern (LEPOCO), a volunteer peace-&-justice organization located in Bethlehem, PA, or with another peace-or- justice-focused organization. Practical work will be combined with a sequence of supervised readings in the history and theory of nonviolent methods of resolving conflict. Requirements include journal-keeping, periodic consultations with the advisor, and a final essay on the student's response to the readings and his or her practical work. Bross or Kaufmann. (HU)

Philosophy

Professors. Gordon Bearn, Ph.D. (Yale); Mark H. Bickhard, Ph.D. (Chicago), Henry R. Luce Professor in Cognitive Robotics and the Philosophy of Knowledge; Robin Dillon, Ph.D. (Pittsburgh), William Wilson Selfridge Professor of Philosophy; Steven Louis Goldman, Ph.D. (Boston), Andrew W. Mellon Distinguished Professor in the Humanities; Roslyn Weiss, Ph.D. (Columbia), chair and Clara H. Stewardson Professor of Philosophy.

Associate Professors. Michael Mendelson, Ph.D. (San Diego); Aladdin Yaqub, Ph.D. (University of Wisconsin, Madison).

Philosophy is born of discomfort. Whether it is the need to account for the tragedies of circumstance, the incongruities between our assumptions about the world and what experience and science reveal, or the shock of being exposed to hitherto unimagined conceptual alternatives, philosophy arises in those contexts in which serious questions emerge about the adequacy of our most cherished beliefs.

Philosophy is driven by the unsettling awareness that we are not beings who act exclusively on instinct but are instead able to choose from among a variety of ways of thinking about ourselves, the world in which we find ourselves, and our relations with others. Moreover, the beliefs we hold are not merely incidental facts about us like height or eye color. What we believe is often central to our moral identity, the nature of our personal relationships, the manner in which we regard ourselves and treat others, and the happiness and unhappiness that form the emotional contours of our practical lives. Philosophy is born out of our awareness that despite the centrality of our beliefs to our identity as moral beings, the truth of our beliefs can be uncertain, for on virtually any topic there is a variety of possible viewpoints, not all of which can be equally adequate.

In its attempt to ground our beliefs and justify them, philosophy becomes a reflective and critical conceptual activity concerned with foundational questions regarding our deepest assumptions and intuitions 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).

The major program in philosophy is designed to provide a broad exposure to all of these areas 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. To this end, the major program involves a combination of required and elective coursework as well as the opportunity to develop and pursue individual interests under faculty supervision. In addition to its regular course offerings, the department also sponsors a variety of activities (e.g. the annual Selfridge Lecture, the Philosophy Forum, the Faculty Seminar, the Philosophy Club, and the annual Reading Party), all of which are designed to complement the course offerings and to promote a university-wide philosophical community.

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 and rigorous conceptual and expository skills.

For additional information about the faculty, frequency of course offerings, and departmental events, please contact the department for a copy of its brochure.

The Minor Program

The minor in philosophy consists of a minimum of 16 credits, at least 4 credits of which must be at the 200-level or above. Independent studies may be taken to satisfy the minor requirements. At least two courses taken for the minor must be taught by a member of the Philosophy Department. 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.

The Major Program

The major program consists of a minimum of 38 credits in philosophy. Of these, 6 credits must come from the senior thesis sequence (Phil 390-391), and at least 12 of the remaining 32 credits from courses at the 200-level or above. Independent studies may be taken to satisfy the major requirements. Each major must also satisfy the following distribution requirements:

Ethics

1 course from PHIL. 8, 105, 116, 205, 206

Logic

1 course from PHIL. 114, 115, 303

History of Philosophy

2 courses from PHIL. 131, 132, 133, 135, 139, 231, 232, 233, 235, 237, 239

Three of the 10 courses (not including the senior thesis) must be at the 200 level or above.

Majors planning to pursue graduate study in philosophy are strongly encouraged to include the following specific courses:

PHIL 105	Ethics
PHIL 114	Symbolic Logic
PHIL 131	Ancient Philosophy
PHIL 135	Modern Philosophy

All Philosophy majors are required to fulfill their junior writing intensive requirements by taking a WI-designated philosophy course.

Senior Thesis

The Senior Thesis (PHIL 3901) is a yearlong, independent project during which philosophy majors, with the consent and under the supervision of a philosophy faculty thesis advisor, investigate a topic of special interest to them. The topic may be historical or non-historical, pure or applied, interdisciplinary or disciplinary; the only constraint is that the topic must be approved by the faculty advisor. During the fall (PHIL 390), the student's energies will be devoted to refining the topic under investigation, working through the bulk of the essential literature, and producing a paper roughly 20 pages in length. During the spring semester (PHIL 391), the student will investigate the same 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 those graduating seniors who satisfy the following two criteria:

e. at the time of graduation, their GPA in philosophy is 3.5 or higher, their overall GPA is 3.25 or higher, and

f. their senior thesis is judged by the consensus of the philosophy faculty to be well-researched, well-argued, well-organized, and well-written and to exhibit original thinking.

Undergraduate Courses

PHIL 1. The Examined Life: An Introduction to Philosophy (4)
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. (HU)

PHIL 3 (REL 3). Global Religion, Global Ethics (4)
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. Steffen (HU)

PHIL 5. Contemporary Moral Problems (4)
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. Issues addressed might include abortion, euthanasia, and physician-assisted suicide for dying patients, punishment and the death penalty, sexual orientation, world hunger and poverty, welfare, the treatment of animals, terrorism and war, racial and sexual discrimination, affirmative action, pornography and hate speech, and the relation of humans to the natural environment. Dillon (HU)

PHIL 8. (GCP 8) Ethics in Global Perspectives (4)
Economic, political, cultural, and ideological globalization presents two ethical challenges: (1) Are there universally justifiable moral standards, principles, and values that would establish universally acceptable answers to the question of how humans should live their lives? That is, can there be a global ethics? (2) What are justifiable responses to the variety of moral issues facing the peoples of the world as a result of current globalization? This course addresses the first question by examining the moral perspectives of a variety of different ethical outlooks, including Euro-American, Hindu, Buddhist, Confucian, African, and Islamic traditions. The second question is addressed by examining a number of serious moral problems arising from globalization, including the increasing

gap between the rich socalled First World nations and the poor so-called Third World nations, global environmental degradation, and war and terrorism. Dillon (HU)

PHIL 100. (POLS 100) Introduction to Political Thought (4)
Some of the most significant ancient and modern political theorists: Plato, Aristotle, Machiavelli, Hobbes, Marx, and others. Matthews (ND)

PHIL 101. (POLS 101) Ancient Political Heritage (4)
Important Political thinkers from the pre-Socratics to early, modern political theorists like Machiavelli. Matthews (SS)

PHIL 102. (POLS 102) Modern Political Heritage (4)
Begins where POLS 101 ends; from early modern theorists (e.g. Hobbes) up to contemporary thinkers (e.g. Marcuse). (SS)

PHIL 105. Ethics (4)
Examination of right and wrong, good and bad, from classic sources such as Plato, Aristotle, Hume, Kant, Mill and Nietzsche. (HU)

PHIL 114. Symbolic Logic (4)
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)

PHIL 115. (MATH 115) Topics in Philosophical Logic (4)
Topics may include the many systems of non-classical logic, truth theory, the impact of incompleteness and undecidability results on philosophy, and the foundational projects of various philosopher/mathematicians. Alternatively, the topic might be the work of an important figure in the history of philosophical logic. May be taken more than once for credit. Prerequisite: Permission of instructor. (MA)

PHIL 116. (REL 116) Bioethics (4)
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, the distribution of health care, etc. (HU)

PHIL 117. (AAS 117) Race and Philosophy (4)
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. (HU)

PHIL 121. Philosophy in Literature (4)
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. (HU)

PHIL 122. Philosophy of Law (4)
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. (HU)

PHIL 123. Aesthetics (4)
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. (HU)

PHIL 124. (REL 124) Philosophy of Religion (4)
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. (HU)

PHIL 125. Social and Political Philosophy (4)
Human beings are by nature sociable; with very few exceptions, we live together in society. Sometimes we do this well, sometimes badly. And so it is natural to ask: what kind(s) of life is good for people who live among people, and what is an (the) appropriate relationship between a person and society? Social and political philosophy seeks not to describe how humans have in fact arranged social life, but to reflect on how best to arrange our lives together. That is, it develops visions of good social life and identifies values that should shape society so that people are able to live good lives together. This course will focus on social philosophy and will address questions about the nature of a free and just society. 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, affirmative action, parenting, the death penalty, privacy, violence, world hunger, homosexuality, and abortion. (HU)

PHIL 126. (Hum 126, REL 126) Professional Ethics (4)
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; whistleblowing; safety and risk; computer ethics; weapons development; discrimination; professional review of ethical infractions. Course will include guest lectures and case studies. Steffen (HU)

PHIL 127. Existentialism (4)
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, MerleauPonty), and out the other side as a vigorous dimension of much literary, psychological, and artistic work produced in the last 50 years. (HU)

PHIL 128. Philosophy of Science (4)
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? (HU)

PHIL 129. (REL 129) Jewish Philosophy (4)
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. (HU)

PHIL 131. (CLSS 131) Ancient Philosophy (4)
Historical survey of selected texts and issues in the classical world, from the pr=eSocratics through Aristotle, with emphasis on the origins of the western philosophical traditions in ethics, metaphysics, and epistemology. (HU)

PHIL 132. (CLSS 132) Hellenistic Philosophy (4)
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 pyrrohnian scepticism, and neoplatonism. (HU)

PHIL 133. Medieval Philosophy (4)
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. (HU)

PHIL 135. Modern Philosophy (4)
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. (HU)

PHIL 137. (Hum 137, REL 137) Ethics in Practice (1-4)
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. Steffen (HU)

PHIL 139. Contemporary Philosophy (4)
Philosophical thought from the late19th 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. (HU)

PHIL 140. (ASIA 140) Eastern Philosophy (4)
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. (HU)

PHIL 141 (REL 141) Medieval Islamic Philosophy (4)
An introduction to Islamic philosophy in the medieval era, the Golden Age of Islamic civilization. The course focuses on primary sources. Readings include both expositions and critiques of philosophical doctrines and arguments, selected from the writings of several Islamic philosophers including al-Farabi, Ibn Sina (Avicenna), al-Ghazali, Ibn Tufayl, and Ibn Rushd (Averroes). (HU)

PHIL 205. Contemporary Ethics (4)
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? Prerequisite: PHIL 105 or consent of the instructor. (HU)

PHIL 206. Figures/Themes in Ethics (4)
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. Prerequisite: One HU-designated course in Philosophy. May be taken more than once for credit. (HU)

PHIL 217. Figures/Themes in Race and Philosophy (4)
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, AimE9 CE9saire, 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. Prerequisite: one HU designated course in Philosophy. May be taken more than once for credit. (HU)

PHIL 220. Theory of Knowledge (4)
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? Prerequisite: one HU designated course in Philosophy. (HU)

PHIL 221. Metaphysics (4)
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. Prerequisite: one HU designated course in Philosophy. (HU)

PHIL 223. Figures/Themes in Aesthetics (4)
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. Prerequisite: one HU designated course in Philosophy. May be taken more than once for credit. (HU)

PHIL 224. (REL 224) Topics in the Philosophy of Religion (4)
Selected problems and issues in the philosophy of religion. Content varies. Prerequisite: one HU designated course in Philosophy. May be taken more than once for credit. (HU)

PHIL 226. (WS 226) Feminism and Philosophy (4)
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. Prerequisite: At least one previous course in philosophy or women's studies. (HU)

PHIL 228. Topics in the Philosophy of Science (4)
Themes in the natural, life and social sciences. May be repeated for credit as topic varies. Prerequisite: One prior course in Philosophy or consent of instructor. (HU)

PHIL 231. (CLSS 231) Figures/Themes in Ancient Philosophy (4)
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. Prerequisite: one HU designated course in Philosophy. May be taken more than once for credit. (HU)

PHIL 232 (CLSS 232) Figures/Themes in Hellenistic Philosophy (4)
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. Prerequisite: one HU designated course in Philosophy. May be taken more than once for credit. Mendelson (HU)

PHIL 233. Figures/Themes in Medieval Philosophy (4)
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. Prerequisite: one HU designated course in Philosophy. May be taken more than once for credit. (HU)

PHIL 235. Figures/Themes in Modern Philosophy (4)
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. Prerequisite: one HU designated course in Philosophy. May be taken more than once for credit. (HU)

PHIL 237. Figures/Themes in Nineteenth Century Philosophy (4)
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. Prerequisite: one HU designated course in Philosophy. May be taken more than once for credit. (HU)

PHIL 239. Figures/Themes in Contemporary Philosophy (4)
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. Prerequisite: one HU designated course in Philosophy. May be taken more than once for credit. (HU)

PHIL 240. (ASIA 240) Figures/Themes in Eastern Philosophy (4)
This seminar course will involve indepth focus upon a major figure in Eastern thought or upon the Eastern treatment of a particular theme or set of themes. Content varies. Prerequisite: one HU designated course in Philosophy. May be taken more than once for credit. (HU)

PHIL (REL 241) Critics of Religion (4)
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. (HU)

PHIL 250. (CogS 250) Philosophy of Mind (4)
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. Prerequisite: one HU designated course in Philosophy. (HU)

PHIL 260. Philosophy of Language (4)
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. Prerequisite: one HU designated course in Philosophy. (HU)

PHIL 265. Philosophy of Mathematics (4)
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. Prerequisite: one HU designated course in Philosophy. (HU)

PHIL 273, Ariadne: Internship (2)
An internship devoted to the construction and maintenance of Ariadne, an online, web-based, undergraduate journal of philosophy. Responsibilities will include research; publicizing the project nationally and locally; reviewing, selecting, and formatting manuscripts for publication; and various other

administrative and editorial activities. Some students may also be involved in the initial states of constructing Dionysos, an externally refereed, online, web-based professional journal of the history of philosophy. Prerequisite: Department permission required: previous coursework in philosophy expected. May be taken more than once for credit. (ND)

PHIL 290. Independent Study (1-4)
Individual philosophical investigation of an author, book, or topic designed in collaboration with a faculty sponsor. Tutorial meetings; substantial written work. May be repeated more than once for credit. Consent of faculty sponsor required. (ND)

PHIL 303. (MATH 303) Mathematical Logic (3-4)
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. Prerequisite: Permission of the instructor. (MA)

PHIL 304. (MATH 304) Axiomatic Set Theory (3-4)
A development of set theory from axioms; relations and functions; ordinal and cardinal arithmetic; recursion the orem; axiom of choice; independence questions. Prerequisite: MATH 301 or consent of the department chair. (MA)

PHIL 329 (MATH 329) Computability Theory (34)
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, Turning degrees, or degrees of uncomputability), computable operators and their fixed points. (MA)

PHIL 347. (REL 347 and AMST 347) American Religious Thinkers (4)
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. Prerequisite: one HU designated course in Philosophy. Raposa (HU)

PHIL 364. (POLS 364) Issues in Contemporary Political Philosophy (4)
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 taken for credit with consent of the political science chair. (SS)

PHIL 367. (POLS 367) American Political Thought (4)
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. (SS)

PHIL 371. Advanced Independent Study (1-4)
Individual philosophical investigation of an author, book, or topic designed in collaboration with a faculty sponsor. Tutorial meetings; substantial written work. May be repeated more than once for credit. Consent of faculty sponsor required. (ND)

PHIL 373. (Hum 373, REL 373) Independent Ethics Project (4)
Supervised ethics research into a topic approved by the advisor for the Humanities Minor in Ethics. An option for completing the ethics minor. For ethics minors only. (HU)

PHIL 390. Senior Thesis (2)
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. (ND)

PHIL 391. Senior Thesis (4)
Continuation and completion of PHIL 390 under the guidance of the thesis advisor. Prerequisites: PHIL 390; permission of the thesis advisor required. (ND)

Physics

Professors. Volkmar Dierolf, Ph.D. (Utah), chairperson; Gary G. DeLeo, Ph.D. (Connecticut), associate chairperson; Ivan Biaggio, Ph.D. (ETH Zurich); James D. Gunton, Ph.D. (Stanford); A. Peet Hickman, Ph.D. (Rice); John P. Huennekens, Ph.D. (Colorado); Alvin S. Kanofsky, Ph.D. (Pennsylvania); Thomas L. Koch, Ph.D. (Cal. Tech.), director, Center for Optical Technologies; Yong W. Kim, Ph.D. (Michigan); Arnold H. Kritz, Ph.D. (Yale); George E. McCluskey, Jr., Ph.D. (Pennsylvania); H. Daniel Ou-Yang, Ph.D. (U.C.L.A.); Jeffrey M. Rickman, Ph.D. (Carnegie-Mellon); Michael Stavola, Ph.D. (Rochester), associate dean, College of Arts and Sciences; Jean Toulouse, Ph.D. (Columbia).

Associate professors. Jerome C. Licini, Ph.D. (M.I.T.); Slava V. Rotkin, Ph.D. (Ioffe Inst.-St. Petersburg).

Assistant professor. M. Virginia McSwain, Ph.D. (Georgia State); Dimitrios Vavylonis, Ph.D. (Columbia).

Emeritus Professors. Robert T. Folk, Ph.D. (Lehigh); W. Beall Fowler, Ph.D. (Rochester); Shelden H. Radin, Ph.D., (Yale); Russell A. Shaffer, Ph.D. (Johns Hopkins).

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.

College of Arts and Sciences

Bachelor of Arts Program Requirements:

PHY (10 or 11), (13 or 21), 12, 22, 31

MATH 21, 22, 23, 205

CHM 30

At least one of the two advanced physics laboratories (PHY 190, PHY 262).

At least 18 credits of advanced physics courses must be selected from the following list: PHY 301, 212, 213, 215, 332, 340, 342, 348, 352, 355, 362, 363, 364, 365, 369, 380.

A total of 120 credits are required for the BA in Physics

Bachelor of Science Program Requirements:

PHY (10 or 11), 21, 12, 22, 31

MATH 21, 22, 23, 205, 322

CHM 30

ENGR 1 or an equivalent course in scientific computing

PHY 190, 262

PHY 212, 213, 215, 362, 364, 340

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, 369, (352 or 355), and (348 or 365) and 380. Students planning graduate work in physics are advised to include PHY 273 and 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		**Bachelor of Science**	
Fall	**Spring**	**Fall**	**Spring**
Freshman Year			
ENGL 1 (3)	ENGL 2 (3)	ENGL 1 (3)	ENGL 2 (3)
PHY 10 or 11 (4)	CHM 30 (4)	PHY10 or 11 (4)	CHM 30 (4)
PHY 12 (1)		PHY 12 (1)	
MATH 21 (4)	MATH 22 (4)	MATH 21 (4)	MATH 22 (4)
Col. Sem.	Dist. Req. (4)	Col.Sem	*ENGR 1 (3)
Sophomore Year			
PHY 13 or 21 (3-4)	PHY 31 (3)	PHY 21 (4)	PHY 31 (3)
PHY 22 (1)	PHY 190 or elective (3)	PHY 22 (1)	PHY 190 (3)
MATH 23 (4)	MATH 205 (3)	MATH 23 (4)	MATH 205 (3)
Dist. Req. (8)	Dist. Req. (4)	Dist. Req. (8)	Dist. Req. (4)
			Appr.Elec. (4)
Junior Year			
Adv. PHY. (6)	Adv.PHY. (6)	PHY 212 (3)	PHY 213 (3)
	PHY 262 or elective (2-3)	PHY 362(3)	PHY 262 (2)
	Jr. Writing (3)	MATH 322 (3)	PHY 364 (3)
		Jr. Writing (3)	PHY 215 (4)
Senior Year			
Adv. PHY. (6)		PHY 340 (3)	Appr. Elec. (6)
		Appr. Elec (8)	Dist.Req. (4)

**or an equivalent course in scientific computing*

P.C. Rossin College of Engineering & Applied Sciences

The tables below indicate both course requirements and recommended enrollment sequences.

Bachelor of Engineering Physics

with a concentration in

Solid State Electronics		Optical Sciences	
Freshman Year			
Fall	**Spring**	**Fall**	**Spring**
ENGL 1 (3)	ENGL 2 (3)	ENGL 1 (3)	ENGL 2 (3)
PHY 11 (4)	CHM 30 (4)	PHY 11 (4)	CHM 30 (4)
PHY 12 (1)	ENGR 5 (3)	PHY 12 (1)	ENGR 5 (3)
MATH 21 (4)	MATH 22 (4)	MATH 21 (4)	MATH 22 (4)
ENGR 1 (3)		ENGR 1 (3)	
[15]	[14]	[15]	[14]
Sophomore Year			
PHY 21 (4)	PHY 31 (3)	PHY 21 (4)	PHY 31 (3)
PHY 22 (1)	PHY 190 (3)	PHY 22 (1)	PHY 190 (3)
MATH 23 (4)	MATH 205 (3)	MATH 23 (4)	MATH 205 (3)
ECO 1 (4)	MATH 208 (3)	ECO 1 (4)	MATH 208 (3)
ECE 81 (4)	ECE 123 (3)	ECE 81 (4)	HSS (4)
[17]	[15]	[17]	[16]
Junior Year			
PHY 212 (3)	PHY 213 (3)	PHY 212 (3)	PHY 213 (3)
ECE 33 (4)	PHY 262 (2)	PHY 362 (3)	PHY 262 (2)
ECE 108 (4)	PHY 215 (4)	OE -Elec (3)	PHY 215 (4)
MATH 322 (3)	ECE 126 (3)	ECE 108 (4)	OE -Elec (3)
HSS (4)	HSS (3)	MATH 322 (3)	HSS (3)
	Elective (3)		Elective (3)
[18]	[18]	[16]	[18]
Senior Year			
PHY 340 or (3) ME 104	HSS (6)	PHY 340 or (3) ME 104	PHY 355 (3)
PHY 363 (3)	SSE -Elec* (8)	PHY 352 (3)	Electives (3)
PHY 362 (3)	Electives (4)	OE -Elec (6)	OE -Elec (6)
SSE -Elec (3)		Electives (5)	HSS (6)
Elective (4)			
[16]	[18] [131]	[17]	[18] [131]

**The 11 credit hours of SSE (Solid State Engineering) electives must include ECE 257 or 258 or PHY 273.*

***The 18 credit hours of OE (Optical Engineering) electives must include ECE 257 or 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 SSE or 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)**		Elec. Engr-Physics **(Electrical Engineering First)**	
Fall	**Spring**	**Fall**	**Spring**
Freshman Year			
ENGL 1 (3)	ENGL 2 (3)	ENGL 1 (3)	ENGL 2 (3)
PHY 11 (4)	CHM 30 (4)	PHY 11 (4)	CHM 30 (4)
PHY 12 (1)	ENGR 5 (3)	PHY 12 (1)	ENGR 5 (3)
MATH 21 (4)	MATH 22 (4)	MATH 21 (4)	MATH 22 (4)
ENGR 1 (3)		ENGR 1 (3)	
[15]	[14]	[15]	[14]
Sophomore Year			
PHY 21 (4)	PHY 31 (3)	PHY 21 (4)	PHY 31 (3)
PHY 22 (1)	ECO 1 (4)	PHY 22 (1)	ECE 121 (2)
MATH 23 (4)	MATH 205 (3)	MATH 23 (4)	MATH 205 (3)

ECE 33 (4)	MATH 208 (3)	ECE 33 (4)	HSS (6)
ECE 81 (4)	ECE 182 (1)	ECE 81 (4)	ECE 182 (1)
	HSS (4)		ECE 123 (3)
[17]	[18]	[17]	[18]
Junior Year			
PHY 212 (3)	PHY 213 (3)	PHY 212 (3)	PHY 213 (3)
PHY 362 (3)	PHY 262 (2)	ECE 126 (3)	
ECE 108 (4)	PHY 364 (3)	ECE 108 (4)	ECE 138 (2)
MATH 322 (3)	PHY 215 (4)	MATH 208 (3)	ECE 136 (3)
Jr. Writing (3)	ECE 121 (2)	MATH 231 (3)	ECE 125 (3)
	ECE 123 (3)	Jr. Writing (3)	ECO 1 (4)
[16]	[17]	[16]	[18]
Senior Year			
PHY 340 (3)	Dist. Req. (4)	PHY 362 (3)	PHY 364 (3)
PHY Appr. (6)	PHY Appr. (5)	ECE Appr. (3)	ECE Appr. (6)
Elective	Elective	Elective	Elective
	ECE 126 (3)	ECE 257 (3)	PHY 215 (4)
	ECE 138 (2)	Elective (4)	HSS (2)
HSS (6)	ECE 125 (3)	HSS (4)	ECE 258 (2)
Elective (3)			
[18]	[17]	[17]	[17]
Fifth Year			
ECE 257 (2)	ECE 136 (3)	PHY 340 (3)	PHY 262 (2)
ECE Appr (3)	ECE Appr (9)	PHY Appr (6)	PHY Appr (5)
Elective	Elective	Elective	Elective
Electives (5)	Elective. (3)	MATH 322 (3)	Electives (3)
MATH 231 (3)		Electives (3)	HSS (3)
HSS (3)			Dist. Req (3)
[16]	[15]	[15]	[16]
S	[163]		[163]

Physics approved electives: three courses selected from PHY 363, 364, 369, (352 or 355), and (348 or 365) and 380.

