ISE 240: Introduction to Deterministic Models in Operations Research
Fall 2019

Syllabus

Where and When

Location: 200 Mohler Lab, Room 451

Time: Tuesday and Thursday 7:55–9:10AM

Instructor and Teaching Assistant

Daniel P. Robinson (instructor)

- Office: 200 Mohler Lab, Room 421, phone 8-4039
- E-mail: daniel.p.robinson@lehigh.edu (network ID: dpr219)
- Office Hours: Tuesday 9:10–10AM, Wednesday 4:00–5:10PM

Brandon Augustino (teaching assistant)

- Office: 200 Mohler Lab, Room 358
- E-mail: bra216@lehigh.edu
- Office Hours: Tuesday 1:00-3:00PM

Course Description

This course will introduce you to deterministic models in operations research. You will learn to formulate, analyze, and solve mathematical optimization models that represent real-world problems. We will discuss *deterministic* models, in which no uncertainty exists. The first section of the course will cover linear programming and the simplex algorithm, as well as related analytical topics. We will then discuss other types of optimization models, including transportation, network, integer, and non-linear models.

Course Objectives

Upon completion of this course, you will be able to do the following:

1. Formulate a real-world problem as a mathematical optimization model;

2. Understand the theoretical workings of the simplex method for linear programming and perform iterations of it by hand;
3. Understand the relationship between a linear program and its dual, including strong duality and complementary slackness;
4. Perform sensitivity analysis to determine the direction and magnitude of change of a model's optimal solution as the data change;
5. Solve specialized linear programming problems like the transportation and assignment problems;
6. Solve network models like the shortest path, minimum spanning tree, and maximum flow problems;
7. Understand the applications of, basic methods for, and challenges in integer programming;
8. Solve single- and multiple-variable unconstrained non-linear optimization problems;
9. Recognize the pros and cons of alternate possible formulations for an optimization problem;
10. Solve real-world optimization problems with optimization solvers.

Textbook

The textbook for the course is:

- Hillier, F. S. and Lieberman, G. J. *Introduction to Operations Research*, 10th ed., New York: McGraw-Hill, 2014.

You are expected to *read the textbook* to prepare for and reinforce the lectures.

The books below may be useful for further reading and practice material:

- Taha, H. A. *Operations Research: An Introduction*, 8th ed., Prentice-Hall, 2006.
- Winston, W. L. *Operations Research: Applications and Algorithms*, 4th ed., Duxbury Press, 2003.

Course Scope

I plan to cover Chapters 1–6, 9–10, and 12–13 of the textbook, with additional chapters added as time permits. Unless specified otherwise, you are not responsible for material in the textbook that is not covered in class.

Prerequisite

Math 205 (linear algebra).

Software

In this class we will use the modeling language AMPL. You will learn how to use this software in class and in additional lab sessions. You should download the demo version of AMPL from `http://ampl.com/try-ampl/download-a-demo-version/`.

Course Website

The course website can be found at

`http://coral.ise.lehigh.edu/danielprobinson/ise240-determ-opt-models-in-or/`.

Please check there regularly for updates.

Exams

You will have one in-class midterm exam and a final exam. The final exam will be cumulative. The exams will be closed-book and closed-notes. **No make-up exams will be given,** and no credit will be given for any missed exam.

Homework

You will have regular homework assignments. The homework assignments are likely to take you a fair amount of time, so get started on them early.

Late Assignments: Homework assignments must be received no later than 11:59PM on the due date assigned, which may always be found on the course website. Homework can be submitted in three ways: (i) handed in at the end of lecture on the day it is due; (ii) handed in to the *instructor* during office hours; or (iii) submitted as a single pdf file via email (in this case, include *both* the instructor *and* teaching assistant on the email). You *cannot* turn any homework assignment in to the teaching assistant during his/her office hour. **No credit will be given for any homework assignment turned in late.** If you wish to have a late assignment graded for no credit, we will be happy to oblige. I will drop your lowest homework grade from your average. This means you get one freebie, so please use it wisely.

Legibility: Homework must be typed or written *neatly* and with problems in the correct (assigned) order. If we have difficulty reading or following your homework, we will not go to great lengths to decipher it. Please take this seriously.

Working Together: You may work on the homework assignments individually or with a partner. If you work with a partner, you and your partner may submit a single write-up, or you may submit individual write-ups.

You may discuss the homework with students other than your partner, but you must cite any people or sources (other than Hillier and Lieberman and the lecture slides) that helped you on a particular problem. For example: "Jane Doe and I worked on this problem together" or "I got help from Jane Doe on problem #3," or "I consulted *Linear Programming for Dummies*, Section 4.2, by John Doe when solving question #2." If you work with a partner but submit individual write-ups, make sure you cite your partner. I also encourage you to come to me or the TA for help when you are stuck. To the extent that it is possible, please use the teaching assistant for help with individual homework questions and the instructor for help with broader course material questions.

