LEHIGH UNIVERSITY

Department of Industrial
and Systems Engineering
Harold S. Mohler Laboratory
200 West Packer Avenue
Bethlehem, PA 18015-1518
Tel: (610) 758-4050 | Fax: (610) 758-4886
Web: www.lehigh.edu/ise

z Optimization Models and Applications (ISE 426)

Instructor:	Luis F. Zuluaga	**Term:**	Spring 2020
Office:	Mohler Lab #385	**Days:**	Tuesday, Thursday
Phone:	(610) 758-5182	**Time:**	12:10am-1:25 pm
Email:	`luis.zuluaga@lehigh.edu`	**Room:**	Mohler #451
Office hours:	Tu., Th., 2:00-3:00pm or by appointment	**Web page:**	`https://coursesite.lehigh.edu/`

1 Course Scope

Optimization deals with problems in which we want to maximize (or minimize) a given objective (e.g., profit, cost, completion time) that depends on several decisions (e.g., where to invest, machines or workers to be used) which must satisfy some constraints (e.g., budget, demand satisfaction, task precedences).

Optimization problems arise very often in industry, and the ability to solve them provides a competitive advantage to today's decision makers. For example, the solution of optimization models is now a cornerstone and ubiquitous tool to support decision makers in industry problems such as: yield management and crew scheduling in the airline industry; scheduling of intensive care units in hospitals; supply chain management in manufacturing; risk management in financial institutions; and routing and pricing in telecommunication networks. However, modeling and solving Optimization problems requires special tools and skills. A problem that is not understood or modeled correctly can lead to the wrong solution or can be very difficult to solve.

The purpose of this course is to provide you with the tools and knowledge necessary to model practical optimization problems and solve them efficiently.

2 Course Goals

By the end of this course, students will be able to:

- properly formulate an optimization problem
- discern the pros and cons of different possible formulations for an optimization problem
- choose an adequate solver to solve a particular optimization problem formulation
- solve real-world optimization problems with state-of-the-art solvers
- analyze the solution of an optimization problem

LEHIGH UNIVERSITY

Department of Industrial
and Systems Engineering
Harold S. Mohler Laboratory
200 West Packer Avenue
Bethlehem, PA 18015-1518
Tel: (610) 758-4050 | Fax: (610) 758-4886
Web: www.lehigh.edu/ise

3 Course Textbook and Material

There are several books on Modeling and Optimization with no overall best. No textbook in particular is required, and any of the following will be sufficient for the course:

- "Introduction to Mathematical Programming: Applications and Algorithms", Volume 1, by W.L. Winston and M. Venkataramanan;
- "Introduction to Operations Research" by F.S. Hiller and G.J. Lieberman, McGraw-Hill: New York, NY, 1990;
- "Operations Research: Applications and Algorithms" by Wayne L. Winston, PWS-Kent Pub. Co., 1991.

4 Course site

Lecture notes will be posted on CourseSite (`https://coursesite.lehigh.edu/`). Homework assignments, solutions, announcements, and other important material will also be posted on CourseSite. Important information, comments, corrections, and updates about the course may also be sent by e-mail (via CourseSite); thus, please let me know if you do not receive class e-mails sent through CourseSite.

4.1 Modeling Tools/Language

The main modeling language used to solve optimization problems will be AMPL, which is described in "AMPL: A Modeling Language for Mathematical Programming" by Robert Fourer, David M. Gay, and Brian W. Kernighan (this book is not required for the course). However, we will also discuss how to model and solve problems using EXCEL Solver, and possibly Matlab. AMPL has student versions that can be downloaded for free at `http://www.ampl.com`. In this same website, AMPL models can be solved online with different solvers. A limited version of EXCEL Solver is available free as an add-in to EXCEL.

5 Course Evaluation

The course grade will be based on a weighted average of the following components:

Homework:	25%
Midterm #1:	15%
Midterm #2:	15%
Case study:	20%
Final exam:	25%

LEHIGH UNIVERSITY

Department of Industrial
and Systems Engineering
Harold S. Mohler Laboratory
200 West Packer Avenue
Bethlehem, PA 18015-1518
Tel: (610) 758-4050 | Fax: (610) 758-4886
Web: www.lehigh.edu/ise

5.1 Grading Scale

Numerical Grade (%)	≥93	≥88	≥83	≥78	≥74	≥68	≥62	≥55	≥50	≥45	≥40	≥0
Letter Grade	A	A-	B+	B	B-	C+	C	C-	D+	D	D-	F

5.2 Case Study

An essential part of this course is a hands-on experience on real Optimization problems. **It must be completed to receive a passing grade in the course**. Groups of three-four students work on an Optimization problem, propose a model, and solve it using a tool of their choice. The result is a short report, and a short presentation (about 15 min, depending on the number of groups) on the whole experience, whose evaluation accounts for 20% of the final grade. Possible topics for the case study are: Inventory Management; Energy Management; Network design; Healthcare Management; Portfolio Optimization; etc.

5.3 Homework

There will be several **equally weighted individual** (unless otherwise stated in class) Homework assignments, related to the topics covered in class.