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 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 Physics 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: Physics (332 or 342 or 350)348, 363, (352 or 355), 369, 380, 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 Physics 5 and 7. 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.

Undergraduate Courses in Physics andAstronomy

PHY 5. Concepts in Physics (4) spring
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. No prerequisites. Staff (NS)

PHY 7. (ASTR 7) Introduction to Astronomy (3) fall
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. (NS)

PHY 8. (ASTR 8) Introduction to Astronomy Laboratory (1) fall
Laboratory to accompany PHY 7 (ASTR 7). (NS)

PHY 9. Introductory Physics I Completion (1-2)
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. Prerequisite: MATH 21, 31, or 51 previously or concurrently; and consent of the department. (NS)

PHY 10. General Physics I (4) fall
Statics, dynamics, conservation laws, thermodynamics, kinetic theory of gases, fluids. Primarily for architecture, biological science, earth and environmental science students. Prerequisite: MATH 21, 31, or 51, previously or concurrently. Dierolf (NS)

PHY 11. Introductory Physics I (4)
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. Prerequisite: MATH 21, 31 or 51, previously or concurrently. Licini (NS)

PHY 12. Introductory Physics Laboratory I (1)
A laboratory course taken concurrently with PHY 11. Experiments in mechanics, heat, and DC electrical circuits. One three-hour laboratory period per week. Prerequisite: PHY 10 or 11, preferably concurrently. Kanofsky (NS)

PHY 13. General Physics II (3) spring
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 10 or 11 and MATH 21, 31, or 51. Vavylonis (NS)

PHY 19. Introductory Physics II Completion (1-2)
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. Prerequisite: 4 credits of PHY 10 or 11, MATH 23, 32, or 52 previously or concurrently; and consent of the department. (NS)

PHY 21. Introductory Physics II (4)
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. Prerequisite: PHY 11; MATH 23, 32, or 52, previously or concurrently. Hickman/Ou-Yang (NS)

PHY 22. Introductory Physics Laboratory II (1)
A laboratory course to be taken concurrently with PHY21. One three-hour laboratory period per week. Prerequisite: PHY 12; PHY 21, preferably concurrently. Licini (NS).

PHY 31. Introduction to Quantum Mechanics (3) spring
Experimental basis and historical development of quantum mechanics; the Schroedinger equation; one-dimensional problems; angular momentum and the hydrogen atom; many-electron systems; spectra; selected applications. Three lectures per week. Prerequisite: PHY 13 or 21; MATH 205, previously or concurrently. Hickman (NS)

PHY 91. Measurement and Transducers (1)
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 21 and 22 or their equivalent or consent of chairperson. Kim (NS)

PHY 105. (ASTR 105, EES 105) Planetary Astronomy (4) fall
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. McCluskey (NS)

PHY 110 (ASTR 110) Methods of Observational Astronomy (1)
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. McCluskey (NS)

PHY 190. Electronics (3) spring
DC and AC circuits, diodes, transistors, operational amplifiers, oscillators, and digital circuitry. Two laboratories and one recitation per week. Prerequisites: PHY 21 and 22, or PHY 13 and 22. Stavola (NS)
For Advanced Undergraduates And Graduate Students

PHY 212. Electricity and Magnetism I (3) fall
Electrostatics, magnetostatics, and electromagnetic induction. Prerequisites: PHY 21 or 13; MATH 205, previously or concurrently. Rotkin (NS)

PHY 213. Electricity and Magnetism II (3) spring
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. Prerequisite: PHY 212. Toulouse (NS)

PHY 215. Classical Mechanics I (4) spring
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 21 or 13 and MATH 205, previously or concurrently. DeLeo (NS)

PHY 262. Advanced Physics Laboratory (2) spring
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 21 and 22 or PHY 13 and 14. Staff (NS)

PHY 272. Special Topics in Physics (1-4)
Selected topics not sufficiently covered in other courses. May be repeated for credit. (NS)

PHY 273. Research (2-3)
Participation in current research projects being carried out within the department. Intended for seniors majoring in the field. May be repeated for credit. (NS)

PHY 281. Basic Physics I (3)
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. (NS)

PHY 282. Basic Physics II (3)
Continuation of PHY 281. (NS)

PHY 301. (ASTR 301) Modern Astrophysics I (4) fall
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 10 and 13, or PHY 11 and 21, MATH 22 or 52. McSwain (NS)

PHY 302. (ASTR 302) Modern Astrophysics II (4) spring
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 10 and 13, or PHY 11 and 21, MATH 22 or 52. McCluskey (NS)

PHY 321 (BioE 321) Biomolecular & Cellular Mechanics (3)
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, Math 231, and PHY 13/22 or 21/22, or permission of the instructor. (NS)

PHY 331 (BioE 331) Integrated Bioelectronics/Biophotonics Laboratory (2) spring
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 13/22 or PHY 21/22 and ECE 81 or PHY 190, or permission of instructor. (NS)

PHY 332. (ASTR 332) High-Energy Astrophysics (3) spring, odd numbered years.
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. Prerequisites: MATH 23 or 33, previously or concurrently, and PHY 21. McCluskey (NS)

PHY 340. Thermal Physics (3) fall
Basic principles of thermodynamics, kinetic theory, and statistical mechanics, with emphasis on applications to classical and quantum mechanical physical systems. Prerequisites: PHY 13 or 21, and MATH 23, 32 or 52. Kim (NS)

PHY 342. (ASTR 342) Relativity and Cosmology (3) spring, even numbered years.
Special and general relativity. Schwarzschild and Kerr black holes. Super massive stars. Relativistic theories of the origin and evolution of the universe. Prerequisites: MATH 23 or 33, previously or concurrently, and PHY21. McCluskey (NS)

PHY 348. Plasma Physics (3)
Single particle behavior in electric and magnetic fields, plasmas as fluids, waves in plasmas, transport properties, kinetic theory of plasmas, controlled thermonuclear fusion devices. Prerequisites: PHY 21, MATH 205, and senior standing or consent of the chairman of the department. Kritz (NS)

PHY 352. Modern Optics (3)
Paraxial optics, wave and vectorial theory of light, coherence and interference, diffraction, crystal optics, and lasers. Prerequisites: MATH 205, and PHY 212 or ECE202. Toulouse (NS)

PHY 355. Lasers and Nonlinear Optics (3)
Basic principles and selected applications of lasers and non-linear optics. Topics include electromagnetic theory of optical beams, optical resonators, laser oscillation, non-linear interaction of radiation with atomic systems, electro- and acousto-optics, optical noise, optical waveguides, and laser devices. Prerequisites: PHY 31; PHY 213 or ECE 203, previously or concurrently. Biaggio (NS)

PHY 362. Atomic and Molecular Structure (3) fall
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. Prerequisite: PHY 31 or CHM 341. Biaggio. (NS)

PHY 363. Physics of Solids (3) fall
Introduction to the theory of solids with particular reference to the physics of metals and semiconductors. Prerequisite: PHY 31 or Mat 316 or CHM 341, and PHY 340 or equivalent, previously or concurrently. Stavola (NS)

PHY 364. Nuclear and Elementary Particle Physics (3) spring
Models, properties, and classification of nuclei and elementary particles; nuclear and elementary particle reactions and decays; radiation and particle detectors; accelerators; applications. Prerequisites: PHY 31 and MATH 205. Kanofsky (NS)

PHY 365. Physics of Fluids (3) spring
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 or equivalent, previously or concurrently. Kim (NS)

PHY 369. Quantum Mechanics I (3) spring
Principles of quantum mechanics: Schroedinger, Heisenberg, and Dirac formulations. Applications to simple problems. Prerequisites: PHY 31, MATH 205; PHY 215, previously or concurrently. Rotkin (NS)

PHY 372. Special Topics in Physics (1-4)
Selected topics not sufficiently covered in other courses. May be repeated for credit. (NS)

PHY 380. Introduction to Computational Physics (3) spring
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. Prerequisite: MATH 205 previously or concurrently. Kritz (NS)

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.

Graduate Courses in Physics

PHY 411. Survey of Nuclear and Elementary Particle Physics (3)
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. Prerequisite: PHY 369. Staff

PHY 420. Mechanics (3) fall
Includes the variational methods of classical mechanics, methods of Hamilton and Lagrange, canonical transformations, Hamilton-Jacobi Theory. Vavylonis

PHY 421. Electricity & Magnetism I (3) spring
Electrostatics, magnetostatics, Maxwell's equations, dynamics of charged particles, multipole fields. McSwain

PHY 422. Electricity & Magnetism II (3) fall
Electrodynamics, electromagnetic radiation, physical optics, electrodynamics in anisotropic media. Special theory of relativity. Prerequisite: PHY 421. Huennekens

PHY 424. Quantum Mechanics II (3) fall
General principles of quantum theory; approximation methods; spectra; symmetry laws; theory of scattering. Prerequisite: PHY 369 or equivalent. DeLeo

PHY 425. Quantum Mechanics III (3)
A continuation of Phys 424. Relativistic quantum theory of the electron; theory of radiation. Staff

PHY 428. Methods of Mathematical Physics I (3) fall
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. Gunton

PHY 429. Methods of Mathematical Physics II (3) spring
Continuation of Physics 428 to include the use of integral equations. Green's functions, group theory, and more on numerical methods. Prerequisite: PHY 428. Staff

PHY 431. Theory of Solids (3)
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. Rickman

PHY 442. Statistical Mechanics (3) spring
General principles of statistical mechanics with application to thermodynamics and the equilibrium properties of matter. Prerequisites: PHY 340 and 369. Kim

PHY 443. Nonequilibrium Statistical Mechanics (3)
A continuation of PHY 442. Applications of kinetic theory and statistical mechanics to nonequilibrium processes; nonequilibrium thermodynamics. Prerequisite: PHY442. Staff

PHY 446. Atomic and Molecular Physics (3)
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. Prerequisite: PHY 424 or consent of the department. Huennekens

PHY 455. Physics of Nonlinear Phenomena (3)
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. Prerequisite: graduate standing in science or engineering, or consent of the chairman of the department. Staff

PHY 462. Theories of Elementary Particle Interactions (3)
Relativistic quantum theory with applications to the strong, electromagnetic and weak interactions of elementary particles. Prerequisite: PHY 425. Staff

PHY 467. Nuclear Theory (3)
Theory of low-energy nuclear phenomena within the framework of non-relativistic quantum mechanics. Staff

PHY 471. (MECH 411) Continuum Mechanics (3)
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. Staff

PHY 472. Special Topics in Physics (1-4)
Selected topics not sufficiently covered in other courses. May be repeated for credit.

PHY 474. Seminar in Modern Physics (3)
Discussion of important advances in experimental physics. May be repeated for credit when a different topic is offered.

PHY 475. Seminar in Modern Physics (3)
Discussion of important advances in theoretical physics. May be repeated for credit when a different topic is offered.

PHY 482. Applied Optics (3)
Review of ray and wave optics with extension to inhomogenous 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. Prerequisite: PHY 352 or equivalent. Toulouse

PHY 491. Research (3)
Research problems in experimental or theoretical physics.

PHY 492. Research (3)
Continuation of PHY 491. May be repeated for credit.

Political Science

Professors. Richard K. Matthews, Ph.D. (Toronto), NEH Distinguished University Professor, Chairperson; Edward P. Morgan, Ph.D. (Brandeis), Distinguished University Professor; Laura Katz Olson, Ph.D. (Colorado).

Associate professors. Frank L. Davis, Ph.D. (North Carolina); Vera Fennell, Ph.D. (Chicago); Janet M. Laible, Ph.D. (Yale); Brian K. Pinaire, Ph.D. (Rutgers); Albert H. Wurth Jr., Ph.D. (North Carolina).

Assistant professors. Breena Holland, Ph.D. (Chicago); Nandini Deo, Ph.D. (Yale); Holona Ochs, Ph.D. (Kansas).

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.

The three core courses are required. Individual exceptions may be made, for good reasons, by the major adviser with the approval of the department chairman.

Major Requirements

POLS 1	American Political System (4)
POLS 3	Comparative Politics (4)
POLS 100	Introduction to Political Thought (4) or
POLS 101	Ancient Political Heritage (4) or
POLS 102	Modern Political Heritage (4)

Electives

Six elective courses with at least one course from each of the two fields listed below. One of the electives may, with the consent of the department, be in a cognate field.

American Politics, Public Law and Interdisciplinary

POLS 103	Intro to Public Administration (4)
POLS 104	Political Sociology (4)
POLS 107	The Politics of the Environment (4)
POLS 108	(Global) Citizenship and Its Discontents (4)
POLS 115	Technology As Politics (4)
POLS 179	Politics of Women (4)
POLS 230	Social Movements and Legacies of the 1960s (4)
POLS 232	The Vietnam War in Politics, Media, and Memory (4)
POLS 240	Law and Order (4)
POLS 274	Political Parties and Elections (4)
POLS 282	First Ladies and the Changing Role of Women (4)
POLS 302	Comparative State Politics (4)
POLS 306	Public Policy Process (4)
POLS 307	The Politics of Mental Health Policy (4)
POLS 309	Nonprofit Administration (4)
POLS 310	Social Entrepreneurship: How to Change the World (4)
POLS 317	The American Presidency (4)

POLS 326	Organizing for Democracy (4)
POLS 328	U.S. Politics and the Environment (4)
POLS 329	Propaganda, Media, and American Politics (4)
POLS 331	Community Politics Internship (4)
POLS 333	Social Psychology of Politics (4)
POLS 348	Land Use, Growth Management, and the Politics of Sprawl (4)
POLS 351	Constitutional Law and Politics (4)
POLS 352	Civil Rights and Civil Liberties (4)
POLS 354	U.S. Health Care Policies (4)
POLS 358	Interest Groups, Factions, and Coalitions in Politics (4)
POLS 359	U.S. Congress (4)
POLS 360	Public Administration (4)
POLS 368	Political Economy (4)
POLS 373	Globalization and Social Policy (4)
POLS 375	Seminar: Green Polity (4)
POLS 376	Seminar: National Social Policy (4)
POLS 378	Honors Thesis in Political Science (4)
POLS 379	Honors Thesis in Political Science (4)

Political Theory and Comparative Politics

POLS 100	Introduction to Political Thought (4)
POLS 101	Ancient Political Heritage (4)
POLS 102	Modern Political Heritage (4)
POLS 105	Environmental Policy and Planning (4)
POLS 106	Environmental Values and Ethics (4)
POLS 125	International Political Economy (4)
POLS 201	Democracy and Dictatorship in South Asia (4)
POLS 301	Current Political Controversies (4)
POLS 321	Research in Political Science (4)
POLS 323	Politics of the European Union (4)
POLS 324	Politics of Western Europe (4)
POLS 325	Nationalism in Comparative Perspective (4)
POLS 335	Latin American Political Systems (4)
POLS 336	U.S. Foreign Policy and Latin America (4)
POLS 337	Religion and Politics in Latin America (4)
POLS 338	Markets, Justice, and Law (4)
POLS 339	The Rise of the State in Modern East Asia (4)
POLS 342	Gender and Third World Development (4)
POLS 343	Global Politics of Race: Asia and Africa (4)
POLS 350	Religion and Politics in Comparative Perspective (4)
POLS 355	Environmental Justice and the Law (4)
POLS 356	Seminar: Political Philosophy (4)
POLS 357	Politics of Authenticity (4)
POLS 364	Issues in Contemporary Political Philosophy (4)
POLS 367	American Political Thought (4)
POLS 370	Seminar: The Citizen versus the Administrative State (4)

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 1, 3 or 100) AND any two other POLS courses (either "core" or elective options).

Public Administration Minor

The minor consists of POLS 360 plus three other courses chosen in consultation with the adviser for a minimum of sixteen credits.

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.

Undergraduate Courses

POLS 1. American Political System (4) fall-spring
Constitutional principles; organization and operation of the national government; and dynamics of power within the U.S. political system. (SS)

POLS 3. (GS 3) Comparative Politics (4) fall-spring
The political systems of foreign countries; approaches to the study of comparative politics. (SS)

POLS 100. (GS 100, PHIL 100) Introduction to Political Thought (4)
A critical examination of political ideologies: Liberalism, Marxism, Fascism, and Islamism. Matthews (ND)

POLS 101. (PHIL 100) Ancient Political Heritage (4)
Important political thinkers from the pre-Socratics to early, modern political theorists like Machiavelli. Matthews (SS)

POLS 102. (PHIL 102) Modern Political Heritage (4)
Begins where POLS 101 ends: from early, modern theorists (e.g., Hobbes) up to contemporary thinkers (e.g., Marcuse). Matthews (SS)

POLS 103. Introduction to Public Administration (4)
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. Ochs (SS)

POLS 104. (SSP 104). Political Sociology (4)
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. Munson (SS)

POLS 105. (ES 105) Environmental Policy and Planning (4)
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. Holland (SS)

POLS 106. (ES 106) Environmental Values and Ethics (4)
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. Holland (SS)

POLS 107. (ES 107) The Politics of the Environment (4)
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. Wurth (SS)

POLS 108 (Global) Citizenship and its Discontents (4)
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 Manefesto of the Unabomber. Pinaire (SS/GC)

POLS 115. Technology as Politics (4)
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. Wurth (ND)

POLS 125. (GS 125, IR 125) International Political Economy (4)
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: Economics 1 or 11 or 12; IR 10. Moon, Barkey (SS)

POLS 179. (WS 179) Politics of Women (4)
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. Olson (SS)

POLS 201. (ASIA 201, GS 201) Democracy and Dictatorship in South Asia (4)
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. Deo (SS)

POLS 230. (AAS 230) Social Movements and Legacies of the 1960s (4)
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. Morgan (SS)

POLS 232. The Vietnam War in Politics, Media, and Memory (4)
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. Morgan (SS)

POLS 240. Law and Order. The Politics of Crime and Punishment (4)
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. Pinaire. (ND)

POLS 274. Political Parties and Elections (4)
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. (SS)

POLS 282. First Ladies and the Changing Role of Women (4)
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. Olson (SS)

For Advanced Undergraduates and Graduate Students

POLS 301. Current Political Controversies (4)
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. Olson (SS)

POLS 302. Comparative State Politics (4)
Analysis of major questions relating to the role of the states in the American federal system and their relationship with the national government. (SS)

POLS 306. Public Policy Process (4)
Power relations and their impacts on selected public policy issues, specifically taxation, housing, environment, poverty, energy, the military, and health. Olson (SS)

POLS 307. The Politics of Mental Health Policy (4)
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. Ochs (SS)

POLS 309. (ENTP 309) Nonprofit Administration (4)
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. Ochs (SS)

POLS 310. (ENTP 310) Social Entrepreneurship: How to Change the World (4)
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. Prerequisite: Eco 1 and at least junior standing, or permission of the minor director. Ochs (SS)

POLS 317. The American Presidency (4)
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. Prerequisite: POLS 1. Olson (SS)

POLS 321. Research in Political Science (4)
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. Prerequisite: Consent of the instructor. Davis (ND)

POLS 323. Politics of the European Union (4)
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. Prerequisite: POLS 3 or IR 10. Laible (SS)

POLS 324. Politics of Western Europe (4)
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. Prerequisite: POLS 3. Laible

POLS 325. (GS 325) Nationalism in Comparative Perspective (4)
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. Prerequisite: POLS 3. Laible

POLS 326. Organizing for Democracy (4)
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. Prerequisite: consent of instructor. Morgan (ND)

POLS 328. (ES 328) U.S. Politics and the Environment (4)
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. Wurth (SS)

POLS 329. Propaganda, Media, and American Politics (4)
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. Morgan (SS)

POLS 331. Community Politics Internship (4)
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. Prerequisite: consent of instructor. Olson (ND)

POLS 333. (PSYC 333, SSP 333) Social Psychology of Politics (4)
Political behavior viewed from a psychological and social psychological perspective. (SS)

POLS 335. Latin American Political Systems (4)
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. Prerequisite: POLS 3. (ND)

POLS 336. U.S. Foreign Policy and Latin America (4)
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. Prerequisite: POLS 3. (ND)

POLS 337. Religion and Politics in Latin America (4)
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. Prerequisite: POLS 3 and 336. (ND)

POLS 338. Markets, Justice, and Law (4)
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. Holland (SS)

POLS 339. (ASIA 339, GS 339) The Rise of the State in Modern East Asia (4)
An examination of the role of Asian nationalism in the construction of the modern state form in Asia. Fennell (SS)

POLS 342. (WS 342, GS 342) Gender and Third World Development (4)
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. Prerequisite: POLS 1 or WS 1. (SS)

POLS 343. (AAS 343, ASIA 343, GS 343) Global Politics of Race: Asia and Africa (4)
An examination of the concept of "race" and its impact on domestic and international politics. Fennell (SS)

POLS 348. Land Use, Growth Management, and the Politics of Sprawl (4)
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. Freeman (SS)

POLS 350. (Rel 350) Religion and Politics in Comparative Perspective (4)
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. Deo (SS)

POLS 351. Constitutional Law and Politics (4)
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 not a prerequisite but is strongly recommended. Pinaire (ND)

POLS 352. Civil Rights and Civil Liberties (4)
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. Prerequisite: POLS 351. Pinaire (ND)

POLS 354 (HMS 354). U.S. Health Care Policies (4)
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. Olson (SS)

POLS 355 (ES 355) Environmental Justice and the Law (4)
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. Prerequisite: PolS 105 or ES 105. Holland (SS)

POLS 356. Seminar: Political Philosophy (4)
Critical examination of several of the "great books" and/or "great ideas" in political thought. Students will help select the material for critical discussion. Course may be repeated with permission of the instructor. Matthews (SS)

POLS 357. Politics of Authenticity (4)
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. Matthews (SS)

POLS 358. Interest Groups, Factions, and Coalitions in American Politics (4)
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. Davis (SS)

POLS 359. U.S. Congress (4)
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. Prerequisite: POLS 1. Davis (SS)

POLS 360. Public Administration (4)
The nature of administration; problems of organization and management; public personnel policies; budgeting and budgetary system; forms of administrative responsibility. (ND)

POLS 364. (PHIL 364) Issues in Contemporary Political Philosophy (4)
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. Matthews (SS)

POLS 367. (PHIL 367) American Political Thought (4)
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. Matthews (SS)

POLS 368. Political Economy (4)
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). Wurth (SS)

POLS 370. Seminar: The Citizen versus the Administrative State (4)
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. (SS)

POLS 373. Globalization and Social Policy (4)
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. Ochs (SS)

POLS 375. Seminar: Green Polity (4)
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. Wurth (SS)

POLS 376. Seminar: National Social Policy (4)
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. Olson (SS)

POLS 378. Honors Thesis in Political Science (4)
Opportunity for undergraduate majors in Political Science to pursue an extended project for senior honors. Department permission required. (ND)

POLS 379. Honors Thesis in Political Science (4)
Continuation of POLS 378. Prerequisite: POLS 378. Department permission required. (ND)

POLS 381, 382, 383, 384. Special Topics (1-4)
A seminar on a topic of special interest in a particular political institution, process, or policy. Prerequisite: consent of the department chairperson. (ND)

For Graduate Students the department of political science offers a graduate program leading to the Master of Arts degree. The applicant for admission is required to demonstrate adequate undergraduate preparation. Those seeking full time graduate studies must submit Graduate Record Examination results.

