School of Systems&Enterprises

EM 605

Elements of Operations Research

2019

Fall Semester

Syllabus/Course Information

School of Systems and Enterprises

STEVENS
INSTITUTE of TECHNOLOGY
THE INNOVATION UNIVERSITY

PLEASE READ THIS SYLLABUS!

- This syllabus gives you an accurate description of the class, and the workload you're going to be assuming
- PLEASE read the syllabus in its ENTIRETY, it should answer 99% of your questions
- PLEASE ask questions that this syllabus doesn't answer
- If you ask questions that are answered in the syllabus, I'm going to refer you back to the syllabus ☺

Course Objectives

- **By the end of this course, you should be able to:**
  - build operations research models of complex systems
  - use software packages for the solution of management problems
  - understand the results of computer modeling
  - apply the appropriate analytical technique to real world problems
  - summarize and present analysis results in a clear and coherent manner

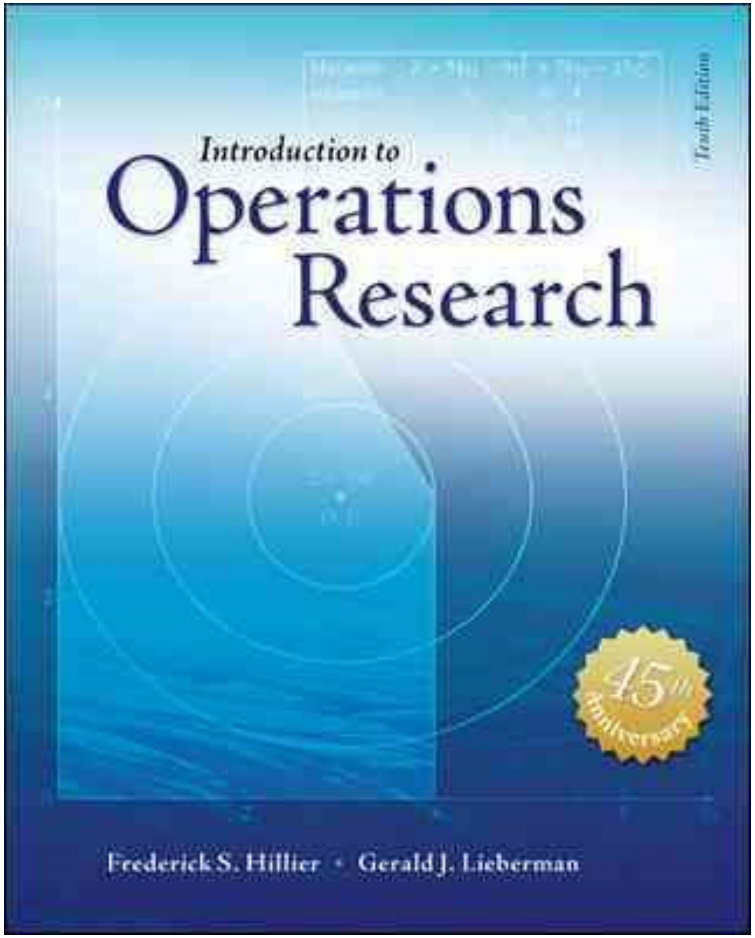
Course Material and Overview

- **Weekly Lectures**
  - Lecture slides for each class are will be posted on Canvas® on the morning following the class.
- **Exams**
  - There is one midterm exam
  - There is one final exam
- **Class Participation**
  - You will receive a grade for class participation and it will be factored into your final grade for the class

Course Textbook

- **The textbook for this course is:**
  - **"Introduction to Operations Research"**
    - **10th edition**
    - **Frederick S. Hillier & Gerald J. Lieberman**
    - **ISBN: 978-0-07-352345-3**
    - **Copyright year: 2015**
    - **Publisher: McGraw-Hill**
- **I recommend that you purchase the *specified version* of the textbook.**
- ***You are responsible for what is presented in the 10th edition (U.S. version)***

Course Textbook Cover



Week	Topics	Chapters
1	Modeling & Optimization, Decision Variables, Objective Function, Constraints	1 – 3
2	Solving Linear Programming Problems, the Simplex Method	4 – 5
3	Duality Theory, Sensitivity Analysis, Other LP Algorithms	6 – 7
4	Integer, Binary , Mixed Integer, Non-linear Programming	12-13
5	Transportation, Transshipment, Assignment , Network	9
6	Multi-Goal Programming	Extra
7	**Midterm Exam**	
8	Meta-heuristics	14
9	Game Theory	15
10	Decision Analysis	16
11	Queuing Theory	17
12	Dynamic Programming	11
13	Inventory Theory	18
14	**Final Exam**	

