IE 316: Optimization Models and Applications
Fall 2010

1 Course Information

Meeting Times: Tuesdays and Thursdays, 10.45am-12pm
Location: Mohler 451
Course Webpage: available through CourseSite.

Instructor: Prof. Aurélie Thiele
Contact Info:
Office: Mohler 329
Office Hours: TBA
Phone: 8-2903
Email: aurelie.thiele@lehigh.edu (preferred)

Teaching Assistant: Ruken Düzgün
Contact Info:
Office: Mohler 472
Office Hours: TBA
Phone: 8-4043
Email: rud207@lehigh.edu

Prerequisites: IE 220 or equivalent.

2 Objectives of the course

Short version: The objective of this course is to make sure that students will be able to model common real-life problems, solve them on the computer and interpret the results correctly, if they are ever asked to do so in their job after graduation.

Long version: The objective of this course is to practice modeling and analysis tools in deterministic operations research, with an emphasis on real-life applications. We will cover mathematical programming techniques in the fields of linear, integer and nonlinear optimization, and apply them to problems in production planning, revenue management and financial engineering. Other topics will depend on the students' interests.

Specifically, upon completion of the course, students will be able to:

- model a wide range of real-world applications,
- understand what makes some formulations more difficult than others,
- solve small-size problems by hand using graphical analysis,
- solve problems using available software,

- analyze the solution given by the computer,
- have a basic understanding of the algorithms involved.

A detailed list of objectives for each part of the course will be posted on CourseSite one week before each quiz.

3 Course Logistics

3.1 Textbook

There is no required textbook for this course. I will post three course packets on Blackboard, which we will go over in class. **You are expected to print the course packet we are currently working on and bring it with you in class.** The course packets contain a lot of blanks that we fill together, so it is important that you attend the lectures. I will also provide sample exercises with solutions and sample quizzes from previous years to help you understand the material. I also plan to provide course notes to help you prepare for the quizzes.

3.2 Grading scale

There will be 6 assignments, 3 in-class quizzes and a final project. There will be no final exam. **Each assignment must be submitted on its due date.** Your grade will be determined as follows:

- assignments: 24% (4% each), scheduled for Thursdays September 9 and 16, October 7, Tuesday October 19, Thursday November 4. Last assignment will be due in late November, date TBD.
- quizzes: 51% (17% each), to be held on Thursdays, September 23, October 21 and December 2. Closed book, closed notes.
- final project: 15%.
- class participation: 10%.

I do not grade on a curve. Final grades will be based on the following Lehigh-recommended percentage system **for students who hand in all their assignments**:

A	=	93%-100%
A-	=	90%-92.99%
B+	=	87%-89.99%
B	=	83%-86.99%
B-	=	80%-82.99%
C+	=	77%-79.99%
C	=	73%-76.99%
C-	=	70%-72.99%
D+	=	67%-69.99%
D	=	63%-66.99%
D-	=	60%-62.99%
F	=	$\leq$ 59.99%

Students who do not hand in some of their assignments will have their final grade, determined as above, **lowered by one notch** (A becomes A-, A- becomes B+, etc) for each assignment they have failed to hand in, in addition to getting a zero for that assignment.

3.3 Policies for the course

Please read the following carefully.

1. You are expected to arrive on time, turn your cell phone off, refrain from reading the newspaper, refrain from text-messaging the rest of the world, and stay in class for the duration of the lecture. Students who need to leave early should notify me ahead of time.

2. Each assignment in the course must be completed on its due date. Assignments are due at the beginning of class. Late assignments will be heavily penalized. Assignments received after the solutions have been posted will not be accepted. **Failure to hand in an assignment will result, in addition to the student receiving a zero for that assignment, to the student's final grade being lowered by one grade notch.** In the past, every student has handed in all assignments.

3. Collaboration between students is allowed, but each student has to write up his or her own solutions to the problems. Students also have to write on their assignment the name of the people they have collaborated with. Students can collaborate with at most two other students on their homework, and me.

4. Any kind of cheating in any part of the course will be severely sanctioned and might result in disciplinary action.

5. Regular attendance is required for the lectures. You should let me know in advance if you are going to be absent for a job interview, an athletic event, a religious holiday, a field trip, or any other good reason. Being sick is a good reason too, but you need to email me.

6. If you plan to miss the lecture on a day where an assignment is due, you should make arrangements ahead of time so that your assignment is turned in on or before the due date. You are very strongly discouraged to miss a quiz.

7. The lectures will be a lot more enjoyable if you participate.

8. You are expected to check the course webpage regularly.

9. Taping lectures, and specifically audio recording, is **illegal** in Pennsylvania without the prior consent of all parties in attendance. (Not only is it illegal, but it is a felony.)

If you have a documented learning disability, and will be requesting academic accommodation for this class, please contact Dean Cheryl Ashcroft in the Office of the Dean of Students, UC 212, at x84152, or by email at caa4@lehigh.edu. She will establish the appropriate accommodations for your case.

4 (Tentative) Course Schedule

Last revised 8/5/10.
Topics are listed in the order we will see them.

Part 1: Linear Optimization

Applications: Production planning, inventory control.

- Introduction and Review of Linear Optimization - *Basic modelling techniques. Solving linear problems with graphs. Sensitivity analysis.*
- Using the Computer to Solve Linear Problems - *Tutorial on how to use Excel Solver and AMPL. Advantages and disadvantages of each.*
- Modeling Techniques - *Modeling using parameters instead of numbers, decision variables with two indices and summations. Data files in AMPL.*
- Network Problems and Systems Evolving Over Time - *Production planning, inventory control and transportation over multiple time periods.*
- Advanced Modeling Techniques - *Modeling using decision variables with three indices, with applications to multi-commodity transportation problems.*
- Recognizing Hidden Linear Problems - *The piecewise linear problems that can be rewritten as linear problems, and those that cannot. Why it matters.*
- Linear Optimization under Uncertainty - *Two-stage problems: making some decisions before the uncertainty is revealed, and some after. Scenarios-based formulations.*
- Additional modeling on examples.

Part 2: Integer Optimization

Applications: inventory control with setup costs, project management, logistics.

- Review on Integer Optimization - *Linear problems with integer decision variables. Issues with rounding up/down the optimal solution of the linear relaxation. Integer, binary, mixed-integer problems. Graphical analysis.*
- Binary Optimization Bootcamp - *Exercises and exercises and exercises on how to model yes-no decisions, if-then, either-or, "at most k/at least k" statements.*
- Why it matters to keep the formulation linear - *Branch-and-bound. Solving an integer problem with the computer: issues, software syntax.*
- Piecewise Linear Problems - *Problems with economies of scale, setup costs.*
- More Integer Problems - *Facility location, hub location, flight tour, traveling salesman problem.*

Part 3: Nonlinear Optimization

Applications: portfolio management, revenue management (pricing).

- Introduction to Nonlinear Optimization - *Examples of nonlinear problems: portfolio management, revenue management, facility location. Graphical analysis.*
- More on Nonlinear Optimization - *Shadow prices. Issues in solving a nonlinear problem on the computer. Local vs global optimum.*
- Optimality conditions - *Slope at zero and related items. Recognizing convex problems.*
- Revenue management - *Pricing subject to capacity constraints. Marketing problems.*
- Portfolio management - *Mean-variance problems. Characterization of the efficient frontier.*