Master of arts in Politics and Policy

Political Science
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.

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.

Graduate Courses

POLS 401. Introduction to Politics and Policy (3)
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. Staff

POLS 402. Methods of Policy Analysis (3)
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. Staff

POLS 403. Creativity, Ideas, and Methods in Political Science (3)
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. Laible

POLS 404. Environmental Valuation: Policy Design/Legal Analysis (3)
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. Holland

POLS 406. Globalization and Social Well-Being (3)
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. Ochs

POLS 407. The Politics of Mental Health Policy (3)
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. Ochs

POLS 408. American Politics Core (3)
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. Davis

POLS 409. Nonprofit Administration (3)
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. Ochs

POLS 413. Modern Political Philosophy (3)
A study of selected modern political philosophers and their continuing effect on politics and political philosophy. Matthews

POLS 415. State and Local Government (3)
Comparative state government, urban politics, intergovernmental relations, regional and local government.

POLS 416. American Environmental Policy (3)
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. Wurth

POLS 421. Research Methods (3)
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. Davis

POLS 423. Politics of the European Union (3)
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. Laible

POLS 425. Nationalism in Comparative Perspective (3)
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. Laible

POLS 426. Organizing for Democracy (3)
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. Prerequisite: consent of instructor. Morgan

POLS 427. American Democracy: Decline or Revival? (3)
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. Morgan

POLS 428. Media & Democracy (3)
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. Morgan

POLS 429. Propaganda, Media & American Politics (3)
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. Morgan

POLS 430. Social Movements & Legacies of 1960s (3)
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. Morgan

POLS 431. Public Management (3)
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)
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. Olson

POLS 435. Power, Persuasion and the American Presidency (3)
Examination of selected modern presidents, from FDR to the current occupant of the White House, and their effectiveness as communicators and policy makers. Olson

POLS 438. Markets, Justice, and Law (3)
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. Holland

POLS 439. The Rise of the State in Modern East Asia (3)
An examination of the role of Asian nationalism in the construction of the modern state form in Asia. Fennell

POLS 443. Global Politics of Race: Asia and Africa (3)
An examination of the concept of "race" and its impact on domestic and international politics. Fennell

POLS 448. (HIST 448) Land Use, Growth Management, and the Politics of Sprawl (3)
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. Freeman

POLS 450. Religion and Politics in Comparative Perspective (3)
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. Deo

POLS 451. Comparative Politics Core (3)
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. Staff

POLS 453. Seminar: Media, Propaganda and Democracy (3)
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. Morgan

POLS 454. The State in Asia (3)
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. Fennell

POLS 455 (ES 455) Environmental Justice and the Law (3)
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. Holland

POLS 456. Seminar: Political Philosophy (3)
Critical examination of several of the "great books" and/or "great ideas" in political thought. Matthews

POLS 457. Politics of Authenticity (3)
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. Matthews

POLS 462. Seminar: American Political Thought (3)
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. Matthews

POLS 464. Community Fellowship I (3) Fall
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) Spring
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)
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. Pinaire

POLS 468. Political Economy (3)
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. Wurth

POLS 473. Globalization and Social Policy (4)
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. Ochs

POLS 475. Seminar: Green Polity (3)
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. Wurth

POLS 477. (SR 477) Advanced Computer Applications (3)
Uses of computers in social sciences, including data collection, management, analysis, presentation, and decision-making; includes weekly lab.

POLS 481. Special Topics (1-3)
Individual inquiry into some problem of government. Reading, field work, and other appropriate techniques of investigation. Conferences and reports. May be repeated for credit.

POLS 482. Special Topics (1-3)
Continuation of POLS 481.

Psychology

Professors. Mark H. Bickhard, Ph.D. (Chicago), *Henry R. Luce Professor in Cognitive Robotics and the Philosophy of Knowledge*; Diane T. Hyland, Ph.D. (Syracuse); Barbara C. Malt, Ph.D. (Stanford); Gordon B. Moskowitz, Ph.D. (NYU); Ageliki Nicolopoulou, Ph.D. (Berkeley), *chair*.

Associate professors. Catherine M. Arrington, Ph.D. (Michigan State); Susan Barrett, Ph.D. (Brown); Michael J. Gill, Ph.D. (Texas, Austin); Deborah J. Laible, Ph.D. (Nebraska, Lincoln); Padraig G. O'Seaghdha, Ph.D. (Toronto).

Assistant professors. Amanda C. Brandone, Ph.D. (Univ. of Michigan); Christopher T. Burke, Ph.D. (NYU); Almut Hupbach, Ph.D. (Univ. of Trier, Germany); Jessecae Marsh, Ph.D. (Yale); Dominic T. Packer, Ph.D. (Toronto).

Emeritus professors. George K. Shortess, (Brown); Martin L. Richter, Ph.D. (Indiana); William Newman, Ph.D. (Stanford).

The Psychology Department offers B.A. and B.S. undergraduate degrees, undergraduate minors in general psychology and clinical psychology, and a Ph.D. program.

B.A. Major Program in Psychology

The bachelor of arts in psychology is a social science major requiring approximately 40 credit hours in psychology as described below. 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.

Required Core Courses

PSYC 1	Introduction to Psychology (4)
PSYC 110	Statistical Analysis of Behavioral Data (4)
PSYC 210	Experimental Research Methods and Laboratory (4)

Required Breadth Courses
Four 100-level courses, spanning at least three of the following four categories.

A)	PSYC 107	Child Development (4)
	PSYC 109 (SSP 109)	Adulthood and Aging (4)
B)	PSYC 121 (SSP 121)	Social Psychology (4)
	PSYC 153 (SSP 153)	Personality (4)
C)	PSYC 117 (COGS 117)	Cognitive Psychology (4)
D)	PSYC 176 (COGS 176)	Mind and Brain (4)

Required Advanced Psychology Seminars
Two Advanced Psychology Seminars are required. Advanced Psychology Seminars are 300-level courses that are offered in a small seminar format. These courses include a significant writing component and utilize primary source readings. Courses that can be used to fulfill this requirement have the

Advanced Psychology Seminar designation at the end of the course description.

Additional 300-levelCourse Requirement
Two additional 300-level courses are required. Students can NOT use PSYC 310, 391, 392, 393 or 394 to fulfill this requirement. All other 300-level psychology courses can be used to fulfill this requirement. Students may take a third or fourth Advanced Psychology Seminar or they may take any of the following courses. These courses fulfill 300-level requirements but NOT the Advanced Seminar requirement:

PSYC 301	Industrial Psychology
PSYC 305	Abnormal Psychology
PSYC 312	Interpersonal Behavior in Small Groups
PSYC 323	The Child in Family and Society
PSYC 327	Health Psychology
PSYC 333	Social Psychology of Politics
PSYC 335	Animal Behavior
PSYC 338	Phenomenology and Theory of Childhood Disorders
PSYC 354	Psychological Assessment
PSYC 382	Endocrinology of Behavior

Recommended Electives
The bachelor of arts 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 law, social work, marketing, and education.

For graduate programs in developmental, social/personality, cognitive, and clinical psychology, additional coursework in research and statistics is desirable, as is participation in the honors program.

Depending on the specific subfield of interest, many courses in the Departments of Biological Sciences (especially the Behavioral Neuroscience program) and Sociology and Anthropology, in the College of Education, and in the interdisciplinary programs of Cognitive Science, Women's Studies, and Africana Studies may be relevant.

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 advisers to determine specific requirements.

Students interested in applying psychology to fields such as law, marketing, social work, or education should consult with faculty in those areas to discuss relevant courses.

The B.S. in Psychology

The bachelor of science in psychology is a highly structured and comprehensive behavioral science major. 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 collaterals for the B.S. in psychology span four areas (Mathematics and Computer Science, Natural Science, Philosophy and Cognitive Science, and Social 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. Collateral courses in the natural sciences can be used to fulfill the natural science college distribution category and collateral courses in mathematics can be used to fulfill the mathematical science college distribution category.

Students in the B.S. program must complete a concentration in cognitive, development, social or clinical psychology. Progression through the program is best served through early commitment. This program requires a minimum of 108 credits of the 120 credits required for a bachelor's degree. Students who do not declare their majors early may find it difficult to complete the B.S. major program.

Requirements for the B.S. in Psychology

University and College Requirements (at least 25 credits):

College Seminar (3-4 credits)

English Composition (2 courses, 6 credits)

Distribution requirements of at least 2 humanities courses for at least 8 credits and at least 2 social science courses for at least 8 credits.

For students in the B.S. program, collateral courses in the natural sciences can be used to fulfill the natural science college distribution category and collateral courses in mathematics can be used to fulfill the mathematical science college distribution category.

The B.S. Program in Psychology: Collateral Requirements (at least 34 credits)

Mathematics and Computer Science (7-8 credits):

Select 1 course from MATH 12, MATH 43, any of the calculus courses

Select 1 additional course from MATH 12, MATH 43, any of the calculus courses, CSE 12, CSE 15

Natural Science: (at least 14 credits)
Select at least one course from BIOS 10, BIOS 41, EES 25, EES 28, EES 31

Select 3 courses from

Biological Sciences: BIOS 10 and above

Chemistry: CHM 30 and above

Physics: PHYS 10 and above

Earth and Environmental Sciences: EES 25, EES 28, EES 31

(Please consult the catalog for information on prerequisites. To fulfill college distribution requirements, at least one course must include the associated lab.)

Philosophy and Cognitive Science: (8 credits)
Select two courses from COGS 7, COGS 140, or Philosophy (PHIL)

Social Science: (7-8 credits)

Select two courses from Anthropology (ANTH), Sociology and Anthropology (SOAN), Sociology/Social Psychology (SSP), Science Technology and Society (STS), and WS 101 that is not cross-listed with psychology.

Psychology Requirements (48 credits)

Psychology Core Requirements

PSYC 1	Introduction to Psychology (4)
PSYC 110	Statistical Analysis of Behavioral Data (4)
PSYC 210	Experimental Research Methods and Laboratory (4)

Required Breadth Courses
Four 100-level courses, one from each of the four categories.

A)	PSYC 107	Child Development (4)
	PSYC 109 (SSP 109)	Adulthood and Aging (4)
B)	PSYC 121 (SSP 121)	Social Psychology (4)
	PSYC 153 (SSP 153)	Personality (4)
C)	PSYC 117 (COGS 117)	Cognitive Psychology (4)
D)	PSYC 176 (COGS 176)	Mind and Brain (4)

Psychology Concentration
Complete courses for one of the following concentrations:

A. Cognitive Psychology Concentration

COGS 7 (may not also be used to fulfill collateral requirement)

Select any Advanced Psychology Seminar.

Select any 300-level course except 310, 391, 392, 393, or 394.

Select two courses from the following list:

PSYC 304 (Memory Development from Infancy to Old Age)

PSYC 307 (Higher Order Cognition)

PSYC 320 (Psychology of Language)

PSYC 351 (Cognitive Development)

PSYC 358 (Inside the Infant Mind)

PSYC 362 (Cognition in Practice & Policy)

PSYC 369 (Memory Under Construction)

PSYC 377 (Attention and Attentional Failures)

B. Social Psychology Concentration

Complete both 121 and 153

Select any Advanced Psychology Seminar.

Select any 300-level course except 310, 391, 392, 393, or 394.

Select two courses from the following list:

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 325 (Theories in Social Psychology)

PSYC 341 (Social Psychology & Social Issues)

PSYC 342 (Motivation)

PSYC 363 (Personality and Social Development in Childhood)

PSYC 384 (Self and Identity)

C. Developmental Psychology Concentration

Complete both 107 and 109

Select any Advanced Psychology Seminar.

Select any 300-level course except 310, 391, 392, 393, or 394.

Select two courses from the following list:

PSYC 321 (Language Development)

PSYC 328 (Educational Psychology)

PSYC 351 (Cognitive Development)

PSYC 358 (Inside the Infant Mind)

PSYC 361 (Personality and Social Development in Adulthood)

PSYC 363 (Personality and Social Development in Childhood)

PSYC 364 (Children and Narratives)

PSYC 365 (Human Development in Cross-Cultural Perspective)

PSYC 366 (Seminar in Cognitive Aging)

PSYC 368 (Children, Psychology and the Law)

PSYC 378 (Emotional Development)

PSYC 383 (Attachment Theory & Research)

PSYC 386 (Psychological Perspectives on Health and Illness in Children and Adolescents)

D. Clinical Psychology Concentration

PSYC 367 (Clinical Psychology: only offered in the summer)

Select any two Advanced Psychology Seminars

Select two courses from the following list:

PSYC 302 (Stress and Coping)

PSYC 305 (Abnormal Psychology)

PSYC 327 (Health Psychology)

PSYC 338 (Phenomenology and Theory of Childhood Disorders)

PSYC 354 (Psychological Assessment)

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 1). Students should declare this minor in the Psychology Department office.

Clinical Psychology

The clinical psychology minor consists of the following courses:

PSYC 153	Personality
PSYC 305	Abnormal Psychology
PSYC 367	Clinical Psychology

And two of the following courses:

PSYC 302	Stress and Coping
PSYC 327	Health Psychology
PSYC 338	Phenomenology and Theory of Childhood Disorders
PSYC 354	Psychological Assessment

This minor is available to Psychology majors as well as to students from other majors. Only one course may be used to jointly fulfill the requirements of a major program and minor program. To complete this minor, students must be prepared to register for at least one summer session since some courses (PSYC 367, 354) are only offered in the summer, and other courses have limited enrollment during the academic year.

Undergraduate Courses

PSYC 1. Introduction to Psychology (4)
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. (SS)

PSYC 107. Child Development (4)
Survey of theories and research concerning perceptual, cognitive, social, and personality development through infancy and childhood. Prerequisite: PSYC 1 or SSP 1. May not be taken pass/fail. (SS)

PSYC 109. (SSP 109) Adulthood and Aging (4)
Social science approaches to the latter two-thirds of life. Cognitive and personality development; attitudes toward aging; social behavior of older adults; widowhood; retirement. Prerequisite: PSYC 1 or SSP 1. May not be taken pass/fail. Hyland (SS)

PSYC 110. Statistical Analysis of Behavioral Data (4)
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. (ND)

PSYC 115. (REL 115) Religion and Psychology (4)
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. (HU)

PSYC 117. (COGS 117). Cognitive Psychology (4)
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. Prerequisite: PSYC 1 or COGS 7. May not be taken pass/fail. (SS)

PSYC 121. (SSP 121) Social Psychology (4)
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. Prerequisite: ANTH 1, SSP1 or PSYC 1. (SS)

PSYC 125. (SSP 125) Social Psychology of Small Groups (4)
Theories and empirical research regarding interpersonal behavior in small groups. Classroom exercises and group simulations. Prerequisite: consent of instructor. Rosenwein (SS)

PSYC 135. (COMM 135, SSP 135, Jour 135) Human Communication (4)
Processes and functions of human communication in relationships and groups. Rosenwein (SS)

PSYC 140. (ANTH 140, COGS 140, MLL 140) Introduction to Linguistics (4)
Relationship between language and mind; formal properties of language; language and society; how languages change over time. No pass/fail option. (SS)

PSYC 153. (SSP 153) Personality (4)
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? Prerequisite: PSYC 1 or SSP 1. Gill (SS)

PSYC 160. Independent Study (1-3)
Readings on topics selected in consultation with a staff member. Prerequisites: PSYC 1 and consent of faculty sponsor. May be repeated for credit. (SS)

PSYC 161. Supervised Research (1-3)
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. Prerequisites: PSYC 1 or COGS 7 and consent of faculty sponsor. (SS)

PSYC 162. Psychological Field Work (1-3)
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. Prerequisites: PSYC 1 plus two additional psychology courses and consent of instructor. (SS)

PSYC 176. (COGS 176) Mind and Brain (4)
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. Prerequisite: PSYC 1 or COGS 7. May not be taken pass/fail. (NS)

PSYC 210. Experimental Research Methods and Laboratory (4)
Designing, conducting, and reporting psychological experiments. Laboratory exercises, report writing, and a group research project. Prerequisites: PSYC 1 and 110. Department permission required. (ND)

PSYC 301. Industrial Psychology (4)
Psychological concepts and methods applied to business and industrial settings. Personnel selection, placement and training, leadership, work motivation, job satisfaction and consumer behavior. Prerequisite: PSYC 1. Department permission required. (SS)

PSYC 302. Stress and Coping (4)
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. Prerequisite: PSYC/SSP 121 or PSYC/SSP 153. Department permission required. Burke (Advanced Psychology Seminar) (SS)

PSYC 304: Memory Development From Infancy to Old Age (4)
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. Prerequisite: PSYC/COGS 117 or PSYC/COGS 176 or COGS 7 or consent of instructor. Department permission required. Hupbach (Advanced Psychology Seminar) (SS)

PSYC 305. (HMS 305). Abnormal Psychology (4)
Examines research and theory on the patterns, causes, and treatment of various forms of abnormal behavior. Prerequisite: PSYC 153 or consent of instructor. Department permission required. (SS)

PSYC 307. Higher Order Cognition (4)
In depth exploration of selected areas of higher level cognition such as thinking and reasoning, metacognition, expertise, executive processes, language and thought. Prerequisite: PSYC 117 or PSYC 176 or COGS 7 or consent of instructor. Department permission required. O'Seaghdha, Malt. (Advanced Psychology Seminar) (SS)

PSYC 310. Advanced Research Methods in Psychology (4)
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. Prerequisite: PSYC 210. Department permission required. (ND)

PSYC 311. The Psychology of Stereotyping, Prejudice, and Discrimination (4)
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. Prerequisite: PSYC/SSP 153 or PSYC/SSP 121. Department permission required. Moskowitz. (Advanced Psychology Seminar) (SS)

PSYC 313. Person Perception (4)
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. Prerequisite: PSYC/SSP 153 or SSP/PSYC 121. Department permission required. Moskowitz (Advanced Psychology Seminar) (SS)

PSYC 314. (SSP 314) Social Cognition (4)
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. Prerequisite: Psyc 110 or SOAN 111. Department permission required. Gill (SS) (Advanced Psychology Seminar)

PSYC 315. History of Modern Psychology (4)
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. Prerequisites: two 300-level PSYC courses. Department permission required. (Advanced Psychology Seminar) (SS)

PSYC 317. Psychology of Emotion (4)
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. Prerequisite: PSYC 110 or consent of instructor. Department permission required. (Advanced Psychology Seminar) (SS)

PSYC 318. (WS 318) Seminar in Gender and Psychology (4)
Gender as shaped by psychological and social psychological processes. Socialization, communication and power, gender stereotypes, methodological issues in sex differences research. Prerequisite: PSYC 210 completed or concurrent or consent of instructor. Department permission required. Hyland. (Advanced Psychology Seminar). (SS)

PSYC 320. Psychology of Language (4)
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. Prerequisite: PSYC 117 or 176 or COGS 7 or consent of instructor. Department permission required. Malt, O'Seaghdha. (Advanced Psychology Seminar) (SS)

PSYC 321. Language Development (4)
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. Prerequisite: PSYC 107 or 117. Department permission required. (Advanced Psychology Seminar). (SS)

PSYC 323. (SSP 323) The Child in Family and Society (4)
Influences such as marital discord, family violence, poverty and prejudice on the development of the child from birth through adolescence. Prerequisite: ANTH 1 or SSP1. Johnson (SS)

PSYC 325. Theories in Social Psychology (4)
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. Prerequisite: Psyc 121 or consent of instructor. Department permission required. (Advanced Psychology Seminar) (SS)

PSYC 327. (HMS 327) Health Psychology (4)
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. Prerequisite: PSYC 110. Department permission required. (SS)

PSYC 328. Educational Psychology (4)
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. Prerequisite: PSYC 107 or 109 or 117 or consent of instructor. Department permission required. Barrett (Advanced Psychology Seminar) (SS)

PSYC 333. (SSP 333, POLS 333) Social Psychology of Politics (4)
Political behavior viewed from a psychological and social psychological perspective. Prerequisite: ANTH 1; SSP 1; PSYC 1, or department permission. Rosenwein (SS)

PSYC 335. (BIOS 335) Animal Behavior (3)
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. Prerequisite: BIOS 120. (NS)

PSYC 338. Phenomenology and Theory of Childhood Disorders (4)
The nature, classification, and treatment of childhood disorders. Prerequisite: PSYC 107. Department permission required. (SS)

PSYC 341. Social Psychology and Social Issues (4)
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. Department permission required. Gill (Advanced Psychology Seminar) (SS)

PSYC 342. Motivation (4)
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. Prerequisite: PSYC 153 or PSYC 121. Department permission required. (Advanced Psychology Seminar) (SS)

