1 Course Description: Summary

Operations Research (OR) has been appropriately labeled as the ‘Science of Better [Decision Making]’, thanks to its significant positive impact related to the improvement of industrial and government operations in many real-world settings. To give just a few examples, the skillful application of OR concepts and techniques leads to better resource allocation, increased profits, improved environmental quality, as well as to better healthcare, higher level of client satisfaction, and improved safety.

Within the context of OR, optimization model development, the ability to solve such models with properly chosen tools, and to interpret the results obtained is a competitive advantage. Modeling and solving optimization problems requires special skills and tools. The purpose of this course is to provide participants with knowledge and tools necessary to model practically motivated optimization problems and to solve them efficiently. We will discuss how to formulate models to handle a range of optimization problems, how to handle practical OR applications using state-of-the-art solver tools, and how to interpret and present the results to provide actionable knowledge.

2 Learning Objectives: Summary

Having completed this course, students will be able to
- Properly formulate OR problems based on a (not necessarily precise and quantitative) problem description
- Select appropriate modeling techniques to handle specific OR problem types
- Solve the stated problems with the aid of appropriate software tools
- Analyze and interpret the solution of problems

Please note that students can enroll either in this course, or alternatively in ISE 316, but not both.
3 Textbook


The course will cover selected chapters from this textbook. Note that the use of the 9th Edition (or of earlier editions) is allowed, but not encouraged. Please make sure to read the material of the 10th edition, especially considering the examples and exercises. We will also provide additional reading materials to enhance the course as deemed appropriate.

4 Model Development and Solver Tools

Several prominent modeling languages can be used to develop feature-rich, fully scalable optimization models. In this course, we will be using the modeling language AMPL and some of the accompanying solver engines linked to AMPL. AMPL is described in the book


An online version of this book is available at www.ampl.com.

AMPL has a student version that can be downloaded at www.ampl.com, to handle size-limited models.

In addition to AMPL, you are allowed to use other modeling and computing systems – such as AIMMS, Excel, GAMS, Julia, Maple, Mathematica, MATLAB, SAS, etc. – in your independent studies. We will offer some advice as needed, but it is your responsibility to learn how to use (optionally) these alternative software products in your own studies. Familiarity with such tools can be useful also in your other courses, and eventually in your work. AMPL will be used in classroom discussions, assignments and exams – so you have to learn it well.

Please see the list of available software products at the Lehigh University Software site http://cf.lehigh.edu/software/info.cfm?SID=209.

5 Course Site

Lecture slides, accompanying materials, homework assignments, solutions, and announcements will be posted in the appropriate course folder at Lehigh University’s Course Site https://coursesite.lehigh.edu/. All important information will be sent by email to all enrolled students via Course Site, and all assignment solutions should also be submitted via Course Site.

Email is the official way of communication for this course: please check your email daily.

6 Lecture Topics: Summary

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. Please note that each ISE 426 class is scheduled as a 75-minute activity in this semester.

The following class schedule within the Fall 2017 semester is tentative. Both Lehigh University and your
instructor reserve the right to make changes if needed.

Course Topics

Please note that in the following description the words ‘optimization’ and programming’ are used as interchangeable synonyms.

Introduction to OR and optimization: motivation; decision variables; constraints; objective function; application examples (2 lectures)

Convexity and non-convexity; model relaxations; lower and upper bounds; examples (2 lectures)

Linear programming (LP) models; graphical solution; solution strategies; sensitivity analysis; application examples (5 lectures)

An introduction to using AMPL and its available solver engines for LP, with examples (1 lecture)

Network models; solution strategies; application examples (3 lectures)

Integer programming (IP) models; binary and general integer variables; logical constraints and binary variables; solution strategies; application examples (5-6 lectures)

Nonlinear programming (NLP); models with nonlinear functions; global and local optima; solution strategies; application examples (6-7 lectures)

An introduction to using AMPL and its available solver engines for NLP, with examples (2 lectures)

Stochastic programming (SP); alternative model forms; multi-stage optimization; solution strategies; application examples (2-3 lectures)

Multi-criteria optimization (MCO); optimization with several (conflicting) objective functions; Pareto-optimality; solution strategies; application examples (2 lectures)

7 Homework Assignments

An essential part of this course is hands-on experience in applying optimization to problems of realistic size and complexity. These problems will be often stated in everyday language: your task is to translate them into an appropriate quantitative model, and to solve them. The related homework assignments have to be completed, also in preparation to the exams. Late homeworks will be penalized or may not be accepted at our discretion.