Contact Information

Dr. Teresa Zigh

- **Office Location/Hours**
  - Altorfer Building
    - 4th floor, Room 419
  - Tuesday
    - 10am – 1pm
- **Email (PREFERRED):**
  - tzigh@stevens.edu
- **Office Phone:**
  - 201-216-8716

This Class - in a Nutshell

- **This course is math-based – it's about translating real-world word problems into mathematical models. If your math skills are rusty, this course will be EXTRA-challenging.**
- **Operations research is *extremely* practical – it was developed to solve real-world problems.**
- **Operations research presents a new way of looking at processes - and it may take you time to assimilate this new "world view."**
  - **You may feel that you're spinning your wheels for a bit – please be patient with the material and with yourself.**
- ***Experience has shown the main stumbling block in EM-605 is that students don't allocate enough time learn the techniques***
  - **In this course, give yourself 10 hrs/week for the problem-solving during the first few weeks; this *doesn't* include the time to read the chapter(s) and think about them.**
  - **If you want a class that requires less time, this isn't it.**

Course Honesty Policies

- Copying or cheating is not acceptable in this course.
- References ***must*** be properly cited and supporting calculations ***must*** be shown, submitted, and be workable; if they are not, then plagiarism will be assumed.
- The first infraction is the last - the student will receive an "F" in the course, and will be reported to the Dean of Graduate Studies; this can also lead to expulsion.
- This has happened during past semesters of this course.
- Cheating or plagiarism is taken very seriously and ***is not tolerated.***
- It does not matter if these actions have been acceptable in another country, school, time, or situation – here and now, they are not tolerated.

Course Grade Determination

- There is one midterm test – 40% of your grade
- There is one final exam – 40% of your grade
- The remaining 20% of your grade will be based on your class participation
- **The grade boundaries are as follows:**

9.3 - 10:	**A**	**8.7 - 8.99:**	**B +**	**7.7 - 7.99:**	**C+**
9.0 - 9.29:	**A-**	**8.3 - 8.69:**	**B**	**7.3 - 7.69:**	**C**
		8.0 - 8.29:	**B-**	**7.0 - 7.29:**	**C-**

- **There is no curve in this class**
- **There is no extra credit or make-up work in this class – only the tests and participation will be counted as constituents of your grade**

Let's Talk if We Need To…

- **If you ever have any question about your status, please email me immediately, letting me know your concerns.**
  - If necessary, we can arrange a time to talk over the phone
- **Please don't HESITATE to contact me via email, if you have any questions.**

Is This You?

- You may be reluctant to accept fractional answers (for instance, 3.5 grandfather clocks or 6.27 velvet shirts), thinking that such answers "don't really make any sense."
  - Erroneous thinking, in this class
- It's the nature of LP problems, in general, to deal with continuous variables - it's rare to have EXACTLY one gallon of oil, or EXACTLY one yard of silk
- Bear in mind that the data used for the constraints might be inaccurate, too
- The upshot? Don't make your answers integer because it "feels right" – do it only when asked or when the problem is formulated or results in an integer solution

Continuous Variables as Answers

- When dealing with continuous variables, it's best to report the results in a continuous format
- It's simpler to let answers be fractional. When the decision variables are exceptionally large, the fractions may make a great deal of difference (depending on dimensional scale – there's a big difference between $12.3 billion and $12 billion)
- NOTE: There are some entities that we'll treat STRICTLY as integer...for instance, assignment problems relating to people. This is one of the few cases that are NOT amenable to continuous treatment

...a Word About "Rounding"

- The problem with rounding is related, but separate
- If you only want integer solutions, then by all means, use the integer restriction as a formal constraint
  - If you restrict your solutions to integers, you will (almost) always end up with a less-than-optimal answer, especially if your problem was originally couched in terms of continuous variables
- If you don't use integer restrictions in your constraints, DO NOT ROUND your answers because you "want to have the solution make sense!" at the end of calculations
  - If you round, especially using normal rounding conventions, you may end up introducing a constraint violation, unknowingly. ***Don't let this happen to you!***

A Cautionary Note

- **Operations research is challenging, mathematically-advanced book-keeping**
- **Good book-keepers exercise care when entering information into spreadsheets**
- **It's happened to me, more than once:**
  - **The model is set up perfectly, then I make a simple mistake entering equations or formula into the spreadsheet**
  - **The result? Incomprehensible answers…simply because I wasn't *meticulous* about setting up the functions and cell formulas**
- **It's *PAINFUL* to have to go over all the cells in your model until you find the problem**
- **So, the moral is…**

Take your time when entering your data and equations

YOUR Side

- **Most of the students in this class are working; and your jobs may require overtime and/or travel – *I realize this*. At the same time, there's a certain number of topics we need to cover during the term.**
- **Review the lectures. Please be realistic about the work load, and your professional and personal commitments!**
- **If you have difficulty understanding a concept/problem, and you've given it a good try but feel stuck – *contact me.***
  - **I'll ask to see what you've done…then I'll help all I can, without giving away the store.**
- **You might be tempted to try "*catching up*" in the last few weeks of the semester. I can't say this strongly enough…**

Catching up is not possible in this class!