PSYC 351. Cognitive Development (4)
Covers Piaget, Vygotsky, and contemporary theoretical perspectives on cognitive development as well as current research in areas such as memory, conceptual understanding of biological and physical concepts, mathematics, problem-solving and literacy. The implications of research in cognitive development for instructional practices will be discussed. Prerequisite: Psyc 107, 117, or COGS 7. Department permission required. Barrett (SS) (Advanced Psychology Seminar)

PSYC 354. Psychological Assessment (4)
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. Prerequisite: PSYC 110. Department permission required. (SS)

PSYC 356. (SSP 356) Seminar in Personality Psychology (4)
Topics in personality psychology: the self, personality consistency, motivation, psychological adjustment. Prerequisite: PSYC/SSP 153 or consent of instructor. Department permission required. (Advanced Psychology Seminar) (SS)

PSYC 358. Inside the Infant Mind (4)
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. Prerequisite: PSYC 107 or consent of instructor. Department permission required. Brandone (Advanced Psychology Seminar) (SS)

PSYC 359. Seminar on Psychological Issues in the Legal System (4)
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. Department permission required. Barrett (Advanced Psychology Seminar) (SS)

PSYC 361. (SSP 361) Personality and Social Development in Adulthood (4)
Theories and current research. Prerequisite: SSP/PSYC 109 or consent of instructor. Department permission required. Hyland (Advanced Psychology Seminar) (SS)

PSYC 362. Cognition in Practice & Policy (4) [3 for graduate registration]
We will take the study of cognition from principle to practice by examining how basic research and theory has informed understanding of human performance in real-world settings. Topics will be chosen from domains such as aviation and automobile safety, environmental and medical decision-making, learning and education, and expert performance in chess or music. We will also consider public policy implications of these findings. Prerequisite: Psyc 117 or consent of instructor. Department permission required. Malt (Advanced Psychology Seminar) (SS)

PSYC 363. (SSP 363) Personality and Social Development in Childhood (4)
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. Prerequisite: PSYC 107 or consent of instructor. Department permission required. (Advanced Psychology Seminar) (SS)

PSYC 364. Children and Narratives (4)
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? Prerequisite: PSYC 107. Department permission required. Nicolopoulou (Advanced Psychology Seminar) (SS)

PSYC 365. Human Development in Cross-Cultural Perspective (4)
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. Prerequisite: PSYC 107 or PSYC 109 or PSYC/SSP 121 or ANTH 1 or consent of instructor. Department permission required. Nicolopoulou (Advanced Psychology Seminar) (SS)

PSYC 366. Seminar in Cognitive Aging (4)
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. Prerequisite: PSYC 109; PSYC 117 not required but strongly recommended. Department permission required. (Advanced Psychology Seminar) (SS)

PSYC 367. Clinical Psychology (4)
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: PSYC 153 and PSYC 305 or consent of instructor. Department permission required. (Advanced Psychology Seminar) (SS)

PSYC 368. Children, Psychology, and the Law (4)
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. Prerequisite: Psyc 107. Department permission required. Barrett. (SS) (Advanced Psychology Seminar)

PSYC 369. Memory Under Construction (4)
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. Prerequisite: PSYC 117 or PSYC 176 or COGS 7 or consent of instructor. Department permission required. O'Seaghdha (Advanced Psychology Seminar) (SS)

PSYC 377. Attention and Attentional Failures (4)
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. Prerequisite: PSYC 117 or PSYC 176 or COGS 7. Department permission required. Arrington (SS) (Advanced Psychology Seminar)

PSYC 378. Emotional Development (4)
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. Prerequisite: Psyc 107. Department permission required. Laible (Advanced Psychology Seminar) (SS)

PSYC 380. Sports Psychology (4)
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. Prerequisite: Psyc 110 or Psyc/SSP153. Department permission required. (Advanced Psychology Seminar) (SS)

PSYC 381. Special Topics in Psychology (4)
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. (SS)

PSYC 382. (BIOS 382) Endocrinology of Behavior (3)
Hormonal effects upon animal and human behavior. Emphasis on neuroendocrinology of steroid hormone involvement in reproductive behaviors. Prerequisite: BIOS 120. (NS)

PSYC 383. Attachment Theory & Research: The Study of Close Relationships Across the Lifespan (4)
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. Prerequisite: PSYC 107. Department permission required. Laible. (SS) (Advanced Psychology Seminar)

PSYC 384. Self and Identity (4)
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. Prerequisite: Psyc/SSP 121 or Psyc/SSP 153. Department permission required. Packer (Advanced Psychology Seminar) (SS)

PSYC 386. (HMS 386) Psychological Perspectives on Health and Illness in Children and Adolescents (4)
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. Department permission required. Barrett (Advanced Psychology Seminar) (SS)

PSYC 391. Thesis (3)
Written report: Literature review and design of project in selected area of psychology. Only open to students in the honors program. Prerequisite: PSYC 210. Consent of Honors Program Coordinator required. (ND)

PSYC 392. Thesis. (3)
Execution of project designed in PSYC 391. Final report and oral presentation. Only open to students in the honors program. Prerequisite: PSYC 391. Consent of Honors Program Coordinator required. (ND)

PSYC 393. Independent Research (1-3)
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. Prerequisite: PSYC 210 or 161. Consent of faculty sponsor required. (ND)

PSYC 394. Senior Research Project (3)
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. (ND)

For Graduate Students

The Department of Psychology offers a distinctive Ph.D. program centered in areas of Human Cognition and Development with specializations in cognition and language, development, and social cognition and personality. Students are trained primarily for positions at universities and in basic or applied research settings. For the most complete and current information visit http://cas.lehigh.edu/CASWeb/default.aspx?id=1398

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://cas.lehigh.edu/CASWeb/default.aspx?id=1418

The Graduate Certificate in Cognitive Science is administered by the Cognitive Science Program. Information is available at: http://cas.lehigh.edu/CASWeb/default.aspx?id=1417

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-Project (PSYC 412). First-year students are expected to choose an adviser and begin to work on a research project as early as possible. A written and oral report of the student's research activities is made to the department. Students entering with an approved Master's thesis are exempt from this requirement.

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 thesis may instead conduct an equivalent non-degree Pre-dissertation Project.

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

Core courses. All students are required to take a one-semester graduate core course in Cognitive Psychology (PSYC 403), Developmental Psychology (PSYC 402), and Social Cognition (PSYC 406).

PSYC 421 and 422. Statistical Analysis of Psychological Data.
These courses represent a two-semester sequence of theoretical and applied statistics and research methodology.

Graduate Seminars (PSYC 430 and above).
Students must take at least three graduate seminars, and one additional course approved by the adviser.

PSYC 409 and 410. Professional Seminar.
Bookend seminars that cover professional development issues for new and advanced students.

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

This is required for all doctoral candidates and must be passed at least seven months prior to the awarding of the degree. The areas to be covered on the exam are selected by the student in consultation with the student's general exam committee.

Graduate-Level Courses

PSYC 402. Developmental Psychology (3)
Survey of theories and research concerning perceptual, cognitive, social, and personality development through infancy and childhood. Prerequisite: Graduate standing or consent of instructor.

PSYC 403. Cognitive Psychology (3)
Survey of theories and research in cognitive psychology. Prerequisite: Graduate standing or consent of instructor.

PSYC 404. (BIOS 404) Behavioral Neuroscience (3)
Theoretical and empirical issues in biopsychology. Prerequisite: Graduate standing or consent of instructor.

PSYC 406. Social Cognition (3)
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. Prerequisite: Graduate standing or consent of instructor.

PSYC 409. Professional Seminar I (1).
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).
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)
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.

PSYC 421. Statistical Analysis of Psychological Data I. (3)
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)
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. Prerequisite: PSYC 421 or consent of instructor. Department permission required.

PSYC 423. (COGS 423) Foundations of Cognitive Science (3)
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)
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. Arrington

PSYC 443. Seminar in Language Acquisition (3)
Special topics in language acquisition. Content will vary each time the seminar is offered. Prerequisite: PSYC 402 or PSYC 403 or consent of instructor.

PSYC 446. Developmental Theories and Special Populations (3)
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. Prerequisite: PSYC 402 or consent of instructor. Barrett

PSYC 448. Seminar in Psychology of Language (3)
Topics in language comprehension and production. Content will vary from year to year. Prerequisite: PSYC 403 or consent of instructor.

PSYC 450. Special Topics in Mathematical Models and Statistics (3)
Selected topics in the application of mathematics to psychological research. May be repeated for credit.

PSYC 460. Special Study (1-9)
Study of some special topic not covered in the regular course offerings. May be repeated for credit.

PSYC 461. Research Seminar (1-9)
Original research designed and executed in collaboration with the faculty. May be repeated for credit.

PSYC 462. Stereotypes, Prejudice, and Discrimination (3)
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. Prerequisite: PSYC 406 or consent of instructor. Gill

PSYC 464. Naive Realism in Social Judgment (3)
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. Prerequisite: PSYC 406 or consent of instructor. Moskowitz

PSYC 466. Prosocial Cognition, Emotion, and Behavior (3)
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? Gill

PSYC 476. Seminar in Cognition (3)
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. Prerequisite: PSYC 403 or consent of instructor.

PSYC 478. (COGS 478) Ontological Psychology (3)
Principles and constraints for the modeling of psychological phenomena: Representation, perception, memory, knowing, emotions, consciousness, language, and rationality. Bickhard

PSYC 480. Seminar in Cognitive Development (3)
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. Prerequisite: PSYC 402 or consent of instructor.

PSYC 481. Selected Topics in Social and Personality Development (3)
Topics include emotional and sex-role development, peer relations, and social competence. Emphasis will vary from year to year. Prerequisite: PSYC 402 or consent of instructor.

PSYC 482. Seminar in Adult Development (3)
Application of lifespan developmental theory and methodology to personality, social, and cognitive development in adulthood. Prerequisite: PSYC 402 or consent of instructor. Hyland

PSYC 483. Seminar in Cultural Psychology (3)
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. Prerequisite: PSYC 402 or consent of instructor. Nicolopoulou

PSYC 484. (WS 484). Psychology of Gender (3)
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. Prerequisite: Consent of instructor. Hyland

PSYC 490. Thesis Research (1-6).
Master's Thesis or Pre-dissertation Project research directed by committee.

PSYC 495. Narrative & Psychology (3)
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. Prerequisite: Psyc 402 or consent of instructor. Nicolopoulou

PSYC 499. Dissertation Research (1-15).
Ph.D. dissertation research directed by dissertation committee.

Religion Studies

Professors. Dena S. Davis, J.D. (Virginia), *Presidential Chair in Health-Social Sciences/Humanities;* Norman J. Girardot, Ph.D. (Chicago), *University Distinguished Professor;* Kenneth L. Kraft, Ph.D. (Princeton); Michael L. Raposa, Ph.D. (Pennsylvania) *Fairchild Chair of American Studies;* Laurence J. Silberstein, Ph.D. (Brandeis), *Philip and Muriel Berman*

Professor of Jewish Studies, and Director of the Philip and Muriel Berman Center for Jewish Studies; Lloyd H. Steffen, Ph.D. (Brown); Lenore E. Chava Weissler, Ph.D. (Pennsylvania), *Chair and Philip and Muriel Berman Chair of Jewish Civilization;* Benjamin G. Wright, III, Ph.D. (Pennsylvania).

Associate Professor. Robert Rozehnal, Ph.D. (Duke).

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.

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.

Course Offerings

REL 1. Sacred Scriptures in Religious Traditions (4)
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. Wright (HU)

REL 2. Death in Religious Traditions (4)
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. Weissler (HU)

REL 3. (GCP 3, PHIL 3) Global Religion, Global Ethics (4)
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. Steffen (HU)

REL 4. How to Study Religion (4)
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? Silberstein (HU)

REL 5. Spiritual Exercises in Religious Traditions (4)
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. Raposa (HU)

REL 6. Religion and the Ecological Crisis (4)
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? Kraft (HU)

REL 7. Jesus, Buddha, Mao, and Elvis (4)
Comparative and cross-cultural exploration of the nature and meaning of "religious founders" in the history of religions. Girardot (HU)

REL 8. (WS 8) Prehistoric Religion, Art, and Technology (4)
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. Girardot (HU)

REL 9. Spiritual Journeys (4)
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. Rozehnal (HU)

REL 12. (ASIA 12) Introduction to Asian Religions (4)
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. Kraft (HU)

REL 22. (ART 22) Visions of God: 2000 Years of Christian History and Art (4)
An Interdisciplinary course that combines art history and the history of Christianity. From the beginnings of their tradition, Christians have represented their theologies and religious sentiments in visual arts and architecture, and for the same two millennia, a myriad of Christians have learned their Christianity through visual representations. Provides a one-semester survey of the history of Christianity as expressed in the visual arts. Wright (HU)

REL 60. (ASIA 60) Religions of South Asia (4)
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. Rozehnal (HU)

REL 64. (ASIA 64) Religions of China (4)
History and meaning of the major forms of Chinese religion-especially Confucianism and Neo-Confucianism, Taoist mysticism, Buddhism (Ch'an/Zen), and popular religion. Girardot (HU)

REL 65. (ASIA 65) Religions of Japan (4)
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. Kraft (HU)

REL 67. (ASIA 67) Japanese Civilization (4)
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. Kraft (H/S)

REL 68. Practical Justice: From Social Systems to Responsible Community (4)
Examination of the role of moral and religious values in social systems, including education, the economic system, criminal justice, with particular attention to the problems of poverty, literacy, homelessness and domestic violence. Students engage in volunteer efforts to gain practical experience with those who deliver and receive services in these systems. An action-reflection model (with reference to liberation theology and religious thinkers like M.L. King, Dorothy Day, and Walter Rauschenbusch) is employed to urge reflection on how social systems can be affected and transformed by visions of justice, ethics, religion and social responsibility. Steffen (HU)

REL 73. The Jewish Tradition (4)
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. Silberstein, Weissler (HU)

REL 75. The Christian Tradition (4)
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. (HU)

REL 76. Reading the Bible in the Contemporary World (4)
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? Wright (HU)

REL 77. (ASIA 77) The Islamic Tradition (4)
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. Rozehnal (HU)

REL 111. Jewish Scriptures/Old Testament (4)
The religious expression of the Hebrews, Israelites, and Jews as found in the Jewish Scriptures (TANAK/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. Wright (HU)

REL 112. The Beginnings of Judaism and Jewish Origins: Jewish Diversity in the Greco-Roman World (4)
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. Wright (HU)

REL 114. (CLSS 114) Christian Origins: New Testament and the Beginnings of Christianity (4)
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. Wright (HU)

REL 115. (PSYC 115) Religion and Psychology (4)
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. (HU)

REL 116. (PHIL 116) Bioethics (4)
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, the distribution of health care, etc. (HU)

REL 120. Newish Jewish: New Forms of Judaism in North America (4)
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. Weissler (HU)

REL 121. Sources for the Life of Jesus: the Jewish and Christian Context (4)
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. Wright (HU)

REL 124. (PHIL 124) Philosophy of Religion (4)
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. Raposa (HU)

REL 126. (HUM 126, PHIL 126) Professional Ethics (4)
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. Steffen (HU)

REL 129. (PHIL 129) Jewish Philosophy (4)
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. (HU)

REL 132. Hasidic Tales (4)
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. Weissler (HU)

REL 133. Alternative Religions in the 21st Century (4)
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? Kraft (HU)

REL 137. (HUM 137, PHIL 137) Ethics in Practice (1-4)
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. Steffen (HU)

REL 138. (WS 138) Women in Jewish History (4)
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. Weissler (HU)

REL 139. (ANTH 139) Jewish Folklore (4)
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. Weissler (SS)

REL 141. (PHIL 141) Medieval Islamic Philosophy (4)
An introduction to Islamic philosophy in the medieval era, the Golden Age of Islamic civilization. The course focuses on primary sources. Readings include both expositions and critiques of philosophical doctrines and argument, selected from the writings of al-Farabi, Ibn Sina (Avicenna), al-Ghazali, Ibn Tufayl, and Ibn Rushd (Averroes). Yaqub (HU)

REL 144. (ART 144) Raw Vision: Creativity and Ecstasy in the Work of Shamans, Mystics, and Artist Outsiders (4)
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. Girardot (HU)

REL 145. (ASIA 145, GCP 145) Islam in the Modern World (4)
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. Rozehnal (HU)

REL 146. (ASIA 146) Islam in South Asia (4)
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. Rozehnal (HU)

REL 148. (GCP 148) Islam Across Cultures (4)
Explores the Muslim world's diversity and dynamism in multiple cultural contests-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. Rozehnal (HU)

REL 150. Judaism in the Modern World (4)
Fundamental themes in the experience of modern Jewry; confrontation with secular culture; crisis of religious faith; Zionism and the renewal of Jewish nationalism; the problem of Jewish identity in America; and the impact of the Holocaust. Silberstein, Weissler (HU)

REL 151. (HIST 151) Medieval Civilization (4)
Formation and development of western culture to about 1400. Rise of universities and towns, legal development and origins of representative government, origins of nation-states, scholasticism and decline of the medieval church. Savage (HU)

REL 152. American Judaism (4)
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? Silberstein (HU)

REL 153. The Spiritual Quest in Contemporary Jewish Life (4)
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? Silberstein (HU)

REL 154. (HIST 154) The Holocaust: History and Meaning (4)
The Nazi holocaust in its historical, political and religious setting. Emphasis upon moral, cultural and theological issues raised by the Holocaust. (HU)

REL 155. Responses to the Holocaust (4)
A multi-media study of the ways in which writers, artists, film makers, cartoonists, composers, and comics have responded to the horrors of the Holocaust. Among the questions to be considered are: How is it possible to describe and represent the Holocaust in writing? In art? In film? What distinguishes the ways in which this is done by different generations? How is the memory of these events being effectively preserved and transmitted through monuments and museums? What role does the memory of the Holocaust play in the life of contemporary Jews? Silberstein (HU)

REL 156. Israel, Zionism, and the Renewal of Judaism (4)
New interpretations of Judaism, the Jewish community and Jewish history developed by Zionist thinkers. Diverse currents within Jewish nationalist thought and critical responses to Zionist ideology. Silberstein (HU)

REL 157. (HIST 157) Europe in the Age of the Reformation (4)
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. Baylor (HU)

REL 158. (WS 158) Sex and Gender in Judaism (4)
Writings by Jewish feminists reflecting the encounter between Judaism and feminism: prayer and ritual, women rabbis, God, and God language, communal power, the marriage and divorce. Silberstein (HU)

REL 159. Roman Catholicism in the Modern World (4)
A survey of the various intellectual, cultural, political and ecclesiastical developments that have shaped contemporary Roman Catholic life and thought. Raposa (HU)

REL 160. (ASIA 160) The Daoist Tradition (4)
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"). Girardot (HU)

REL 162. (ASIA 162) Zen Buddhism (4)
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.) Kraft (HU)

REL 165. Jews, Christians, and Buddhism: The Turn to the East in American Culture (4)
In recent decades, a growing number of Americans raised as Jews and Christians have embraced the teachings and practices of Buddhism. Through a study of contemporary Buddhist writings, personal accounts, and other readings, we shall examine what Jews and Christians find attractive in Buddhism. We shall also explore the areas of conflict between Buddhism and Western religions as well as cultural conditions that are contributing to Buddhism's growing appeal. Silberstein (HU)

REL 166. (ASIA 166, GCP 166) Religious Nationalism in South Asia (4)
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. (HU)

REL 167. (ASIA 167) Engaged Buddhism (4)
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. Kraft (HU)

REL 168. (ASIA 168) Buddhism in the Modern World (4)
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? Kraft (HU)

REL 171. (SSP 171) Religion and Society (4)
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. Munson (SS)

REL 174. Contemporary Theology (4)
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. Raposa (HU)

REL 175. (ASIA 175, GCP 175) Sufi Saints and Muslim Missionaries [Lehigh India Summer Program] (6)
This month-long summer study-travel program in north India focuses on the intersection of religion and politics among South Asia's dynamic Muslim communities. The course focuses in particular on two distinct traditions of Islamic piety: Sufism (Islamic mysticism) and the conservative, transnational political movement, the Tablighi Jama'at. Students travel to a range of important historical sites, mosques, Sufi shrines and university campuses and engage local experts through a series of guest lecturers. Rozehnal (HU)

REL 176. (GCP 176) The Islamic Heritage of Turkey [Lehigh in Turkey Summer Program] (6)
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. Rozehnal (HU)

REL 180. (HIST 180) Religion and the American Experience (4)
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. Najar (HU)

REL 181. (IR 181) Israel: Religion, Culture, National Identity (4)
What is "Israeliness?" Beginning with an exploration of the basic premises of Zionism, the course will then examine the debates within Israeli society concerning national identity, religion and culture. Silberstein (HU)

REL 184. (WS 184) Religion, Gender, and Power (4)
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. Silberstein (HU)

REL 186. Judaism in Israel and the United States (4)
Explores the differences/similarities in the ideologies, myths and symbols which shape the views of Jews in Israel and the United States on such issues as: the meaning of Judaism, the interpretation of Jewish history, the relationship of religion and peoplehood, and the relationship of democracy and Jewish values. Readings include Amos Oz, A.B. Yehoshua, Haim Hazaz, Leonard Fein, Mordecai Kaplan. Silberstein (HU)

REL 187. Science, Technology, and the Religious Imagination (4)
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. Raposa (HU)

REL 188. Religion and Literature (4)
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. Steffen (HU)

REL 189. Religion and the Visual Arts (4)
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? Girardot (HU)

REL 213. (CLSS 213, HIST 213) Ancient Roman Religion (4)
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. (SS)

REL 220. (ASIA 220) Classics of Asian Religion (4)
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? Kraft, Girardot (HU)

REL 221. (ASIA 221) Topics in Asian Religions (4)
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. Girardot, Kraft, Rozehnal (H/S)

REL 222. Topics in Western Religions (4)
Selected historical, thematic, and comparative issues in Judaism, Christianity, and Islam. May be repeated for credit as the subject matter varies. (HU)

REL 224. (PHIL 224) Topics in the Philosophy of Religion (4)
Selected problems and issues in the philosophy of religion. May be repeated for credit as the subject matter varies. Prerequisite: One HU designated course in Philosophy. Raposa (HU)

REL 225. Topics in Religion and Ethics (4)
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. (HU)

REL 226. (HMS 226) From Black Death to AIDS: Plague, Pandemic, Ethics and Religion (4)
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. Steffen (HU)

REL 228. Theories of Religion (4)
What is religion? Does it have a universal, cross-cultural and trans-creedal essence? Drawing on numerous academic disciples, the course engages the major issues and most influential authors in the academic study of comparative religions. Rozehnal (HU)

REL 230. Kabbalah: The Jewish Mystical Tradition (4)
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. Weissler (HU)

REL 231. Classic Jewish Texts (4)
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. Weissler (HU)

REL 234. (ASIA 234) Buddhist Visions of a Good Society (4)
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. Kraft (HU)

REL 241. (PHIL 241) Critics of Religion (4)
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. Silberstein (HU)

REL 244. (GCP 244, GS 244) Globalization and Religion (4)
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. Rozehnal (HU)

REL 247. (ASIA 247) Islamic Mysticism (4)
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. Rozehnal (HU)

REL 251. (CLSS 251) Classical Mythology (3)
Myth, religion and ritual in ancient Greece and Rome. Emphasis on primary sources; introduction to ancient and modern theories of myth. Cross-cultural material. (SS)

REL 254. (ASIA 254, ES 254) Buddhism and Ecology (4)
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? Kraft (HU)

REL 335. (ANTH 335) Religion, Witchcraft and Magic (4)
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. Vann (SS)

REL 337. (ANTH 337, ASIA 337) Buddhism and Society (4)
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. Tannenbaum (SS)

REL 347. (PHIL 347, AMST 347) American Religious Thinkers (4)
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. Raposa (HU)

REL 350. (POLS 350) Religion and Politics in Comparative Perspective (4)
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. Deo (SS)

REL 361. Fieldwork (1-4)
Opportunity for students to work, or observe under supervision, religious organizations or institutions. Consent of chair required. (ND)

REL 371. Directed Readings (1-4)
Intensive study in areas appropriate to the interests and needs of students and staff. (ND)

REL 373. (HUM 373, PHIL 373) Independent Ethics Project (4)
Supervised ethics research into a topic approved by the advisor for the Humanities Minor in Ethics. An option for completing the ethics minor. For ethics minors only. (HU)

REL 374. Seminar for Majors (4)
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. (HU)

REL 375. (SSP 375) The Christian Right in America (4)
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. Prerequisite: One 100-level SSP course. Munson (SS)

REL 391. Senior Thesis in Religion (4)

Russian

See listing under Modern Languages and Literature.