- Besides turning one copy of your HW to the instructor, keep a copy for your records so you can compare it to solutions even before the HW has been even marked
- **The grade of a Homework will be penalized by 10% for each day it is late, and it will not be accepted after its solution is posted on CourseSite.**
- Each homework must be turned in **at the beginning of class** on the day that it is due.
- You are free to consult with other students when working on the Homework. However, **the Homework you turn in must be your own individual work**. Please cite any references you use, including fellow students.
- You **can and will lose** credit for illegible work.

5.4 Midterms and Final Exam

- The Midterms and the Final Exam will cover topics from material presented in class, reading assignments, and Homework assignments.
- The Midterms and the Final Exam will be open book and open notes.
- The content to be evaluated on the Midterms will be discussed prior to each Midterm.
- The Final Exam will be comprehensive.
- There will be two (2) Midterms, one about the third week of February and one about the first week of April. The Midterms will be in-class for the duration of the class (75 min).
- The format and date of the Final Exam is to be announced.

LEHIGH UNIVERSITY

Department of Industrial
and Systems Engineering
Harold S. Mohler Laboratory
200 West Packer Avenue
Bethlehem, PA 18015-1518
Tel: (610) 758-4050 | Fax: (610) 758-4886
Web: www.lehigh.edu/ise

6 Tentative Calendar

The following tentative class schedule is subject to change.

Part	Subject	No. of Lectures	Topics
1	Introduction	1	Optimization models: variables, constraints, objective functions. Practical Impact.
2	Linear Programming	10	Linear Programming models: graphical solution, sensitivity analysis, duality.
2'	Optimization Solvers	4	AMPL, EXCEL Solver
3/4	Network models	4	Transportation, Shortest Path, and Assigment problems.
4/3	Integer Programming	6	Modeling with integer and binary variables. Logical constraints. Solving Integer Programs
5	Intro to Nonlinear Programming	3	Nonlinear models, Optimality conditions
6	Stochastic Programming, Robust Optimization, Machine Learning	? ? ?	Uncertainty models, Duality

7 Policies

7.1 Attendance

This course will be recorded for distance students, hence it will be available to the students on campus as well through CourseSite. However, I strongly encourage you to attend all lectures and to actively participate. The material is much harder to learn on your own.

7.2 Missed Midterm

Students who miss a Midterm for medical or other acceptable reasons will have the weight of the missed Midterm carried on to the Final Exam. For medical reason, fully documented medical documents signed by appropriate physician(s) must be provided within ten days after your recovery date. For other acceptable reasons, please provide appropriate documents within ten days of missing the Midterm.

LEHIGH UNIVERSITY

Department of Industrial
and Systems Engineering
Harold S. Mohler Laboratory
200 West Packer Avenue
Bethlehem, PA 18015-1518
Tel: (610) 758-4050 | Fax: (610) 758-4886
Web: www.lehigh.edu/ise

7.3 Accommodations for Students with Disabilities

If you have a disability for which you are or may be requesting accommodations, please contact both your instructor and the Office of Academic Support Services, University Center C212 (610-758-4152) as early as possible in the semester. You must have documentation from the Academic Support Services office before accommodations can be granted.

7.4 The Principles of Our Equitable Community

Lehigh University endorses The Principles of Our Equitable Community (`http://www4.lehigh.edu/diversity/principles`). We expect each member of this class to acknowledge and practice these Principles. Respect for each other and for differing viewpoints is a vital component of the learning environment inside and outside the classroom.

7.5 Irresponsible Behavior

Please take a look at the material about Academic Integrity available in the CourseSite website of the course. There are many forms of irresponsible behavior that can ruin opportunities for you or for others in this course; there is no room and no excuse for bad behavior. Examples of irresponsible behavior cover a wide range, and include cheating, plagiarism, creating hazards or disruptions, slacking on responsibilities, unfairly exploiting the efforts of others, etc. Further explanation and guidelines on academic integrity at Lehigh can be found on the University Student Conduct System web page `http://www.lehigh.edu/~indost/conduct/handbook/sect6.shtml`, and on the Fostering Academic Integrity at Lehigh University web site `http://www.lehigh.edu/~infdli/AcademicIntegrity.htm`. It is highly recommended that you take a look at the information in the web site `http://www.lehigh.edu/lts/official/Academic_Integrity_Vignettes.pdf`. It is firm policy in this course that cheating or plagiarism are unacceptable violations of academic integrity, and will earn an F as the semester grade in the course. Please meet requirements in good spirit, and do your part in advance of deadlines. For example, do not copy data or sections of Homework reports from students currently or previously enrolled. While students are encouraged to discuss Homework problems together, the final solution should be obtained independently, and the writing of the Homework report is an individual responsibility... do not ask for other student's work, and do not share yours with others. Various forms of carelessness or disregard for safety considerations, abuse of others, compromising opportunities for others, failing to participate in good faith, etc., can also have serious consequences. Appropriate penalties should be expected. Offenders may loose points from their course totals, and serious offenders may be dropped from the course.

Note: this syllabus is subject to change.