Electronic submissions via the course site are the only way to submit an assignment. Paper submissions and email attachments will not be accepted. Please submit well-prepared documents to expect good feedback and grades. Use MS Word or a similar quality text processor to create high-quality documents – as opposed to hand-written sketches. This work experience will be useful also in your future career.

For homeworks that include computer-based exercises, provide your commented code as well as the output of your code in an Appendix submitted with your homework.

You are allowed to discuss assignments in small groups. However, you must work out the solution by yourself, and you must write up and submit your own homework. For computer exercises, all
discussions must stop when you start writing code. These rules will help you to actually learn.

8 Midterms and Final Exam

The exams can in principle cover all materials presented in class, the topical examples and exercises of the textbook, and the homework assignments. There will be two midterm exams, about 5 and 10 weeks after the beginning of the semester, respectively. The content for each exam will be clarified in class prior to each midterm. The final exam is comprehensive. The midterms and the final exam are all closed-book, closed-notes exams. It will be clarified in class which formulae are provided with the questions.

Please do your best to avoid missing exams, since you create problems for yourself and extra work for all else involved. In case of medical or other valid reasons, please inform us and follow the normal procedures for obtaining an Absence Information Report through the Associate Dean of Students Office (U.C. Room 210). Upon receipt of the report, we can arrange for a make-up exam. Do not miss the final exam.

9 Attendance and Participation

All students are expected to attend all lectures, and to actively participate. The material is (quite a lot) harder to learn on your own. Please contact me in advance if you require special accommodations with a valid reason. Please also provide feedback about the classes, so that we can make the best use of your and everyone else’s time during class and throughout the entire course.

10 Communications

In all verbal or email communications with your instructor or classmates, please observe business etiquette and communicate your messages carefully and politely.

11 Electronic Devices

You are not allowed to use electronic devices during class, except when asked to do calculations or to solve computer-based exercises. Audio or video recording may be done only with the approval of everyone in the classroom. Please let me know in advance if you need to use audio or video recording, stating also the reason for doing this.

12 Evaluation and Grades

The evaluation of your course work is based on the following weighted components:

<table>
<thead>
<tr>
<th>Component</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proper class participation</td>
<td>10%</td>
</tr>
<tr>
<td>Homework and projects</td>
<td>30%</td>
</tr>
<tr>
<td>Mid-term exam 1</td>
<td>15%</td>
</tr>
<tr>
<td>Mid-term exam 2</td>
<td>15%</td>
</tr>
</tbody>
</table>
| Final exam                | 30%    | Your FE score must be at least 50 out of 100 on its own

Students who participate in class and work responsibly on their assignments – as a rule – do well at the exams. Hence, take all classes and assignments as an opportunity to develop your knowledge and to get feedback, rather than just a “grade component” where you can get points.
The following conversion table between numerical scores and letter grades is used for grading:

<table>
<thead>
<tr>
<th>Numerical Grade (%)</th>
<th>≥93</th>
<th>≥88</th>
<th>≥83</th>
<th>≥78</th>
<th>≥68</th>
<th>≥62</th>
<th>≥55</th>
<th>≥50</th>
<th>≥45</th>
<th>≥40</th>
<th>&lt;40</th>
</tr>
</thead>
<tbody>
<tr>
<td>Letter Grade</td>
<td>A</td>
<td>A-</td>
<td>B+</td>
<td>B</td>
<td>B-</td>
<td>C+</td>
<td>C</td>
<td>C-</td>
<td>D+</td>
<td>D</td>
<td>D-</td>
</tr>
</tbody>
</table>

13 University Policies Related to the Course

Principles of Equitable Community

Lehigh University endorses The Principles of our Equitable Community, see 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.

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 related documentation from Academic Support Services office before such accommodations can be granted.

Academic Integrity

Please consult the material about Academic Integrity available at the Course Site. There are many forms of irresponsible behavior that can ruin opportunities for you or for others in the course, and there is no room or excuse for bad behavior. Examples of irresponsible behavior cover a wide range: this includes 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 web page at http://www.lehigh.edu/~inprv/pdfs/AcademicIntegrityVignettes.pdf.

It is the firm policy of this course (and of all other Lehigh courses) that cheating or plagiarism are unacceptable violations of academic integrity, and such actions will earn an F semester grade in the course. Please meet all work requirements in good spirit, and do your part in advance of deadlines. Do not copy data or sections of homework reports from other students currently or previously enrolled, and do not attempt to cheat on exams. While all 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 completed work, and do not share your completed work 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 lose points from their course totals, and serious offenders may be excluded from the course.

Information regarding some other relevant Lehigh University Policies can be found at Lehigh University Library & Technology Services: http://lts.lehigh.edu/services. Religious Holidays: http://www.lehigh.edu/~incha/holidays.html.