School Psychology

See listings under Education.

Science, Environmental and Technical Writing

See listings under Journalism and Communication.

Science, Technology and Society

Program Director: Stephen H. Cutcliffe, Ph.D.
610-758-3369; shc0@lehigh.edu

Core Faculty: Stephen H. Cutcliffe, Ph.D. (Lehigh), professor of science, technology and society and history, and director, STS program; Gail A Cooper, Ph.D. (U.C., Santa Barbara), associate professor of history; Sharon M. Friedman. M.A. (Penn State), professor of journalism and communication; Steven Louis Goldman, Ph.D. (Boston), Andrew W. Mellon Professor in the Humanities; John K. Smith, Jr., Ph.D. (Delaware), associate professor of history; Albert H. Wurth, Jr., Ph.D. (N.C., Chapel Hill), associate professor of political science.

Affiliated Faculty: Henri J. Barkey, international relations; Mark Bickard, philosophy; Derrick Brown, civil and environmental engineering; Robin Dillon, philosophy; Edward B. Evenson, geological sciences; Edward J. Gallagher, English; John Gillroy, international relations; Norman J. Girardot, religion studies; Ned D. Heindel, chemistry; Breena Holland, political science; Sharon Kalafut, computer science and engineering; Chaim D. Kaufmann, international relations; Kenneth L. Kraft, religion studies; Judith N. Lasker, sociology; Jeffrey Milet, speech and theater; Vincent G. Munley, economics; Roger N. Nagel, electrical engineering and computer science; Anthony O'Brien; economics; Michael Raposa, religion studies; Robert E. Rosenwein, sociology and anthropology; Dork Sahagian, earth and environmental science; Roger D. Simon, history; Bruce Thomas, Art, Architecture and Design; Ricardo Viera, Art, Architecture and Design; Todd Watkins, economics; Peter K. Zeitler, earth and environmental sciences.

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.

STS Studies 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

E. Required STS Courses (minimum of 30 hours)

CORE Courses (20 credits)

STS 11	Technology and Human Values (4)
HIST 7	Technology in America's Industrial Age (4) or
HIST 8	Technology in Modern America (4)
STS/JOUR 124	Politics of Science (4) or
POLS 115	Technology as Politics (4)
PHIL 128	Philosophy of Science (4) or
PHIL 228	Topics in Philosophy of Science (4)
STS 381	Senior Seminar (4)

Electives

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 (10-12 credits)

A. Concentration in a complementary discipline (minimum of 15 hours to be chosen in conjunction with STS studies advisor); or approved departmental or interdisciplinary program minor; or double major.

B. Science and Mathematics Requirement. Students must fulfill the college's regular B.A. distribution requirements of at least eight credits in the natural sciences; and at least three credits in mathematical sciences. At least one of the courses in the natural sciences must also include the associated laboratory course. These courses should be chosen in consultation with the 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 4credit Honors Thesis sequence (STS 391 and 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 11: Technology and Human Values and electives chosen from the list of all courses eligible for STS studies which follows below. Students should consult with the program director when selecting courses for either the major or the minor.

Science, Technology and Society Courses

STS 11. Technology and Human Values (4)
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. Cutcliffe (SS)

STS 112. Engineering and Society (4)
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. Goldman. (SS)

STS 117. (HIST 117/WS117) Women, Science and Technology (4)
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. Cooper (SS)

STS 118 (HMS 118, HIST 118) History of Modern Medicine (4)
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. Grafe (HU)

STS 124. (JOUR 124) Politics of Science (4)
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. S. Friedman (SS)

STS 145. (HIST 145) Introduction to the History of Science (4)
The history of modern science, primarily physical and biological, with emphasis on the development of major theoretical models since the seventeenth century. Goldman (SS)

STS 181. Independent Study (1-4) fall/spring
Prerequisite: consent of the program director. (HU or SS)

STS 221. (MAT 221/ANTH 221) Materials in the Development of Man (3)
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. Small (SS)

STS 252. (CSE 252, EMC 252) Computers, the Internet, and Society (3)
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. Nagel (SS)

STS 323. (HMS323/JOUR 323) Health and Environmental Controversies (4) spring
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. S. Friedman (SS)

STS 341. Issues in American Competitiveness: At Home and Abroad (4)
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. Goldman, Nagel (SS)

STS 381. Senior Seminar (4)
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. Prerequisite: STS 11 or consent of program director. Cutcliffe (SS)

STS 391 Honors Thesis (1) Fall
Preparation for honors research thesis (STS 392). Identification of topic, preliminary compilation of source materials, and preparation of a proposal. Program permission required. (ND)

STS 392 Honors Thesis (3) Spring
Directed undergraduate research thesis required of students who apply and qualify for graduation with program honors. Prerequisite: STS 391, or concurrent with STS392. (ND)

Graduate Courses in STS

(Open to undergraduates by petition only.)

STS 481. Readings in Science, Technology and Society (3)
Readings seminar on selected themes and topics in science, technology, and society. May be repeated for credit with permission of the program director.

Other STS courses

The following 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 (Thomas)
ARCH 210	20th Century Architecture (Jung)
CHM 5	Chemistry and National Issues
CSE/EMC/STS 252	Computers, the Internet, and Society (Nagel
DES 66	Design History
ECO 311	Environmental Economics
ECO 314	Energy Economics
EES 2	Intro to Environmental Science
EES 4	Science of Environmental Issues
ES 1	Intro to Environmental Studies
ES 331	U.S. Environmental Law I: Pollution and Risk Abatement (Gillroy)
ES 338	Environmental Risk: Perception and Communication
HIST 7	Technology in America's Industrial Age (Smith)
HIST 8	Technology in Modern America (Smith)
HIST 107	Technology and World History (Smith)
HIST 111	Engineering in the Modern World (Smith)
HIST/STS/WS 117	Women, Science and Technology (Cooper)
HIST/STS/HMS 118	History of Modern Medicine (Grafe)
HIST/STS 145	Introduction to the History of Science (Goldman)
HIST 308	Industrial American Since 1945 (Cooper)
HIST/ES 315	American Environmental History (Cutcliffe)
HIST/ASIA 340	Japanese Industrialization (Cooper)
IR 34	Society, Technology, & War (Kaufmann)
IR/ES 333	International Environmental Law and Policy (Gillroy)
IR/ES 343	Comparative Environmental Law and Policy (Gillroy)
IR 344	International Politics of Oil (Barkey)
JOUR/STS 124	Politics of Science (Friedman)
JOUR/ES 125	Environment, Public and Mass Media (Friedman)
JOUR/HMS/STS 323	Health and Environmental Controversies (Friedman)
MAT/ANTH/STS 221	Materials in the Development of Man
PHIL/REL 116	Bioethics
PHIL 128	Philosophy of Science
PHIL 228	Topics in the Philosophy of Science
PHIL /COGS 250	The Philosophy of Mind
POLS/ES 105	Environmental Policy and Planning (Holland)
POLS/ES 106	Environmental Values and Ethics (Holland)
POLS/ES 107	The Politics of the Environment (Wurth)
POLS 115	Technology as Politics (Wurth)

POLS/ES 328	U.S. Politics and the Environment (Wurth)
POLS/ES 355	Environmental Justice and the Law (Holland)
POLS/ES 375	Seminar: Green Polity (Wurth)
REL 6	Religion and the Ecological Crisis (Kraft)
REL/WS 8	Prehistoric Religion, Art, and Technology (Girardot)
REL/PHIL 116	Bioethics
REL 187	Science, Technology, & the Religious Imagination (Raposa)
SSP/HMS 160	Medicine and Society (Lasker)
SSP 302	The Sociology of Cyberspace (Rosenwein)
SSP/JOUR 327	Mass Communication and Society (Rosenwein)
SSP 367	Sociology of Science (Rosenwein)
THTR/ARCH 161	Performing Arts Venue Design and Technology

Social Psychology

See listings under Sociology and Anthropology.

Sociology and Anthropology

Professors. James R. McIntosh, Ph.D. (Syracuse); Raymond Bell, Ed.D. (Lehigh) emeritus; Barbara B. Frankel, Ph.D. (Princeton), Emerita; John B. Gatewood, Ph.D. (Illinois); Roy C. Herrenkohl, Ph.D. (N.Y.U.) Emeritus Distinguished Service Professor, Emeritus; Judith N. Lasker, Ph.D. (Harvard) Chairperson and NEH Distinguished Professor; Robert E. Rosenwein, Ph.D. (Michigan); David B. Small, Ph.D. (Cambridge); Nicola Tannenbaum, Ph.D. (U. of Iowa); Robert C. Williamson, Ph.D. (Southern California), Emeritus.

Associate professors. Heather Johnson, Ph.D. (Northeastern); Jackie Krasas, Ph.D. (Southern California); Ziad Munson, Ph.D. (Harvard);

Assistant professors. Tanya L. Saunders, Ph.D. (Michigan); Bruce Whitehouse, Ph.D. (Brown); Yuping Zhang, Ph.D. (University of Pennsylvania).

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.

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://cas.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.

B.A. Major Programs

Anthropology

Collateral Requirement (4 credits)

One general course in statistics: MATH 12, ECO 145, PSYC 110, or equivalent. (Note: MATH 12 fulfills the College of Arts and Sciences requirement.)

Introductory (4 credits)

ANTH 1.	Introduction to Anthropology

Disciplinary Core Courses (8 credits)

ANTH 111.	Comparative Cultures [fall] or ANTH 140. Introduction to Linguistics [spring] and ANTH 112. Doing Archaeology [spring] or ANTH 145 Human Evolution (NS) [fall, alternate years]

Methodology (4 credits)

SOAN 111.	Research Methods and Data Analysis [fall]

Major Electives (20 credits)

Five additional anthropology courses, at least two of which must be at the 300-level. (Individualized study courses 300, 393, 394, 395, and 399 cannot be used to fulfill this requirement; however, one SSP course can be substituted as an anthropology elective.)

Research, Internship, or Thesis (4 credits)

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:

ANTH 300.	Apprentice Teaching
ANTH 393.	Supervised Research
ANTH 394.	Field School
ANTH 395.	Internship
ANTH 399.	Senior Thesis

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 (4 credits)

One general course in statistics: MATH 12, ECO 145, PSYC 110, or equivalent.

(Note: MATH 12 fulfills the College of Arts and Sciences' mathematics requirement.)

Introductory (8 credits)

SSP 1	Introduction to Sociology and Social Psychology (4)
ANTH 1	Introduction to Anthropology (4)

Theory and Methodology (8 credits)

SOAN 111	Research Methods and Data Analysis (4) fall
SOAN 112	Development of Social Theory (4) spring

Major Electives (24 credits)

Three additional courses in sociology/social psychology, one of which must be at the 300-level or above, AND three additional courses in anthropology, one of which must be at the 300-level.

(Individualized study courses300, 393, 394, 395, 395, and 399can be taken as major electives but cannot be used to fulfill the 300 level course requirement.)

Sociology/Social Psychology Collateral Requirement (4 credits)

One general course in statistics: MATH 12, Eco 145, PSYC 110, or equivalent.

(Note: MATH 12 fulfills the College of Arts and Sciences' mathematics requirement.)

Introductory (4 credits)

SSP 1	Introduction to Sociology and Social Psychology (4) fall

Theory and Methodology (8 credits)

SOAN 111	Research Methods and Data Analysis (4) fall
SOAN 112	Development of Social Theory (4) spring

Major Electives (20 credits)

Five additional courses in sociology/social psychology, at least two of which must be at the 300-level. (Individualized study courses300, 393, 394, 395, 395, and 399cannot be used to fulfill this requirement; however, one ANTH course can be substituted as a "sociology/social psychology" elective.)

Research, Internship, or Thesis (4 credits)

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:

SSP 300	Apprentice Teaching (4)
SSP 393	Supervised Research (1-4)
SSP 394	Field School (1-8)
SSP 395	Internship (1-4)
SSP 399	Senior Thesis (2-4)

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:

ANTH 106.	Culture and Globalization
ANTH 111.	Comparative Cultures
ANTH 121.	Culture and the Environment
ANTH 123.	The Cultural Construction of Gender
ANTH 140.	Introduction to Linguistics
ANTH 160.	Health, Illness, and Healing
ANTH 182.	North American Indians
ANTH 184.	Cultures of the Pacific
ANTH 187.	Peoples 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

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 1, PSYC 1, POLS 3, IR 10, Eco 1, and history offerings.

Concentration in Archaeological Anthropology

Anthropology majors electing to concentrate in archaeological anthropology must complete at least four of courses in archaeological anthropology at the 100-level or above. Regular course offerings that would satisfy this concentration include the following:

ANTH 112.	Doing Archaeology
ANTH 121.	Culture and the Environment
ANTH 145.	Human Evolution
ANTH 172.	North American Archaeology
ANTH 174.	Greek Archaeology
ANTH 176.	Roman Archaeology
ANTH 178.	Mesoamerican Archaeology
ANTH 221.	Materials in the Development of Man
ANTH 340.	Archaeological Theory
ANTH 345.	Evolution of the State
ANTH 370.	Historical Archaeology
ANTH 377.	Archaeology of Death
ANTH 394.	Field School (archaeology field school)

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 1 and four additional courses at 100 level or above in anthropology.

Sociology and Anthropology: One of the following introductory courses: ANTH 1 or SSP 1 and two courses in sociology at the 100 level or above and two courses in anthropology at the 100 level or above.

Sociology/Social Psychology: SSP 1 and four additional courses at 100 level or above in sociology/social psychology.

Undergraduate Courses

Anthropology

ANTH 1. (GCP 1) Introduction to Anthropology (4) fall and spring
General introduction to the four subfields of anthropology: biological, archaeological, cultural, and linguistic. Class will center around lectures and discussion of ancillary media. Staff (SS)

ANTH 100. Seminar in Anthropology (1-4)
Topics in anthropology. May be repeated for credit. (SS)

ANTH 104. (AAS 104) Contemporary Issues in African Societies (4)
Using an anthropological lens to engage issues confronting African societies today, we examine local-level ethnographic accounts and analyses of continent-wide trends, and consider a range of topics including famine, political violence, AIDS, poverty, and corruption. Where does Africa fit into the current neo-liberal world order and what is the role "African culture" plays in shaping all these issues? Whitehouse (SS)

ANTH 106. (GS 106) Cultural Studies and Globalization (4)
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. Whitehouse. (SS)

ANTH 111. Comparative Cultures (4)
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. Tannenbaum (SS)

ANTH 112. (CLSS 112) Doing Archaeology (4)
Principles of archaeological method and theory. Excavation and survey methods, artifact analysis, dating techniques, and

cultural reconstruction. Course includes field project. Small (SS)

ANTH 121. (ES 121) Environment and Culture (4)
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. Staff (SS)

ANTH 123. (WS 123) The Cultural Construction of Gender (4)
Comparative study of the meanings and social roles associated with gender. Psychological, symbolic, and cultural approaches. Tannenbaum (SS)

ANTH 127. (CLSS 127) Early Civilizations (4)
Introduction to early civilizations in the Near East, Mediterranean, Africa, Europe, and New World. Similarities and differences in economics, politics, social organization, and religion. Small (SS)

ANTH 139. (REL 139) Jewish Folklore (4)
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, lifecycle rituals, and food. Weissler (SS)

ANTH 140. (COGS 140, PSYC 140, MLL 140) Introduction to Linguistics (4)
Relationship between language and mind; formal properties of language; language and society; how languages change over time. (SS)

ANTH 145. Human Evolution (4)
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. Prerequisite: ANTH 1. Gatewood (NS)

ANTH 160. Health, Illness, and Healing (4)
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. Staff (SS)

ANTH 172. North American Archaeology (4) fall
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. (SS)

ANTH 174. (CLSS 174, ART 174, ARCH 174) Greek Archaeology (3)
Ancient Greek culture from the Neolithic to Hellenistic periods. Reconstructions of Greek social dynamics from study of artifacts. Small (SS)

ANTH 175. Archaeology of Classical Cultures (4)
Course introduces the student to an overview of the archaeology of ancient Greece and Rome from Iron Age to Late Antiquity. Emphasis on aspects of cultural development and change. Small (SS)

ANTH 176. (CLSS 176, ART 176, ARCH 176) Roman Archaeology (3)
Cultures of the Roman Empire. Reconstructions of social, political, and economic dynamics of the imperial system from study of artifacts. Small (SS)

ANTH 178. Mesoamerican Archaeology (4)
Ancient civilizations of Mesoamerica: Olmec, Zapotec, Maya, Toltec, and Aztec. Reconstructions of urban centers, political and economic organizations, and theories of the Mayan collapse. Small (SS)

ANTH 182. North American Indians (4)
Culture areas of native North America prior to substantial disruption by European influences north of Mexico. Environmental factors and cultural forms. Gatewood (SS)

ANTH 183. (AAS 183) Peoples and Cultures of Africa (4)
Studies African modernity through a close reading of ethnographies, social stories, novels, and African feature films. Whitehouse (SS)

ANTH 187. (ASIA 187) Peoples of Southeast Asia (4)
Peoples and cultures of Burma, Laos, Cambodia, Thailand, Malaysia, Singapore, Indonesia, and the Philippines. World view, religion, economy, politics, and social organization. Tannenbaum (SS)

ANTH 188. Southeast Asians in Southeast Asia and America (4)
In this course we explore the ways in which different peoples lived in Southeast Asia, why they moved to America, and the ways in which this move affected their cultures. Topics explored include: aspects of their culture, particularly religion and social organizations; motivations for migrating including war, political, and economic reasons; and their adaptations to America and American responses to their presences. No prerequisites. Tannenbaum (SS)

ANTH 305. Anthropology of Fishing (4)
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. Gatewood (SS)

ANTH 320. (GS 320) Global Capitalism (4)
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. Staff (SS)

ANTH 324. (AAS 324, GS 324) Globalization and Development in Africa (4)
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"? Whitehouse (SS)

ANTH 325. Economic Anthropology (4)
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. Tannenbaum (SS)

ANTH 330. Food for Thought (4)
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. Tannenbaum (SS)

ANTH 335. (REL 335). Religion, Witchcraft, and Magic (4)
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. Staff (SS)

ANTH 337. (Asia 337, RS 337) **Buddhism and Society** (4)
The course approachs 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. Tannenbaum (SS)

ANTH 339. Seminar in Anthropology (4)
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. (SS)

ANTH 340. Archaeological Theory (4)
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. Small (SS)

ANTH 345. (CLSS 345) Evolution of the State (4)
Theories of state formation. Comparison of evolutionary trajectories of early states in the Near East, Mediterranean, and New World. Small (SS)

ANTH 370. (HIST 370) Historical Archaeology (4)
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. Small (SS)

ANTH 371. Special Topics (1-4)
Advanced work through supervised readings. May be repeated for credit. Prerequisite: consent of the department chairperson. (SS)

ANTH 376. Culture and the Individual (4)
Concepts and methods of studying relations between the individual and the sociocultural milieu. Culture and personality language and thought, cross-cultural studies of cognition. Gatewood (SS)

ANTH 377. Archaeology of Death (4)
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. Small (SS)

ANTH 378. (LAS 378) Blood, Pyramids, and the Tree of Life (4)
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. Small (SS)

ANTH 393. Supervised Research (1-4)
Conducting anthropological research under the supervision of a faculty member. May be repeated for credit. Prerequisite: consent of the department chairperson. (SS)

ANTH 394. Field School (1-8)
Field school in archaeology or ethnography. Maximum of eight credits for a single season or field experience. May be repeated once for credit. (SS)

ANTH 395. Internship (1-4)
Supervised experience involving nonpaid work in a setting relevant to anthropology. May be repeated once for credit. Prerequisite: open only to department majors. (SS)

ANTH 399. Senior Thesis (24)
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. Prerequisite: consent of the department chairperson. (SS)

Sociology and Anthropology

SOAN 41. (WS 41) Human Sexuality (4)
Sexuality and gender roles across the life cycle, including human reproduction, decision-making, and the societal regulation of sexual behavior. (ND)

SOAN 42. (WS 42) Sexual Minorities (4)
How minority sexual identities have been the subject of speculation, misunderstanding, and sometimes violent attempts at correction or elimination. Sexual orientation, gender role, including transvestitism and "drag," trans-sexualism, sexism, heterosexism, and homophobia. Emphasis on critical thinking, guest speakers, and discussions. (SS)

SOAN 100. Seminar in Social Relations (1-4)
Topics in social relations. May be repeated for credit. (SS)

SOAN 111. Research Methods and Data Analysis (4) fall
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. (ND)

SOAN 112. Development of Social Theory (4) spring
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. (SS)

SOAN 395. Methods in Observation (4) alternate years
Naturalistic and participant observation in uncontrolled field settings. (SS)

SOAN 399. Senior Thesis (4)
Research during senior year culminating in senior thesis. Required for social relations majors seeking departmental honors. Prerequisite: consent of the department chairperson. (SS)

Sociology/Social Psychology

SSP 1. Introduction to Sociology and Social Psychology (4) fall and spring
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. Staff (SS)

SSP 100. Seminar in Sociology and Social Psychology (1-4)
Topics in sociology and social psychology. May be repeated for credit. (SS)

SSP 103. (AAS 103) Race and Ethnicity in the Contemporary U.S. (4) fall
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." Johnson (SS)

SSP 104. (POLS 104). Political Sociology (4)
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. Munson (SS)

SSP 105. (GCP 105) The Social Origins of Terrorism (4)
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. Munson (SS)

SSP 106. (AAS 106, LAS 106) Race and Ethnicity in Latin America and the Spanish Speaking Caribbean (4)
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. Saunders (SS)

SSP 109. (PSYC 109) Adulthood and Aging: (4)
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. Prerequisite: PSYC 1 or SSP 1. May not be taken pass/fail. Hyland (SS)