MY Side

- I try to answer all email within 24 hours, and usually do it sooner
- I'm not always available by phone, and not always in my office. Use the Stevens email system to get in touch with me…it's almost always up and working.
- I don't have email access on Sundays, so please plan your communications accordingly.
- Last, but not least…
  - I'd *really* like everyone to end up *loving* O.R.
  - I'll settle for every student succeeding brilliantly. ☺

Software in General

- **All the recommended software is available at NO COST. I assume that everyone in the class has access to Microsoft Excel®**
  - **Excel® Solver®: add-in to Excel®. You can install this add-in (it's licensed through MS-Office®) easily, via the toolbar at the top of Excel®. This version will be more than sufficient for this class**
  - **QM for Windows®: A stand-alone package that I strongly recommend but please read all compatibility instructions before downloading. The software runs on Windows XP®, Vista®, and Windows 7® and on the Mac (select the QM for Windows software link). See the file posted on the class site for install/setup on Macs**

http://wps.prenhall.com/bp_taylor_introms_10/112/28870/7390752.cw/index.html

  - **R: A mathematical programming environment and language which has extensive libraries. It must be installed on your computers from https://www.r-project.org/ A guide is posted on Canvas.**

Online Tutorials for Optimization and Excel Solver®

- This link brings you to an online tutorial which provides a good overview of optimization in general, and how to set up and use Solver® in particular to solve problems (it's supplied by Frontline, the developers of Solver®)
  - http://www.solver.com/tutorial.htm
- Another tutorial, this one from MS-Office®, on optimization and the use of Excel Solver® to generate solutions
  - http://office.microsoft.com/en-us/excel-help/introduction-to-optimization-with-the-excel-solver-tool-HA001124595.aspx

Getting Started with Solver®

- Once you've entered your objective function cell, your variables that change, and your constraints, make sure you specify which type of model you're selecting – linear, non-linear or evolutionary. Also, do not forget to check the box which specifies non-negativity for variables. We'll use linear models for most of the course, with some exceptions which should be self-evident (the section on non-linear models, for instance).
- You'll see that the constraints have several options for the operator used in the equation, i.e., ≤, ≥, =, bin, int. Remember this, you'll need it later.
- Once you press the Solve button, you'll see a selection of responses that can be returned. Try looking at all of them - the answer sheet, the sensitivity analysis, and the limits. You'll see that you get new data sheets in Excel® – you should get familiar with them, and what the components mean.

More about the preferred use of Excel and Solver® in this class

- **If you're an Excel master, you may be tempted to use the NamedCells option in Excel – please do not use this option in this course. It causes confusion when trying to untangle your work.**
- **Always show your model in canonical form on the worksheet – it helps reduce entry errors.**
- **If you're going to run several models using almost the same layout and equations, put them on separate worksheets in one Excel file.**
  - **I MUST be able to replicate your work, and can't do that if you place multiple problems on one worksheet.**

Getting Started with QM for Windows®

- Once you select a module, you'll need to select "New" from the "File" menu. You may see another drop-down list offering you various options for the chosen model.
- After you set up an LP model (selecting Linear Programming from the Module pull down menu), I recommend first hitting the "Solve" button to see your answers. Then investigate all the attendant result windows for different aspects of the solution.
- After you review your results, try using the "Step" button, to see the various pivots that the software is doing - it's fascinating as well as instructional.
- This software has modules for most of the topics we'll cover in this class, save one – transshipment.

Good Luck!

- This course takes effort, but you'll be introduced to a wealth of topics - your sense of accomplishment will be substantial, as will your understanding of real-world systems
- If you feel like this, especially in the beginning, don't worry - it's perfectly normal
- I'm here to help!

Local construction worker Jason Oglesbee, suspended from a crane, rescues a woman who fell into the Des Moines River in downtown Des Moines, Iowa. A group of building workers spotted the woman in the water 30 minutes after the boat she was crewing with her husband capsized. (Photo AP/The Des Moines Register)