Remember that you are ultimately responsible for mastering the material on your own, and your performance on the exams will depend on your ability to do so. Therefore, you should make sure that you fully understand all of the details of the write-up you submit, regardless of whether you submit an individual or joint write-up.

Re-grade Requests

If you disagree with the grade you received on a homework or exam problem, you may submit a request for that problem to be re-examined. This request must be submitted **in writing no more than 48 hours after you receive the graded assignment.** It must contain a clear explanation, in no more than one paragraph, of why you feel the grade you received is incorrect. Once we re-examine your work and decide whether to change your grade, our decision will be final.

Class Participation

You are expected to attend class regularly, come to class prepared, participate in the discussions we have in class, participate in in-class problem solving sessions, and ask questions when you are confused. A portion of your grade will be based on class participation.

Extended Absences

If you believe you will miss two or more consecutive lectures due to illness, family emergencies, etc., please contact me as early as possible so that we can develop a plan for you to make up the missed material. Under no circumstances will I give credit for missed work unless you have discussed your absence with me in advance.

Grading

Your grade will be calculated as follows:

Item	Percentage
Homework assignments	40%
Mid-term exam	25%
Final exam	25%
Class participation	10%

Use of Electronic Devices

The use of computers, smart phones, tablets, and other mobile electronic devices is permitted to be used in class but *only* as a tool for taking notes on lecture material. Any other use of electronic devices without my prior consent is prohibited.

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, Williams Hall, Suite 301 (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.

The Principles of Our Equitable Community

Lehigh University endorses The Principles of Our Equitable Community `http://www.lehigh.edu/~inprv/initiatives/PrinciplesEquity_Sheet_v2_032212.pdf`. 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.

Academic Integrity

Read the material on Academic Integrity available on the Provost's Academic Integrity site (`http://www.lehigh.edu/~inprv/faculty/academicintegrity.html`) and on the CITL web site (`https://citl.lehigh.edu/academic-integrity-resources`). Example behaviors that violate Lehigh's academic integrity principles include (but are not limited to) plagiarism, cheating, copying assignments from previous semesters, creating disruptions, and unfairly exploiting the efforts of others.

Perhaps the most misunderstood violation of academic integrity is plagiarism. Plagiarism is defined in the Lehigh student handbook as "the unacknowledged appropriation of another's work, words,

or ideas in any themes, outlines, papers, reports, or computer programs." This includes "innocent plagiarism," in which an author essentially quotes another author's work when paraphrase it.

There will be a zero-tolerance approach to academic integrity violations in this class: **Work that violates the academic integrity principles will receive a grade of 0**, and **repeat offenses will be grounds for failure for the course.** All offenses will be reported to the appropriate office at Lehigh University so that appropriate action and/or documentation may be maintained.

Tentative Course Schedule

The following is a *tentative* schedule for lectures, lab sessions, and midterm. These are likely to change many times throughout the course, so please come back and look frequently.

Date	Topic	Chapter(s)	Notes
Aug 27	Introduction	1	
Aug 29	Overview of OR	2	
Sep 3	Intro to Linear Programming	3	
Sep 5	Intro to Linear Programming	3	
Sep 10	Intro to Linear Programming	3	Lab Session
Sep 12	Intro: the Simplex Method	4	HW#1 Due
Sep 17	Intro: the Simplex Method	4	
Sep 19	Theory: the Simplex Method	5	
Sep 24	Theory: the Simplex Method	5	HW#2 Due
Sep 26	Theory: the Simplex Method	5	
Oct 1	Duality and Sensitivity Analysis	6	
Oct 3	Duality and Sensitivity Analysis	6	HW#3 Due
Oct 8	Duality and Sensitivity Analysis	6	
Oct 10	Duality and Sensitivity Analysis	6	
Oct 15	*No Lecture*		University break; pacing day.
Oct 17	The Dual Simplex Method	8	HW#4 Due
Oct 22	*Midterm Exam*		Chapters 1-6, no notes, no books.
Oct 24	*No Lecture*		Instructor attending a conference.
Oct 29	Transportation and Assignment Problems	9	
Oct 31	Transportation and Assignment Problems	9	
Nov 5	Network Optimization Models	10	
Nov 7	Network Optimization Models	10	HW#5 Due
Nov 12	Integer Programming	12	
Nov 14	Integer Programming	12	
Nov 19	Integer Programming	12	HW#6 Due
Nov 21	Integer Programming	12	Lab Session
Nov 26	Nonlinear Programming	13	
Nov 28	*No Lecture*		University break; Thanksgiving.
Dec 2	Additional topics; wrap-up; review		HW#7 Due
Dec 4	Additional topics; wrap-up; review		

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