SSP 110. (WS 110, GCP 110) Women's Work in Global Perspectives (4)
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. Krasas (SS)

SSP 114. (Asia 114) Social Issues in Contemporary China (4)
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. Zhang (SS)

SSP 121. (PSYC 121) Social Psychology (4)
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. Prerequisite: One of the following introductory courses: ANTH 1 or SSP 1 or PSYC 1. Staff (SS)

SSP 125. (PSYC 125) Social Psychology of Small Groups (4)
Theories and empirical research regarding interpersonal behavior in small groups. Classroom exercises and group simulations. Prerequisite: consent of instructor. Staff (SS)

SSP 126. (GS 126) The Political Economy of Globalization (4)
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. Staff (SS)

SSP 128 (WS 128) Race, Gender, and Work (4)
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. Krasas (SS)

SSP 135. (Jour 135, PSYC 135) Human Communication (4)
Processes and functions of human communication in relationships and groups. Staff (SS)

SSP 141. Social Deviance and Social Control (4)
Analysis of deviant social systems, supporting factors maintaining them, and societal responses to deviant roles and collectivities. McIntosh (SS)

SSP 144. (AAS 144) Global Hip Hop and Social Change (4)
Hip Hop has become a global phenomenon. In this course 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. Saunders (SS)

SSP 152. (HMS 152) Alcohol, Science and Society (4)
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. McIntosh (SS)

SSP 153. (PSYC 153) Personality (4)
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? Prerequisite: Psyc 1 or SSP 1. Gill (SS)

SSP 155. (AAS 155) (LAS 155) Afro-Latino Social Movements in Latin America & Ca (4)
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. Saunders (SS)

SSP 160. (HMS 160) Medicine and Society (4)
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. Lasker (SS)

SSP 161. The American Dream: Popular Ideologies in American Society (4)
Is the "American Dream" a myth or reality? This course explores this question and various aspects of basic American values through a sociological lens. The American Dream, meritocracy, and individualism are strongly held beliefs the United States the of opportunity. We will examine the implications, causes, and consequences of these beliefs and other popular ideologies in the context of a highly stratified and increasingly diverse society. The course focuses on how ideologies function to both reproduce and transform society. Johnson (SS)

SSP 162. (HMS 162) AIDS and Society (4)
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. (SS)

SSP 163. Pass the Peas: Mapping the Blueprint of Hip Hop Culture (4)
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. Staff (SS)

SSP 165. Contemporary Social Problems (4)
Studies of major problems facing contemporary society. (SS)

SSP 166. (AAS 166) Wealth and Poverty in the United States (4)
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." Johnson (SS)

SSP 171. (REL 171). Religion and Society (4)
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. Munson (SS)

SSP 177. (AAS 177, LAS 177) (4)
Course will analyze the role of race and culture in the Afro Cuban struggle for equality. By focusing on the arts, particularly music, film, and literature, this course will examine 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 wrap up the semester by addressing the significance of contemporary cultural movements that challenge the social issues facing Afro Cubans. Saunders (SS)

SSP 302. The Sociology of Cyberspace (4)
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. Staff (SS)

SSP 310. (AAS 310, WS 310) Gender, Race, and Sexuality: The Social Construction of Differences (4)
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. Prerequisite: SSP 103, or instructor permission. Staff (SS)

SSP 313. (AAS 313) Social Movements (4)
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. Prerequisite: One 100-level SSP course. Munson (SS)

SSP 314. (PSYC 314) Social Cognition (4)
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. Prerequisite: Psyc 110 or SOAN 111. Department permission required. Gill (SS) (Advanced Psychology Seminar)

SSP 322. (GC 322, GS 322, HMS 322) Global Health Issues (4)
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 â€˜traditional' and â€˜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. Lasker (SS)

SSP 323. (PSYC 323) The Child in Family and Society (4)
Influences such as marital discord, family violence, poverty and prejudice on the development of the child from birth through adolescence. Prerequisite: One of the following introductory courses: ANTH 1 or SSP 1. Johnson (SS)

SSP 325. (HIST 325, WS 325) History of Sexuality and the Family in the U.S. (34) fall
Social change from early agrarian communities to beginnings of industrialism, emphasizing socioeconomic class, family structure, and treatment of women and minority groups. Najar (SS)

SSP 326. (HIST 326, WS 326) Social Class in American History (34) spring
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. Simon (SS)

SSP 327. (JOUR 327) Mass Communication and Society (4)
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.). Prerequisite: One of the following introductory courses: ANTH 1 or SSP 1 or instructor permission. Rosenwein (SS)

SSP 328. (GS 328) Global Food Systems (4)
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. Staff (SS)

SSP 329. (GS 329) Global Migration (4)
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 trans-nationalization of social relations, alters existing livelihoods, transforms economic production and social support arrangements, and recreates racial, ethnic, and national identities. Staff (SS)

SSP 331. (WS 331) Gendered Experience of Globalization (4)
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. Zhang (SS)

SSP 341. (WS 341, HMS 341) Women and Health (4)
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. (SS)

SSP 345. (AAS 345) Colonialism and the Black Radical Tradition (4)
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. Saunders (SS)

SSP 346. (LAS 346) Society, Democracy and Revolution in Latin America (4)
Latin America is a region fi lled 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? Saunders (SS)

SSP 351. (WS 351) Gender and Social Change (4)
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. (SS)

SSP 355. Sociology of Education (4)
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. Prerequisite: ANTH 1 or SSP 1 or instructor permission. Johnson (SS)

SSP 356. (PSYC 356) Seminar in Personality Psychology (4)
Topics in personality psychology: the self, personality consistency, motivation, psychological adjustment. Prerequisite: SSP/PSYC 153 or consent of instructor. Department permission required. (Advanced Psychology Seminar) (SS)

SSP 361. (PSYC 361) Personality and Social Development in Adulthood (4)
Theories and current research. Prerequisite: SSP/PSYC 109 or consent of instructor. Department permission required. Hyland (Advanced Psychology Seminar) (SS)

SSP 363. (PSYC 363) Personality and Social Development in Childhood (4)
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. Prerequisite: PSYC 107 or consent of instructor. Department permission required. (Advanced Psychology Seminar) (SS)

SSP 364. (WS 364) Sociology of the Family (4)
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. Staff (SS)

SSP 365. (WS 365) Inequalities at Work (4)
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. Krasas (SS)

SSP 367. Sociology of Science (4)
Review of sociological, social psychological, and anthropological perspectives on science as a cognitive and social enterprise. Analysis of past and contemporary case studies as well as experimental/simulation research. Staff (SS)

SSP 371. Special Topics (1-4)
Advanced work through supervised readings. May be repeated for credit. Prerequisite: consent of the department chairperson. (SS)

SSP 373. Seminar in Sociology (4)
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. (SS)

SSP 374. Social Stratification: Race, Class, Gender (4)
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. Prerequisite ANTH 1 or SSP 1. Johnson (SS)

SSP 375 (REL 375). The Christian Right in America (4)
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. Prerequisite: One 100-level SSP course. Munson (SS)

SSP 379. (AAS 379) Race and Class in America (4)
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. Prerequisite: SSP 103, or consent of instructor. Johnson (SS)

SSP 391. Evaluation Research (4)
Application of social research methods of evaluation of the effectiveness of social programs. Measurement, research design, criteria of effectiveness and decision making. Prerequisite: SOAN 111 or consent of department chairperson. Staff (SS)

SSP 393. Supervised Research (1-4)
Conducting sociological or social psychological research under the supervision of a faculty member. May be repeated for credit. Prerequisite: consent of the department chairperson. (SS)

SSP 395 Internship (1-4)
Supervised experience involving nonpaid work in a setting relevant to sociology/social psychology. May be repeated once for credit. Prerequisite: open only to department majors. (SS)

SSP 399. Senior Thesis (24)
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. Prerequisite: consent of the department chairperson. (SS)

Graduate Courses in Sociology

The Master's Program in Sociology prepares students to apply sociological and social psychological perspectives and methods to the analysis of social problems. Grounded in a strong theoretical and substantive understanding of social institutions, social relations, and social policy, as well as in advanced research and computer skills, students are prepared to be effective and experienced practitioners in the field of applied social research. Specialty areas include: policy studies (health, education, family, diversity, substance abuse, delinquency); human communication (teamwork in organizations, interactional processes, mass communication, personal relationships); and program evaluation.

The Sociology MA program requires 30 hours of course work. Required courses are: Advanced Research Methods Part I and Part II; Statistics; Classical Social Theory; Research Practicum, either in an agency or firm in the community or with a faculty member; and three electives. All students take a comprehensive exam. Students choose whether to write a thesis or to take an additional six credits of elective courses.

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.

SSP 401. Classical Social Theory (3)
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. Staff (SS)

SSP 403. Sociology of Cyberspace (3)
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. Staff (SS)

SSP 411. Advanced Research Methods, Part I (3)
Study of quantitative and qualitative methodologies, measurement and research design issues at an advanced level. Specific methodologies include participant observation, survey/interview, laboratory or field methods, content analysis, and focus groups. Prerequisite: SOAN 111 or equivalent. Staff (SS)

SSP 412. Advanced Research Methods, Part II (3)
Application of research methods to specific project, including design, data collection, and analysis. Focus on use of SPSS and other appropriate software. Prerequisite: SSP 411 or equivalent. Staff (SS)

SSP 413. Research Practicum (36)
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. Staff (SS)

SSP 414. Survey Research (3)
Examination of survey methods, sample design, interview design, training of survey personnel, data management and analysis. (SS)

SSP 415. Case Studies of Social Control (3)
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. McIntosh (SS)

SSP 418 (WS 418). Gendered Experience of Globalization (3)
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. Zhang (SS)

SSP 419. Global Food Systems (3)
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. Staff (SS)

SSP 420. Global Migration (3)
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 trans-nationalization of social relations, alters existing livelihoods, transforms economic production and social support arrangements, and recreates racial, ethnic, and national identities. Staff (SS)

SSP 441 (WS 441) Women and Health (3)
Relationships of women to the medical system. Influence of medicine on women's lives and the impact of the women's movement on health. Staff (SS)

SSP 452. Organizing, Community, and Power (3)
Seminar on grassroots and national social movement organizing built around theories of social and political power. Specific topics to be covered include recruitment and media strategies, organizational models, the role of ideology, and movements in the political process. Emphasis will be on practical, applied knowledge of help to practitioners. We will examine examples of both faith based and race-based organizing, as well as both liberal and conservative social movements. Munson (SS)

SSP 453. Urban Communities (3)
Reading of classical and contemporary urban theory and community studies in sociology and anthropology. Examination of patterns of social class, power, and social change in urban settings, community organizing and public policy aimed at addressing urban social problems, and evaluation of community interventions. Lasker (SS)

SSP 454. Urban Education: Inequality and Public Policy (3)
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. Johnson (SS)

SSP 461. Seminar in Sociology (1-4)
Topics vary. (SS)

SSP 465 (WS 465) Inequalities at Work (3)
Primary focus in 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. Krasas (SS)

SSP 471. Special Topics (13)
Intensive study in an area of sociology that is appropriate to the interests and needs of staff and students. (SS)

SSP 472. Special Topics (13)
Continuation of SSP 471. (SS)

SSP 473. (EDUC 473) Social Basis of Human Behavior (3)
Development of human behavior from a social psychological perspective. Emphasis placed on the impact of society upon school-age children and adolescents. (SS)

SSP 476. Issues in Health Policy Analysis (3)
Sociological analyses of health care and health care policy issues of current concern in American and other societies. Application of analytic frameworks to several majors 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. Lasker (SS)

SSP 490. Master's Thesis

SSP 493. Methods in Observation (3)
Naturalistic and participant observation in uncontrolled field settings. Students will carry out a field project. Tannenbaum (SS)

South Mountain College

Benjamin Wright, *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://cas.lehigh.edu/smc).

Participation in South Mountain College (SMC) involves a two-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 (typically, applications are due on January 1). 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 4 semesters, two of which must include the first year.
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 (32-64 credits):

Year 1, fall and spring:
SMC 050 Investigations (2-6)
SMC 010 Seminar (2)

Years 2 – 4, fall and spring:
SMC 200 Seminar (2)
SMC 250 Investigations (2-6)

Notes: Two credits of SMC Seminar are required each semester a student is enrolled on-campus, for a total of up to 16 credits. A minimum of two credits of SMC Investigation is required each semester a student is enrolled on-campus. If a student is involved in Study Abroad or another off-campus activity, they must still meet the minimum total of 16 credits for SMC Investigation. A maximum total of 48 credits of SMC Investigation may be applied to University graduation requirements. South Mountain College encourages students to take advantage of opportunities like Study Abroad and will assist students in developing a program that works.

Courses in South Mountain College

SMC 10. South Mountain College Seminar (2)
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. (ND)

SMC 050. South Mountain College Investigations (2-6)
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 includes coverage equivalent to Arts 001 (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. (ND)

SMC 200. South Mountain College Advanced Seminar (2)
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. (ND)

SMC 250. South Mountain College Advanced Investigations (2-6)
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. (ND)

Spanish

See listings under Modern Languages and Literature.

Special Education

See listings under *Education.*

Speech

See listings as Communication under Journalism and Communication.

Statistics

See listing under Mathematics.

Supply Chain Management

Program director. Robert J. Trent, Ph.D. (Michigan State) professor of management.

Program faculty. Susan A. Sherer, Ph.D. (Pennsylvania) Kenan Professor of Information Technology Management; Mei Li, Ph.D. (Arizona State) assistant professor of management; Nada Sanders, Ph.D. (Ohio State) Iacocca Chair; Yuliang Yao, Ph.D. (Maryland) associate professor of business information systems; Zachary Zacharia, PhD. (Tennessee) assistant professor of 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 and Courses

For specific course descriptions please see subject area heading in this catalog. Check index for page number.

Required Major Courses (18 hours)

SCM 309	Supply and Cost Management (3)
SCM 354	Integrated Logistics and Supply Chain Management (3)
BUS 211	Integrated Product Development
SCM 328	Negotiations and Conflict Management (3) (cross-listed as MGT 328)
SCM 340	Demand and Supply Chain Planning (3)
SCM 342	e-Business Enterprise Applications (3) (also cross-listed as BIS 342)

And an optional:

SCM 373	Supply Chain Management Internship (1-3)

Undergraduate Courses

SCM 186. Supply Chain Operations Management (3)
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: MATH 21 or 75/76, ECO 045.

SCM 309. Supply and Cost Management (3)
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: SCM 186 or consent of the instructor.

SCM 328. Negotiations and Conflict Management (3) (cross listed as MGT 328)
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)
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. Prerequisite: SCM 186 or consent of instructor.

SCM 342 (BIS 342). E-Business Enterprise Applications (3)
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: BIS 111 or consent of the instructor.

SCM 354. Integrated Logistics and Supply Chain Management (3)
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: SCM 309, SCM 340 or consent of the instructor.

Bus 211. Integrated Product Development Projects (3)
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. Prerequisite: Junior standing in business, economics, arts or engineering.

SCM 371. Directed Readings (13)
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.

SCM 372. Special Topics (1-3)
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.

SCM 373. Supply Chain Management Internship (1-3)
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 Mgt 372, Special Topics in Logistics, 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. Prerequisite: Junior standing in the College of Business and Economics and Supply Chain Management declaration.

Supply Chain Management Minor

The Supply Chain Management minor is designed to offer students in other disciplines an opportunity to learn about the implications of supply chain issues. The College of Business and Economics offers a Supply Chain Management minor to any student that has completed the following prerequisites:

ECO 1	Principles of Economics
ECO 045	Statistical Methods or applicable statistics from the student's college

The SCM minor consists of 3 courses equaling 9 credit hours

All SCM minors take the following two (2) courses:

SCM 309	Supply and Cost Management (3)
SCM 354	Integrated Logistics and Supply Chain Management (3)

Plus one (1) of the following:

SCM/MGT 328	Negotiations and Conflict Management (3)
SCM 324	E-Business Enterprise Applications (3)
SCM 340	Demand and Supply Chain

Planning (3)

Technology, Interdisciplinary Courses

See listings under Science, Technology and Society.

Theatre

Professors. Jeffrey Milet, M.F.A. (Yale); Augustine Ripa, M.F.A. (Northwestern); Pam Pepper, M.F.A. (Ohio)

Associate professors. Erica Hoelscher, M.F.A. (Northwestern); Kashi Johnson, M.F.A. (Pittsburgh).

Assistant professors. Jorge I. Cortiñas, M.F.A. (Brown); Melpomene Katakalos, M.F.A. (California).

Adjunct professors. E. Laura Hausmann, B.F.A. (Boston Conservatory); R. Elizabeth Miller, Certificate (LAMDA); Pamela Richey, M.F.A. (Montana); Christopher Bohan, M.F.A. (Wayne State); Sue Ragusa, M.F.A. (Wisconsin-Madison); Kristian Ball, M.F.A. (Missouri); Andrew F. Southard, M.F.A. (Yale).

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.

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, 24 hrs

THTR 1	Introduction to Theatre (4)
THTR 60	Dramatic Action, (4)
THTR 87	Scenography I, (4)
THTR 127	The Development of Theatre and Drama from Ritual to Renaissance (4)
THTR 128	The Development of Theatre and Drama from Renaissance to Present (4)
THTR	Acting, any appropriate level (4)
THTR 315	Senior Study (0)

Production Requirement, 8 hrs

Four courses from the following: THTR 20, 21, 22, 23, 25, 26, 27, 28, 30, 31, 35, 42, 45, 47, 67, 68, 69, 175. Advanced courses may be substituted.

Electives, 16 hrs

Four courses carefully selected with an advisor, emphasizing depth or breadth of study.

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 active semesters in theatre production totaling at least four 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 Theatre 11, 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 Theatre 11 prerequisite.

Courses in Theatre

THTR 1. Introduction to Theatre (4)
Foundations of theatre: historical, literary and practical. (HU)

THTR 11. Introduction to Acting (4)
Preparation for scene study and characterization. (HU)

THTR 20. Stagecraft I (2)
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. (HU)

THTR 21. Stagecraft II (2)
A continuation of THTR 20 – Stagecraft I. Specialty tools, materials, methods and problem-solving. Practical experience in executing scenery for the stage. Prerequisite: THTR 20. (HU)

THTR 22. Stage Properties and Decoration (2)
Creating props and decor for the stage. Production assignment as assistant property master. (HU)

THTR 23. Basic Scene Painting (2)
Painting for the stage. Production assignments painting with scenic artist. (HU)

THTR 25. Costume Construction I (2)
Introduction to the art of costume construction. Costume construction materials, techniques, tools and safety. Practical experience in executing costumes for the stage. (HU)

THTR 26. Costume Construction II (2)
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. Prerequisite: THTR 25. (HU)

THTR 27. Lighting Technology and Production I (2)
Introduction to the art of lighting technology and production. Lighting techniques, tools and safety. Practical experience in executing lighting for the stage. (HU)

THTR 28. Lighting Technology and Production II (2)
Specialty equipment, methods and problem solving. Practical experience in programming the lighting console for production. Assignment as light board operator on a production. (HU)

THTR 30. Sound Technology and Production I (2)
Introduction to the art and technology of sound reinforcement. Audio theory, methods and practice. Practical experience in executing audio technical support for the stage. (HU)

THTR 31. Sound Technology and Production II (2)
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. Prerequisite: THTR 30 (HU)

THTR 35. Performance (2)
Performing in a department-approved production. May be repeated for credit. (HU)

THTR 42. Marketing and Publicity for the Theatre (2)
Theory and practice of marketing and publicity for productions. (HU)

THTR 45. Stage Management (2)
Organization, scheduling, coordination of various production specialties. Production assignment as assistant stage manager. (HU)

THTR 47. House Management (2)
Front of house coordination, audience services, interface with stage management and production team. Production assignment as house manager. (HU)

THTR 50. (DES 50) Stage Lighting (4)
An introduction to the art and practice of lighting design for the stage. History of theatrical lighting design. (HU)

THTR 54. (CLSS 54) Greek Tragedy (3)
Aspects of Greek theater and plays of Aeschylus, Sophocles, and Euripides in their social and intellectual contexts. Pavlock (HU)

THTR 56. Jazz Dance (2)
Jazz dance styles and combinations. May be repeated for credit. Prerequisite: fee. (HU)

THTR 57. Modern Dance (2)
Modern dance styles and combinations. May be repeated for credit. Prerequisite: fee. (HU)

THTR 58. (CLSS 58) Greek and Roman Comedy (3)
Study of comedy as a social form through plays of Aristophanes, Menander, Plautus, and Terence. Pavlock (HU)

THTR 60. (ENGL 60) (GC 60) Dramatic Action (4)
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. (HU) FALL

THTR 065. (ENGL 065) Introduction to Playwriting (4)
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. (HU)

THTR 67. Stage Crew (2)
Production run crew assignment. Can be repeated for credit. (HU)

THTR 68. Costume Crew (2)
Production run crew assignment in wardrobe, hair and makeup. Can be repeated for credit. (HU)

THTR 69. Lighting Crew (2)
Production run crew assignment as master electrician. Can be repeated for credit. Permission of instructor. (HU)

THTR 77. Ballet (2)
Classical ballet for beginners and those who have had some training. May be repeated for credit. Prerequisite: fee. (HU)

THTR 87. (DES 87) Scenography I (4)
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. (HU) SPRING

THTR 111. (DES 111) Sound Design (2)
Techniques, materials, and methods of designing sound for theatrical production (HU)

THTR 127 (ENGL 127). The Development of Theatre and Drama from Ritual to Renaissance (4)
Survey of Western theatre and dramatic literature from ritual origins to the Renaissance. (HU) FALL

THTR 128 (ENGL 128). The Development of Theatre and Drama from Renaissance to Present (4)
Survey of Western theatre and dramatic literature from the renaissance to the present. (HU) SPRING

THTR 129 (WS 129). History of Fashion and Style (4): also C/L w/ (DES 129)
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. (HU)

THTR 130. Drafting for the Theatre (4)
Theatre drafting techniques and conventions. Material, methods and theory in stage graphics. Model building techniques and practice. An introduction to computer drafting. (HU)

THTR 132 (AAS 132). Hip Hop Theatre (4)
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. Prerequisite: Audition. Consent of instructor. (HU)

THTR 135. (ENGL 135) Playwriting II (4)
For students interested in continuing and deepening their writing for the stage. Instructor approval required. (HU)

THTR 140 (AAS 140). African American Theatre (4)
Studies in African American theatre: literary, and practical and historical. May be repeated for credit. (HU)

THTR 144. Directing (4)
Introduction to the theatrical director’s art. Research, rehearsal techniques, scene work. Prerequisites: THTR 60, Dramatic Action, and acting experience as determined by the department, or consent of chairperson. (HU) SPRING

THTR 145. Advanced Stage Management (4)
Advanced Application, practice, and leadership development of stage management role and skills: production assignment as stage manager.

THTR 147. Acting Modern Realism (4)
Characterization and scene study in modern realistic drama e.g. Ibsen, Chekov, O’Neill, Hellman, Miller and Williams. Prerequisite: THTR 11.

THTR 148. Acting Contemporary Drama (4)
Characterization and scene study in modern contemporary drama. Prerequisite: THTR 11.

THTR 152. Stage Make-up (4)
Theatrical make-up techniques for the actor and designer. (HU)

THTR 154. (DES 154) Scene Painting (4)
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. (HU)

THTR 161. (Arch 161) Performing Arts Venue Design and Technology (4)
Designing theatres. Theatre equipment systems and acoustics. Function and form. ((HU)

THTR 166. (ENGL 166, GCP 166, GS 166) The Playwright as Traveler (4)
This class will read and analyze plays and critical essays to discern how playwrights navigate the tricky ethical and artistic enterprise that is travel. The material is challenging and will require students to utilize analytic tools culled from various disciplines including political economy, literary criticism, feminism and queer studies. We will focus on aesthetic devices that either foreground or obscure questions of politics, power, race, gender and class. Concepts such as ideology, orientalism, interpellation and hegemony will be covered. (HU)

THTR 175. Special Projects (1-4)
Theatrical topics of current or special interest. Can be repeated for credit. (HU)

THTR 181. Theatre Management (4)
Concepts, techniques and practices related to managing the theatrical enterprise. (HU)

THTR 185. Production Seminar (1-4)
Practicum in various approaches to theatre production, e.g. performance ensemble. Prerequisite: audition, or consent of the chairperson. Can be repeated for credit. (HU)

THTR 187. (DES 187) Scenography II (4)
Includes beginning scene design, lighting design, and costume design principles and techniques. Introduction to design history. Significant texts, scenographic design and media techniques in graphic and three-dimensional solutions. Introduction to drafting and mechanical perspective. Prerequisite: THTR 87 or consent of instructor. (HU) FALL

THTR 211 (Germ 211). German Drama (4)
Drama as a literary genre; plays from various periods of German literature. (HU)

THTR 218 (Germ 218). Goethe's "Faust" (4)
Study of Goethe's play with an introduction to the Faust tradition. (HU)

THTR 221. Breaking into the Business (4)
This course will explore the world of the professional actor with comprehensive coverage of all aspects of the acting profession. Abundant information on auditioning techniques, the tools of the actor, the acting unions, professional theater companies, graduate and professional training programs and the world of film & television will be examined.

THTR 222. (ENGL 222) Readings in Non-Realism (4)
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. (HU

THTR 236. Acting Presentational Styles (4)
Elements of characterization and scene study in presentational dramatic literature from classical through post-modern periods. Prerequisite: 100-level acting course, or consent of chairperson. (HU)

THTR 244. Acting Shakespeare (4)
Monologue scene study and ensemble work from Shakespeare's dramatic and poetic canon. Prerequisite: 100-level acting course. (HU)

THTR 245. Advanced Directing (4)
Continuation of Theatre 144. The director's voice. Supervised practical experience. Prerequisite: THTR 144. (HU)

THTR 253. Scene Painting II (4)
Applied advanced scene painting methods for the theatre. Shop management for the scenic artist. Collaboration with designers and stage technology. Prerequisite: THTR 154. (HU)

THTR 255. (ENGL 255) The Collectively Devised Text (4)
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. (HU)

THTR 260. Design Practicum (1-4)
Scenic, costume, lighting or sound design for the theatre. Realized design production assignments and portfolio building. Collaboration, process and presentation. Prerequisite: Dept. Permission. Repeatable for credit. (HU)

THTR 275. Internship (1-4)
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. Prerequisite: consent of chairperson. (ND)

THTR 287. (DES 287) Scenography III (4)
Includes advanced scene design, lighting design, and costume design principles and techniques. Design history projects in specific periods. Complex design problems of traditional texts. Emphasis on color and color theory. Prerequisite: THTR 187 or permission. (HU) SPRING

THTR 315. Senior Study (0)
Seminar for senior theatre majors. Enhancement of current theatre studies while preparing for further theatre studies or activity. (ND)

THTR 318. (FREN 318) Drama in the Twentieth Century (3)
Contemporary French drama with an analysis of its origins and movements. Armstrong (HU)

THTR 328. (ENG 328). Shakespeare (4)
An introduction to Shakespearean drama including comedies, histories, tragedies, and romances. Emphasis on textual study, cultural contexts, and performance strategies. Hawkes, Traister (HU)

THTR 351. Advanced Special Projects (1-8)
Independent study in theatre. Prerequisite: consent of the chairperson. Can be repeated for credit. (HU)

THTR 361. Research in Theatre Technology (1-4)
Solving technological problems in theatre. Application of new technologies. May be repeated for credit. Prerequisite: consent of chairperson. (HU)

THTR 387. (DES 387) Scenography IV (4)
Advanced problem solving of non-traditional design problems, experimental approaches and solutions, contemporary issues in environmental design. Design history focus on contemporary design trends and non-traditional history. Prerequisite: THTR 287 or permission. (HU) FALL

Women's Studies

Program Director. Jackie Krasas, Ph.D.
jkr205@lehigh.edu; 610-758-5119

The Women's Studies Program has several major goals: to expand students' understanding of women's present status and rich history; to stimulate a critical examination of the impact of gender roles and stereotypes on social structures and individual lives; to evaluate proposals for alternative arrangements; and to connect issues addressed in the classroom with those raised in personal, political, and cultural contexts. The program challenges students to think beyond the boundaries of traditional gender roles, traditional disciplines, and established institutions. In the best tradition of a liberal arts education, Women's Studies encourages women and men to think critically and constructively, to redesign knowledge, and to gain a better understanding of themselves and their world.

Professors. Marie-Helene Chabut, Ph.D. (U.C., San Diego), Modern Language and Literature; Constance A. Cook, Ph.D., (U.C., Berkeley) Modern Languages and Literature; Robin S. Dillon, Ph.D. (Pittsburgh), Philosophy; Elizabeth N. Fifer, Ph.D. (Michigan), English; Edward J. Gallagher, Ph.D. (Notre Dame), English; Lucy C. Gans, M.F.A. (Pratt), Art and Architecture; Diane T. Hyland, Ph.D. (Syracuse), Psychology; Judith N. Lasker, Ph.D. (Harvard), Sociology and Anthropology; Ageliki Nicolopoulou, PhD. (U.C., Berkeley), Psychology; Laura Katz Olson, Ph.D. (Colorado), Political Science; Jill E. Schneider, Ph.D. (Wesleyan), Biological Sciences; Laurence J. Silberstein, Ph.D. (Brandeis), Philip & Muriel Berman Professor of Jewish Studies and Religion Studies; Lloyd H. Steffen, Ph.D. (Brown), University Chaplain and Professor of Religion Studies; Nicola B. Tannenbaum, Ph.D. (Iowa), Sociology and Anthropology; Lenore E. Chava Weissler, Ph.D. (Pennsylvania), Philip and Muriel Berman Chair of Jewish Civilization and Professor of Religion Studies.

Associate professors. Gail A. Cooper, Ph.D. (U.C., Santa Barbara), History; Erica Hoelscher, M.F.A (Northwestern) Theatre; Dawn Keetley, Ph.D., (Wisconsin, Madison), English, Women’s Studies, and American Studies; Jackie Krasas, Ph.D. (U. Southern California), Sociology and Anthropology, Director of Women’s Studies; Monica Najar, Ph.D., (Wisconsin), History; John Pettegrew, Ph.D. (Wisconsin, Madison), History; Miren Edurne Portela, Ph.D. (N.C., Chapel Hill), Modern Language and Literature; Vera S. Stegman, Ph.D. (Indiana), Modern Language and Literature.

Undergraduate Major in Women's Studies

The Women's 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. Women's studies 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 or gender. Women's studies 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 Women's Studies 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. WS 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.

I. Major Core Courses (16 credits)

Required Core Courses (12 credits)

WS 001	Women & Men in Society (4) (SS)
WS 124 (HIST 124)	Women in America (4) (SS)
WS 350	Seminar in Feminist Theory (4) (SS)

Global/Diversity (4 credits) (Please choose one of the following; cannot be double-counted in categories)

WS 42 (SOAN 42)	Sexual Minorities (4) (SS)
WS 73 (ASIA 73/GCP73/MLL 73)	Film, Fiction, and Gender in Modern China (4) (HU)
WS 110 (GCP 110/SSP 110)	Women's Work in Global Perspectives (4) (SS)
WS 123 (ANTH 123)	The Cultural Construction of Gender (4) (SS)
WS 138 (REL 138)	Women in Jewish History (4) (HU)
WS 145 (AAS 145)	African American Women Writers (4) (HU)
WS 158 (REL 158)	Sex and Gender in Judaism (4) (HU)
WS 310 (AAS 310/SSP 310)	Gender, Race, and Sexuality: The Social Construction of Differences (4) (SS)
WS 326 (SPAN 326)	Traditions and Resistance: Women Writers of Latin America (4) (HU)
WS 327 (FREN 327)	Women Writing in French (4) (HU)

II. Major Concentration students must concentrate in

- Social Science or Humanities (8 credits)
- 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.

III. Major Non-concentration either from social science if humanities concentration OR humanities if social sciences concentration, 4 credits total.

IV. Major Electives. Can be any combination of social science and humanities for 8 credits total.

V. Major Senior Experience. Choose internship, independent research, or senior thesis (2 - 4 credits).

Social Science Courses:

WS 41 (SOAN 41)	Human Sexuality (4) (ND)
WS 42 (SOAN 42)	Sexual Minorities (4) (SS)
WS 110 (GCP 110/SSP 110)	Women's Work in Global Perspective (4) (SS)
WS 117 (HIST 117/STS 117)	Women, Science, and Technology (4) (SS)
WS 123 (ANTH 123)	The Cultural Construction of Gender (4) (SS)

WS 128 (SSP 128)	Race, Gender, and Work (4) (SS)
WS 130 (ECO 130)	Economics of Race and Gender (2)(SS)
WS 179 (POLS 179)	Politics of Women (4) (SS)
WS 310 (AAS 310/SSP 310)	Gender, Race, and Sexuality: The Social Construction of Differences (4) (SS)
WS 318 (PSYC 318)	Seminar in Gender and Psychology (4) (SS)
WS 325 (HIST 325/SSP 325)	History of Sexuality and the Family in the U.S. (3-4) (SS)
WS 341 (HMS 341/SSP 341)	Women and Health (4) (SS)
WS 351 (SSP 351)	Gender and Social Change (4) (SS)
WS 364 (SSP 364)	Sociology of the Family (4) (SS)
WS 365 (SSP 365)	Inequalities at Work (4) (SS)

Special Topics Courses 91, 191, 272, 291, 371, 381, 382, 391, 392 (1-4) (ND)

Humanities Courses:

WS 8 (REL 8)	Prehistoric Religion, Art, and Technology (4) (HU)
WS 73 (ASIA 73/ GCP 73/MLL 73)	Film, Fiction, and Gender in Modern China (4) (HU)
WS 121 (ART 121/)	Women in Art (4) (HU)
WS 129 (DES 129/THTR 129)	History of Fashion and Style (4) (HU)
WS 138 (REL 138)	Women in Jewish History (4) (HU)
WS 145 (AAS 145)	African American Women Writers (4) (HU)
WS 158 (REL 158)	Sex and Gender in Judaism (4) (HU)
WS 184 (REL 184)	Religion, Gender, and Power (4) (HU)
WS 226 (PHIL 226)	Feminism and Philosophy (4) (HU)
WS 303 (GERM 303/MLL 303)	Grimms' Fairy Tales: Folklore, Feminism, Film (4)
WS 311 (ENGL 311)	Literature of Women (4) (HU)
WS 326 (SPAN 326)	Tradition and Resistance: Women Writers of Latin America (4) (HU)
WS 327 (FREN 327)	Women Writing in French (4) (HU)
WS 346 (LAS 346/SPAN 346)	Contemporary Hispanic Women Writers: The Novelists (4) (HU)

Special Topics Courses 91, 191, 272, 291, 371, 381, 382, 391, 392 (1-4) (ND)

Senior Experiences:

WS 271	Independent Reading and Research (1-4) (SS/HU
WS 330	Internship in Women's Studies (1-4) (SS)
WS 373	Internship in Women's Center (1-3) (SS)

Undergraduate Minor in Women's Studies

The minor in Women's Studies engages students in the study of two 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.

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, Women's Studies courses attend to women's diverse experiences and perspectives and acknowledge the critical significance of gender. By shifting the focus to women and gender, Women's Studies seeks to provide an alternative paradigm for understanding human experience. Students in Women's Studies 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 Women's Studies consists of a minimum of 18 credit hours. Students pursuing the minor are required to take the introductory course (WS 001) and one upper-level course from among those concerned with the theory and practice of Women's Studies. The remaining courses 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 (18 credits total); 6 credits from the following courses and an additional 12 credits of courses other than those listed here:

WS 001 Women & Men in Society (4)

And any one of the following

WS 271	Independent Reading and Research (1-4)
WS 330	Internship in Women's Studies (1-4)
WS 350	Seminar in Feminist Theory (4)
WS 373	Internship in Women's Center (1-3)

Undergraduate Course Descriptions

In addition to these courses, new courses may be offered annually. Students should check with the director for an updated list.

WS 001. Women & Men in Society (4)
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. (SS)

WS 008. (REL 008) Prehistoric Religion, Art, and Technology (4)
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. Girardot (HU)

WS 041. (SOAN 041) Human Sexuality (4)
Sexuality and gender roles across the life cycle, including human reproduction, decision-making, and the societal regulation of sexual behavior. (ND)

WS 042. (SOAN 042) Sexual Minorities (4)
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. (SS)

WS 073. (ASIA 073, GCP 073, MLL 073) Film, Fiction, and Gender in Modern China (4)
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. Cook (HU)

WS 110. (GCP 110, SSP 110) Women's Work in Global Perspectives (4)
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. Krasas (SS)

WS 117. (HIST 117, STS 117) Women, Science, and Technology (4)
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. Cooper (SS)

WS 121. (ART 121) Women in Art (4)
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. Gans (HU)

WS 123. (ANTH 123) The Cultural Construction of Gender (4)
Comparative study of the meanings and social roles associated with gender. Psychological, symbolic, and cultural approaches. Tannenbaum (SS)

WS 124. (HIST 124) Women in America (4)
Roles of women in American society from colonial to present times : attitudes toward women, female sexuality, women's work, and feminism. Cooper, Najar (SS)

WS 128. (SSP 128) Race, Gender, and Work (4)
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. Krasas (SS)

WS 129. (DES 129/THTR 129) History of Fashion and Style (4)
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. (HU)

WS 130. (ECO 130) Economics of Race and Gender (2)
The question of the role of race and gender in economic decision-making is explored. Various sorts of discrimination are discussed in an economic framework and possible remedies are evaluated. The historical role of race and gender in the economy is also discussed. Prerequisite: ECO 1. (SS)

WS 138. (REL 138) Women in Jewish History (4)
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. Weissler (HU)

WS 145. (AAS 145) African American Women Writers (4)
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. Staff (HU)

WS 158. (REL 158) Sex and Gender in Judaism (4)
Writings by Jewish feminists reflecting the encounter between Judaism and feminism: prayer and ritual, women rabbis, God and God language, communal power, and marriage and divorce. Silberstein (HU)

WS 179. (POLS 179) Politics of Women (4)
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. Olson (SS)

WS 184. (REL 184) Religion, Gender, and Power (4)
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. Silberstein (HU)

WS 226. (PHIL 226) Feminism and Philosophy (4)
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. Prerequisite: At least one previous course in philosophy or women's studies. Dillon (HU)

WS 271. Independent Reading and Research (1-4)
Independent study of selected topics designated and executed in close collaboration with a member of Women's 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. Prerequisite: consent of the Women's Studies program director. (SS/HU)

WS 330. Internship in Women's Studies (1-4)
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 Women's Studies 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. Prerequisites: WS 001 and consent of the Women's Studies program director. (SS)

WS 275. (LAS 275/SPAN 275) Introduction to Hispanic Women Writers (4)
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. Portela (HU)

WS 303 (GERM 303, MLL 303) Grimms' Fairy Tales: Folklore, Feminism, Film (4)
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. Stegmann (HU)

WS 310. (AAS 310, SSP 310) Gender, Race, and Sexuality: The Social Construction of Differences (4)
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. Prerequisite: WS 001 or department permission. Saunders (SS)

WS 311. (ENGL 311) Literature of Women (4)
Constructions of gender in literature from different historical periods, traditions, and nationalities, with a focus on the ways that women writers imagine their own literary authority. Context changes each semester. (HU)

WS 318. (PSYC 318) Seminar in Gender and Psychology (4)
Gender as shaped by psychological and social psychological processes. Socialization, communication and power, gender stereotypes, methodological issues in sex differences research. Prerequisite: PSYCH 210 completed or concurrent or consent of instructor. Department permission required. (Advanced Psychology Seminar) Hyland (SS)

WS 325. (HIST 325, SSP 325) History of Sexuality and the Family in the U.S. (3-4)
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. Najar (SS)

WS 326. (SPAN 326) Tradition and Resistance: Women Writers of Latin America (4)
Study of poetry and narrative works by Latin American women writers. Authors include Rosario Ferré, Rosario Castellanos, Elena Poniatowska, Cristina Peri Rossi, among others. Prerequisite: Spanish 152 or equivalent. (HU)

WS 327. (FREN 327) Women Writing in French (4)
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 Chédid. Chabut
(HU)

WS 331 (SSP 331) Gendered Experience of Globalization (4)
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. Zhang (SS)

WS 341. (HMS 341, SSP 341) Women and Health (4)
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. Lasker (SS)

WS 346. (LAS 346, SPAN 346) Contemporary Hispanic Women Writers: The Novelists (4)
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 cannon 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 cannon. Special attention will be paid to issues related to interpretations of

history, exile, different forms of violence and repression, expressions of desire, and sexuality. Portela (HU)

WS 350. Seminar in Feminist Theory (4)
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. Prerequisite: WS 001 or consent of the Women's Studies program director. (SS)

WS 351. (SSP 351) Gender and Social Change (4)
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. (SS)

WS 364. (SSP 364) Sociology of the Family (4)
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. Staff (SS)

WS 365. (SSP 365) Inequalities at Work (4)
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. Krasas (SS)

WS 373. Internship in Women's Center (1-3)
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 Women's Studies minor must take the Women's Center internship for (3). This course may be repeated for credit up to a maximum of 6 credits. Prerequisites: WS 001 and consent of the Women's Center director. Jones (SS)

WS 91, 191, 272, 291, 371, 381, 382, 391, 392. Special Topics (1-4)
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. Prerequisite: consent of the Women's Studies program office. (ND)

Graduate Certificate in Women's Studies

The Graduate Certificate in Women's Studies 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 Women's Studies Program offers the Graduate Certificate as a means to enrich academic, personal, and employment horizons. A Certificate in Women's Studies 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:

- 4 courses for a total of at least 12 credits
- 2 courses outside home department (for matriculating students)
- WS 450 Seminar in Feminist Theory

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.

Graduate Course Descriptions

WS 403 (GERM 403) Grimms' Fairy Tales: Folklore, Feminism, Film (3)
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. Stegmann (HU)

WS 411. (ENGL 411) Literature of Women (3)
Constructions of gender in literature from different historical periods, traditions, and nationalities, with a focus on the ways that women writers imagine their own literary authority. Context changes each semester. (HU)

WS 418 (SSP 418) Gendered Experience of Globalization (3)
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. Zhang (SS)

WS 430. Internship in Women's Studies (1-3)
Internship related to women's studies. Supervised by Women's Studies faculty. Prerequisite: consent of the Women's Studies program director. (SS)

WS 441. (SSP 441) Women and Health (3)
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. Staff (SS)

WS 450. Seminar in Feminist Theory (3)
A graduate seminar providing foundational study of multidisciplinary theoretical frameworks of women's studies. (SS)

WS 458. (HIST 458) Readings in Gender History (3)
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. Cooper, LeMaster, Najar, Pettegrew (HU)

WS 465. (SSP 465) Inequalities at Work (3)
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. Krasas (SS)

WS 484. (PSYC 484) Psychology of Gender (3)
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. Prerequisite Consent of instructor. Hyland (SS)

WS 491. Independent Study (3)
Individually supervised course in area of Women's Studies not ordinarily covered in regularly listed courses. Prerequisite: consent of the Women's Studies program director. (SS)

VI. 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 4,650 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 2,000 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 at the end of 1986. It links the Asa Packer and Murray H. Goodman campuses and brings 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 400 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. Today he is professor emeritus of government, and lives in Oregon.

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 purposed 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 17th 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's 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 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 North East 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 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 1971-72 and received the prestigious L-in-Life Award in 1979. An ROTC student at Lehigh, Hittinger 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 Farrington's 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, Lamberton Hall, Maginnes Hall, Wilbur Power House, 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 BS 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 Superieure de Physique et de Chimie Industrielles in Paris.

Dr. Gast has served on numerous advisory committees, including the Homeland Security Science and Technology Advisory Committee and the National Research Council Committee for Science, Technology, and the Law. She was elected to the Board of the American Association for the Advancement of Science in 2006. 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.

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 Ben Franklin Technology Partners of Northeastern Pennsylvania, 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, five of which are owned by the University, including a landmark tower building visible for miles around. Acquisition of the facilities — the largest single transaction in Lehigh history — connects 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, and Ben Franklin TechVentures incubator companies.

Technology Center. 125 Goodman Drive (1972). Situated on the Murray H. Goodman Campus in Saucon Valley, the building houses the Lehigh-based North East Tier Ben Franklin Advanced Technology Center, the Manufacturers Resource Center, and the University Communications office.

University Buildings

Lehigh has a major collection of 19th 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 1000-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).

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.

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.

Campus Landmarks

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, the military science (ROTC) department, the Women's Networking Center, The Center for Academic Success, a bank office, and conference facilities.

Academic and Research Facilities

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.

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, 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.

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. It most recently housed the music department until its move to the Zoellner Arts Center. In January of 2006 it reopened as a late-night diner called the "Hawk's Nest" and student programming facility.

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 Science, Technology, and Society Program, the Philip and Muriel Berman Center for Jewish Studies, and the Center for International 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 operates in conjunction with the E. W. Fairchild-Martindale Library and Computing Center.

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, 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 $62.1 million facility is the university's first "green" building with the goal of LEED silver 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 IBE (Integrated Business and Engineering).

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

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 upper level houses the Ulrich Student Center, including movie theatre, gameroom, and mailboxes. The lower level houses the recently renovated Leeman-Turner Arena.

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

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 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 Residential College (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 16 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.

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
Psi Upsilon	1884	1909	1966
Sigma Chi	1953	1953	
Sigma Phi Epsilon	1907	1963	
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.

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	

VII. 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. Daniel E. Smith Jr., chair William F. Hecht, vice chair Dennis E. Singleton III, vice chair Frank A. Roth, corporate secretary Denise M. Blew, treasurer and assistant secretary David L. Hammer, assistant treasurer

Members of the Board

Peter E. Bennett, B.S. '63, M.B.A. '67, Columbia University; chairman/chief executive officer, Liberty Partners LP

Nancy M. Berman, B.A. '67, Wellesley College; M.A. '77, Hebrew Union College; Honorary Doctor of Humane Letters '97; president, Philip and Muriel Berman Foundation; Museum Director Emerita, Skirball Cultural Center

Nicholas P. Bigelow, B.S. '80, B.S. '81, M.S. (no year available) Cornell University, Ph.D. '89, Cornell University, department chair and Lee A. DuBridge professor of physics and professor of optics, University of Rochester

Robert L. Brown, III, B.S. '78, partner, Pricewaterhouse Coopers

Maria K. Chrin, B.S. '87, MBA '89, '10P, Columbia University, managing partner, Circle Wealth Management, LLC

Kevin L. Clayton, B.A. '84, M.B.A. '88, St. Joseph's University; principal, Oaktree Capital Management LLC

Janet G. Davidson, B.A. '78,M.S. '79, Georgia Tech University; president, Quality and Customer Care, Alcatel-Lucent, Inc.

John R. Delaney, B.A. '64, M.A. '67, University of Virginia, Ph.D. '77, University of Arizona, professor of oceanography, Jerome M. Paros Endowed Chair in Sensor Networks, University of Washington

Patrick A. Fischer, B.S. '97, M.S. '98, safesforce.com

Eduardo D. Glandt, B.S. '68 University of Buenos Aires, M.S. '75, University of Pennsylvania, Ph.D. '77, University of Pennsylvania, Dean of the School of Engineering and Applied Science, University of Pennsylvania

Margaret E. Goodman, B.S. '80, '13P

Daniel Haime, B.S. '82, Trans Oceanic Corporation

Francis J. Ingrassia, B.S. '75, president and chief executive officer, Clever Devices

Jane P. Jamieson, B.A. '75, M.S. '76, Boston University, retired executive vice president, Pyramid Global Advisors.

Paul N. Leitner, B.S. '76, M.B.A. '80, New York University, principal, The Leitner Thomas Group

Mark V. Mactas, B.A. '74, deputy chairman, president and chief operating officer, Towers Watson

John E. McGlade, B.S. '76, M.B.A. '81, president & chief executive officer, Air Products & Chemicals, Inc.

Marc L. Paley, B.S. '83, M.B.A. '87, Columbia University, chief executive officer & president, Beacon Trust Company

Joseph R. Perella, B.S. '64, M.B.A. '72, Harvard University, principal, Perella Weinberg Partners LP

J. Stuart Ryan, B.S. '81, M.B.A. '86, '11P, '13P, Harvard University, owner, Rydout LLC

Brad Eric Scheler, B.A. '74, J.D. '77, '05P, '08P, Hofstra University; senior partner, Fried, Frank, Harris, Schriver & Jacobson LLP

Sarat Sethi, B.S. '92, M.B.A. '97, Harvard Business School, principal portfolio manager/equity analyst/partner, Douglas C. Lane & Associates

Philip B. Sheibley, B.S. '81, managing partner, Accenture LLP

Dennis E. Singleton, III, B.S. '66; M.B.A. '68, Harvard University; partner, Spieker Properties, Inc.

Daniel E. Smith, Jr., B.S. '71, M.B.A. '76, Harvard University, president and CEO, Sycamore Networks, Inc.

Tara I. Stacom, B.S. '80, vice chairman, Cushman & Wakefield, Inc.

Ralph Albert Thomas, B.S. '76, M.B.A. '77, executive director, New Jersey Society of CPA's

Kathleen D. Trimble, B.A. '87, principal, Duggan Resources, LLC

Ronald J. Ulrich, B.S. '67; M.B.A. '71, '98P, '99P, New York University, Breithorn Capital Management

Karen O'Donnell VanderGoot, B.A. '99, M.P.P. '02, Duke University, policy advisor, U.S. Department of State

John J. Vresics Jr., B.S. '81, M.B.A. '86, '12P, University of Pennsylvania, chief executive officer/president, The Step2 Company LLC

Wendell P. Weeks, B.S. '81, M.B.A. '87, Harvard University; chairman and chief executive officer, Corning Inc.

Michael D. Zisman, B.S. '70, M.S. '73, University of Pennsylvania, Ph.D. '77, University of Pennsylvania, president, Wayne Strategy Consultants

Trustees Emeriti

Dexter F. Baker, B.S. '50, M.B.A. '57, Honorary Doctor of Engineering '91, Honorary Doctor of Humane Letters '91,

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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

Alice P. Gast, Ph.D., president; 758-3156

Patrick V. Farrell, Ph.D., provost and vice president for academic affairs; 758-3605

Margaret F. Plympton, Ph.D., vice president for finance and administration; 758-3178

Joseph P. Kender, M.B.A., vice president for advancement; 758-4711

Fred J. McGrail, B.A., vice president for communications; 758-4487

Frank A. Roth, J.D., general counsel, secretary to the board; 758-3572

Joanne C. Anderson, B.A., director, Office of the President; 758-3155

Denise M. Blew, B.S., CMA, CPA, associate vice president for finance and administration and assistant secretary to the board; 758-4405

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Peter M. Gilbert, M.B.A., chief investment officer; 758-2920

Mohamed S. El-Aasser, Ph.D., vice president for international affairs; 758-2981

Paul R. Brown, Ph.D., dean, College of Business and Economics; 758-6725

Anne S. Meltzer, Ph.D., Herbert J. and Ann L. Siegel dean, College of Arts and Sciences; 758-4570

Gary M. Sasso, Ph.D., dean, College of Education; 758-3221

S. David Wu, Ph.D., dean, P.C. Rossin College of Engineering and Applied Science; 758-5308

Gerard P. Lennon, Ph.D., deputy provost for academic affairs; 758-3705

Vincent G. Munley, Ph.D., deputy provost for faculty affairs; 758-5923

J. Leon Washington, M.A., dean of admissions and financial aid; 758-3101

Bruce M. Taggart, Ph.D., vice provost for library and technology services; 758-3025

Jacqueline Matthews, M.S., associate vice president for human resources; 758-3894

Anthony L. Corallo, M.A., associate vice president for facilities services and campus planning; 758-3970

William D. Michalerya, M.B.A., M.Eng., associate vice president for government relations and economic development; 758-5802

Henry Odi, Ph.D., vice provost for academic diversity; 758-3705

College Offices

College of Arts and Sciences
Maginnes Hall
9 West Packer Avenue; 758-3300
Anne S. Meltzer, Ph.D., Herbert J. and Ann L. Siegel dean
Jeffrey Sands, Ph.D., associate dean for faculty and staff
Michael Stavola, Ph.D., associate dean, research and graduate programs
Augustine Ripa, Ph.D., associate dean, undergraduate programs

College of Business and Economics
Rauch Business Center
621 Taylor Street; 758-3400
Paul R. Brown, Ph.D., dean
Katrina Zalatan, Ph.D., associate dean and director of the undergraduate programs
Martin Saffer, Ph.D., associate dean, graduate programs

College of Education
Iacocca Hall
111 Research Drive; 758-3221
Gary M. Sasso , Ph.D., dean
Ward Cates, Ph.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
Vacant, executive director of academic outreach and special projects

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
Steve A. Schatten, 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
Donna L. Goldfeder, director

Center for Writing, Math and Study Skills
35 Sayre Drive; 758-3098
Edward E. Lotto, director

Chaplaincy Services
36 University Drive; 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
Anthony L. Corallo, associate vice president

Finance and Administration
27 Memorial Drive West; 758-3180
Margaret F. Plympton, vice president
Denise M. Blew, associate vice president

Financial Aid
218 W. Packer Avenue; 758-3181
Linda F. Bell, director

Fraternity Management Association
219 Warren Square; 758-3888
Elizabeth M. Fisher, executive director

General Counsel
27 Memorial Drive West, Room 307; 758-3572
Frank A. Roth. Esq., general counsel
Heather K. Hosfield, 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
Jacqueline Matthews, associate vice president

Institutional Research
422 Brodhead Ave.; 758-5890
J. Gary Lutz, director
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; 758-3266

Registrar
27 Memorial Drive West; 758-3200
Bruce S. Correll, 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 Relations
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
Elizabeth Scofield, executive director

Faculty and Emeriti

The first date after the name is the date of appointment to continuous service on the Lehigh University faculty or staff; the second date, when the first fails to do so, indicates the date of appointment to the present professional rank. Where the name of the institution awarding a high-level degree is not given, the institution is the same one that awarded the previous degree listed.

P.E. indicates certification as a professional engineer; C.P.A. indicates certified public accountant. A.P.R. indicates accreditation by Public Relations Society of America.

A

John H. Abel, Jr. (1985, 2003), professor emeritus of biological sciences. B.A., Wooster, 1959; M.A., Brown, 1964; Ph.D., 1966.

John W. Adams (1965, 1995), professor emeritus of industrial engineering. B.S., Nebraska, 1952; Ph.D., North Carolina, 1962; CQE.

Eugene O. Albulescu (1997, 2007), Ronald J. Ulrich chair in orchestral and string music and associate professor of music. P.D., Conservatorium of Music (New Zealand), 1988; A.D., Indiana, 1992; M.M., 1994; B.D., Rongotai (New Zealand), 1997.

Jack A. Alhadeff (1982, 2009), professor emeritus of chemistry. B.A., Chicago, 1965; Ph.D., Oregon Medical School, 1972.

Carlos J. Alvare (1984), professor emeritus of art, architecture and design. B. Arch., Yale, 1947; M.C.P., Pennsylvania, 1954; M. Arch., Yale, 1973.

Saladin M. Ambar (2011), assistant professor of political science. B.S., Georgetown, 1990; M.A., The New School for Social Research, 1994; Ph.D., Rutgers, 2008.

David Curtis Amidon, Jr. (1965, 2008), professor emeritus of urban studies. B.A., Juniata, 1957; M.A., Pennsylvania State, 1959.

David J. Anastasio (1986, 2007), professor of earth and environmental sciences. B.A., Franklin and Marshall, 1980; M.A., Johns Hopkins, 1984; Ph.D., 1988.

Anne-Marie Anderson (2003, 2009), Joseph R. Perella and Amy M. Perella Chair and associate professor of finance. B.S., U.S. Military Academy, 1987; M.B.A., Tulsa, 1998; Ph.D., Arizona, 2003.

David C. Angstadt (2009), professor of practice of finance. B.S., Lehigh, 1987; M.S., 2001; Ph.D., 2004.

Rosemarie Arbur (1972, 2000), professor emerita of English. B.A., Nazareth, 1966; M.A., Illinois, 1967; Ph.D., 1972.

Diego Argibay (2010), lecturer of modern languages and literature. B.A., Duke, 1992; M.A., North Carolina at Chapel Hill, 1998.

Marie-Sophie Armstrong (1986, 1992), associate professor of modern languages and literature. B.A., Institut Superieur d'Interpretariat et de Traduction (France), 1979; B.A., Sorbonne (France), 1979; M.A., Oregon, 1982; Ph.D., 1986.

J. Richard Aronson (1965, 1972), William L. Clayton professor of business and economics and director, Martindale Center for the study of private enterprise. B.A., Clark, 1959; M.A., Stanford, 1961; Ph.D., Clark, 1964.

Catherine M. Arrington (2005), assistant professor of psychology. B.A./B.S., Furman, 1994; M.A., Wake Forest, 1996; Ph.D., Michigan, 2002.

Lloyd W. Ashby (1966, 1971), professor emeritus of education and human services. A.B., Hastings, 1927; M.A., Teachers College, Columbia, 1935; Ed.D., 1950.

Betzalel Avitzur (1964, 1995), professor emeritus of materials science and engineering. B.S., Israel Inst. of Tech. (Israel), 1947; Dip., 1949; M.S., Michigan, 1956; Ph.D., 1961.

B

D. Raymond Bainbridge (1972, 2001), professor emeritus of accounting. B.S., Rider, 1963; M.S., Lehigh, 1972; Ph.D., 1978; C.P.A., Pennsylvania, 1971.

Henry S. Baird (2004), professor of computer science and engineering. B.A., Harvard, 1966; M.S., Rutgers, 1976; Ph.D., Princeton, 1984.

Nicholas W. Balabkins (1957, 1994), professor emeritus of economics. Dipl.rer.pol., Gottingen (Germany), 1949; M.A., Rutgers, 1953; Ph.D., 1956.

Linda M. Bambara (1988, 2002), associate chair and professor of education and human services. B.S., SUNY at Oneonta, 1975; M.S.Ed., SUNY at Binghamton, 1977; Ed.D., Vanderbilt, 1985.

Soutir Bandyopadhyay (2010), assistant professor of mathematics. B.Sc., St. Xavier's College (India), 2003; M. Stat., Indian Statistical Institute (India), 2005; Ph.D., Texas A&M, 2010.

Thoburn V. Barker (1953, 1984), professor emeritus of speech. B.A., Ohio Wesleyan, 1943; M.A., Columbia, 1951.

Henri J. Barkey (1987, 1999), Bernard L. and Bertha Cohen professor of international relations. B.Sc., City Univ. (London), 1975; M.Sc., Univ. College (London), 1976; Ph.D., Pennsylvania, 1984.

Robert F. Barnes, Jr. (1965, 1995), professor emeritus of philosophy and professor emeritus of computer science. B.S., M.I.T., 1957; M.A., Dartmouth, 1959; Ph.D., California at Berkeley, 1965.

Susan E. Barrett (1987, 1994), associate professor of psychology. B.A., Clark, 1981; ScM., Brown, 1983; Ph.D., 1987.

Donald D. Barry (1963, 2000), university professor emeritus of political science. B.A., Ohio, 1956; M.A., Syracuse, 1959; Ph.D. 1963.

Richard W. Barsness (1978, 2004), dean emeritus, college of business and economics and university service professor emeritus of management. B.S., Minnesota, 1957; M.A., 1958; M.A., 1960; Ph.D., 1963.

Filbert Bartoli (2005), Chandler-Weaver chair and chairperson of electrical and computer engineering. B.E.E., Catholic University of America, 1965; M.E.E., 1967; Ph.D., 1971.

Daniel Bayak (2007), professor of practice of finance. B.S., Bloomsburg, 1971; M.B.A., Scranton, 1974.

Michael G. Baylor (1976, 1990), chairperson and professor of history. B.A., Knox, 1964; M.A., Stanford, 1966; Ph.D., 1971.

Floyd D. Beachum (2009), Peter E. Bennett '63 chair in urban principalship and associate professor of education and human services. B.S., Alabama State, 1995; M.E., 1999; Ph.D., Bowling Green State, 2002.

Barry S. Bean (1973, 1998), professor of biological sciences. B.S., Tufts, 1964; Ph.D., Rockefeller, 1970.

Gordon C. F. Bearn (1986, 2002), professor of philosophy. B.A., Williams, 1977; B.A., Oxford, 1979; Ph.D., Yale, 1985.

Gray E. Bebout (1991, 2003), professor of earth and environmental sciences. B.S., Texas, 1981; M.A., 1984; Ph.D., California at Los Angeles, 1989.

Michael J. Behe (1985, 1997), professor of biological sciences. B.S., Drexel, 1974; Ph.D., Pennsylvania, 1978.

Carl R. Beidleman (1967, 1995), DuBois professor emeritus of finance. B.S., Lafayette, 1954; M.B.A., Drexel, 1961; Ph.D., Pennsylvania, 1968.

Peter G. Beidler (1967, 2007), Lucy G. Moses distinguished professor emeritus of English. B.A., Earlham, 1962; M.A., Lehigh, 1965; Ph.D., 1968.

Liuba Y. Belkin (2007), assistant professor of management. B.S., Institute for Economics and Law (Russia), M.S., 1997; M.B.A., Rutgers, 2002; Ph.D., 2002.

Raymond Bell (1966, 2004), university service professor emeritus of education and social relations. Teaching Cert., St. John's (England), 1961; M.A., Temple, 1967; Ed.D., Lehigh, 1971.

Russell E. Benner (1962), professor emeritus of mechanical engineering and mechanics. B.S., Cornell, 1947; M.S., Lehigh, 1951; Ph.D., 1959; P.E., Pennsylvania, 1970.

Bryan W. Berger (2010), assistant professor of chemical engineering. B.S., Illinois at Urbana-Champaign, 1999; Ph.D., Delaware, 2005.

Taïeb Berrada (2009), assistant professor of French, modern languages and literature. Maîtrise de langues étrangères appliqués, Paul Valéry (France), 1997; M.A., North Carolina at Chapel Hill, 2001; Ph.D., Northwestern, 2007.

William A. Best (2008) professor of practice of electrical and computer engineering. B.S.M.E., Tufts, 1981; M.S., Virginia Polytechnic Inst. and State University, 1984; Ph.D., London (United Kingdom).

Ivan Biaggio (2002, 2010), professor of physics. M.S., Swiss Federal Inst. of Tech. (Switzerland), 1986; Ph.D., 1993.

Mark H. Bickhard (1990), Henry R. Luce professor in cognitive robotics and director, institute for interactivist studies. B.S., Chicago, 1966; M.S., 1970; Ph.D., 1973.

Jerry T. Bidlack (1973, 1995), professor emeritus of music. B.A., Oberlin, 1953; M.A., Boston, 1957.

Mary Jean Bishop (2001, 2007), associate professor of education and human services. B.A., Lebanon Valley, 1984; M.A., Millersville, 1987; Ed.D., Lehigh, 2000.

Glenn D. Blank (1984, 2011), professor emeritus of computer science and engineering. B.A., Pennsylvania State, 1974; M.A., Michigan, 1975; M.S., WisconsinMadison, 1983; Ph.D., 1984.

Rick S. Blum (1991, 2002), Robert W. Wieseman chair in electrical engineering and professor of electrical and computer engineering. B.S., Pennsylvania State, 1984; M.S., Pennsylvania, 1987; Ph.D., 1991.

Philip A. Blythe (1968, 1970), professor of mechanical engineering and mechanics. B.Sc., Manchester (England), 1958; Ph.D., 1961.

Alec M. Bodzin (1999, 2005), associate professor of education and human services. B.S., Michigan, 1988; M.Ed., George Washington, 1992; Ph.D., North Carolina State, 1999.

John W. Bonge (1972, 2002), professor emeritus of management. B.S., Princeton, 1957; M.B.A., Northwestern, 1959; Ph.D., 1968.

Robert Booth (2006), assistant professor of earth and environmental sciences. B.S., Pennsylvania State, 1995; M.S., Georgia Southern, 1998; Ph.D., Wyoming, 2003.

Berrisford W. Boothe (1989, 1996), associate professor of art, architecture and design. B.A., Lafayette, 1983; M.F.A., Maryland Institute, 1986.

Garold J. Borse (1966, 2007), professor emeritus of physics. B.S., Detroit, 1962; M.S., Virginia, 1964; Ph.D., 1966.

Amanda C. Brandone (2010), assistant professor of psychology. B.A., Boston College, 2003; M.A., Michigan, 2007; Ph.D., 2010.

Paul D. Brockman (2009), Joseph R. Perella and Amy M. Perella chair and professor of finance. B.A., Ohio State, 1983; M.B.A., Nova, 1987; M.B.A., Florida Atlantic, 1989; Ph.D., Louisiana State, 1994.

Jay D. Brodish (2009), professor of practice of accounting. B.S., Lehigh, 1966.

Addison C. Bross (1967, 2009), professor emeritus of English. B.A., Davidson, 1959; M.A., Duke, 1960; Ph.D., Louisiana State, 1967.

Derick G. Brown (2001, 2007), associate professor of civil and environmental engineering. B.S., Boston, 1986; M.S., California, 1994; M.A., Princeton, 1996; Ph.D., 2000.

Forbes T. Brown (1970, 2004), professor emeritus of mechanical engineering and mechanics. B.S., M.I.T., 1958; M.S., 1958; Mech.E., 1959; Sc.D., 1962.

Jill A. Brown (2007), assistant professor of management. B.A., Lehigh, 1983; M.B.A., Augusta State, 1998; Ph.D., Terry College of Business, Georgia, 2007.

Paul Brown (2007), dean of the college of business and economics and professor of accounting. B.A., Franklin and Marshall, 1972; M.P.A., Texas at Austin, 1978; Ph.D., 1979.

Stephen G. Buell (1973, 1995), professor of finance. B.S., Lehigh, 1970; M.A., 1971; Ph.D., 1977.

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R. Michael Burger (2006), assistant professor of biological sciences. B.A., Ithaca College, 1993; Ph.D., Texas at Austin, 2000.

Christopher T. Burke (2008), assistant professor of psychology. B.S., Carnegie Mellon, 2003; Ph.D., New York, 2008.

Matthew Bush (2008), assistant professor of modern languages and literature. B.A., Nebraska at Lincoln, 2000; M.A., Colorado at Boulder, 2003; Ph.D., 2008.

Sidney R. Butler (1969, 1991), professor emeritus of materials science and engineering. B.S., Maine, 1954; M.S., Pennsylvania State, 1956; Ph.D., 1960.

C

Mary Beth Calhoon (2010), associate professor of education and human services. B.A. Oklahoma, 1984; M.Ed., Oral Roberts, 1994; Ph.D., Vanderbilt, 1999.

Huai-Dong Cao (2003), A. Everett Pitcher professor of mathematics. B.A., Tsinghua (China), 1981; M.A., Princeton, 1983; Ph.D., 1986.

Amy Hitchcock Camp (2010), assistant professor of biological sciences. A.B., Princeton, 1997; Ph.D., Harvard, 2003.

Hugo S. Caram (1977, 1986), professor of chemical engineering. B.S., Buenos Aires (Argentina), 1967; Ph.D., Minnesota, 1977.

G. Slade Cargill III (1997, 2008), Sherman Fairchild professor emeritus of materials science and engineering. B.S., Georgia Institute of Technology, 1966; S.M., Harvard, 1966; Ph.D., 1969.

Kimberley Carrell-Smith (2002), professor of practice of history. B.A., Wesleyan, 1979; M.A., Delaware, 1981; Ph.D., 1989.

Bobb Carson (1971, 2003), dean emeritus and professor emeritus of earth and environmental sciences. B.A., Carleton, 1965; M.S., Washington, 1967; Ph.D., 1971.

Grace Caskie (2004, 2010), associate professor of education and human services. B.A., Millersville, 1993; M.A., North Carolina, 1996; Ph.D., 1998.

Lynne U. Cassimeris (1992, 2004), professor of biological sciences. B.S., Springfield, 1980; Ph.D., North Carolina at Chapel Hill, 1988.

Alfred J. Castaldi (1966, 1987), professor emeritus of education and human services. B.S., Pennsylvania, 1951; M.S., 1956; Ed.D., 1964.

Ward M. Cates (1991, 2007), associate dean of the college of education and professor of education and human services. B.A., Duke, 1971; Ed.D., 1979.

MarieHélène Chabut (1988, 2000), chairperson and professor of modern languages and literature. Licence de Lettres Modernes, Université de Toulouse (France), 1977; Maïtrise de Lettres Modernes, 1979; C. Phil., California at San Diego, 1982; Ph.D., 1984.

Helen M. Chan (1986, 1995), New Jersey Zinc Company professor and chairperson of materials science and engineering. B.S., Imperial College of Science Tech. (England), 1979; Ph.D., 1982.

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