Optimization Techniques for Transportation Engineering (CE 377K)
Spring 2015

Instructor: Steve Boyles
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Course Meeting Time and Place: Tuesday and Thursday, 12:30–2:00, ECJ 6.406 (#15395)
Office Hours: Tuesday and Thursday, 10:30–11:30 (primary), 9:30–10:30 (secondary)
Course Website: `http://tinyurl.com/ce377-sp15` *(Not Blackboard!)*

This course will expose you to the basic concepts of formulating and solving optimization problems, particularly in transportation engineering. Transit and roadway network design, vehicle routing and logistics, and resource allocation rely heavily on optimization theories and methods. By the end of this course, you will have the knowledge to address these questions and many others which arise in civil engineering. You will be able to formulate a variety of engineering problems as optimization models, and have the practical knowledge needed to solve them. Furthermore, you will have a conceptual understanding of optimization models which allows you to understand and critically evaluate model results which others may present to you. This course will require you to both understand the basic concepts of optimization, and to apply them in a project involving an oral presentation and written report.

Prerequisites

The prerequisite for this course is CE 321. This course also involves a number of programming assignments. The particular language you know (C, Java, Python, Excel VBA, MATLAB, FORTRAN, etc.) is not important. If it has been a while since you have taken CE 311K, you may wish to review this material.

Course Materials

There is no assigned textbook for the course; I will be providing you notes as needed. You may find the following textbooks useful for more detail on specific topics or for alternative explanations, but they are not required:

- Ahuja, R., T. Magnanti, and J. Orlin. (1993) *Network Flows.* Prentice-Hall, Englewood, NJ.
- Bertsimas, D. and J. N. Tsitsiklis. (1997) *Introduction to Linear Optimization.* Athena Scientific, Cambridge, MA.
- Bradley, Hax, and Magnanti. (1977) *Applied Mathematical Programming.* Available online: `http://web.mit.edu/15.053/www/`
- Revelle, C. S., E. E. Whitlatch, and J. R. Wright. (1999) *Civil and Environmental Systems Engineering.* Prentice-Hall, Upper Saddle River, NJ.

Grading

Final course grades are determined by performance on homeworks, an in-class exam, a group term project, and a final exam. The weight of each of these factors is as follows:

Category	Weight
Homeworks	30%
Midterm Exam	20%
Project	25 %
Final Exam	25%

These components are designed to work together: the exams focus on concepts, while the course project involves application and skills involved in engineering practice. The homeworks and lectures give you a chance to learn these skills and practice them throughout the semester.

Six homeworks will be assigned throughout the semester, each worth 5% of your final grade. Homeworks are assigned, collected, and returned on a two-week cycle. Each assignment will include problems requiring computer work; please submit these electronically by emailing me. You are encouraged to work together on homeworks, but you must submit solutions in your own words. These homeworks will require a significant amount of time and effort — do not wait until the night before to start! **Late homeworks are only accepted if you notify me of a time conflict or need for extension 48 hours before the due date.**

The midterm exam will take place roughly halfway through the semester. The final exam is comprehensive, but focuses on material since the midterm. The final will be held at the University-scheduled time (Monday, May 18 from 9:00–12:00 noon). You may bring one double-sided sheet of notes to the midterm, and two double-sided sheets of notes to the final. Calculators are optional. While attendance is not a component of the final grade, students are strongly encouraged to attend all lectures. Succeeding in this course requires full understanding of the concepts, and few students are able to do this without lecture attendance and participation.

The project will culminate in oral presentations and a written report, both due in the last week of class. This project involves your group selecting one or more optimization models to apply to a real-world scenario of your choosing, obtaining any data and implementing any algorithms necessary to do so. At the end of the semester, you will be required to present your project to the rest of the class, and complete a written report documenting all of your work.

Miscellanea

An evaluation of the course and instructor will be conducted at the end of the semester using the approved UT Course/Instructor evaluation forms.

From the 1st through the 12th class day, an undergraduate student can drop a course via the web and receive a refund, if eligible. From the 13th class day through the universitys academic drop deadline, a student may Q drop a course with approval from the Dean, and departmental advisor.

The University of Texas at Austin provides, upon request, appropriate academic accommodations for qualified students with disabilities. For more information, contact the Division of Diversity and Community Engagement, Services for Students with Disabilities, 471-6259 (voice) or 410-6644 (video phone) or `http://www.utexas.edu/diversity/ddce/ssd`.

Students who violate University rules on scholastic dishonesty are subject to disciplinary penalties, including the possibility of failure in the course and/or dismissal from the University. Since dishonesty harms the individual, all students, and the integrity of the University, policies on scholastic dishonesty will be strictly enforced. For further information, please visit the Student Judicial Services website at `www.utexas.edu/depts/dos/sjs/`.

A tentative class schedule is shown on the next page. All dates and topics are subject to change.

Schedule

Tuesday		Thursday	
$\boxed{\text{Jan 20th}}$ Course orientation and overview	**1**	22nd Optimizaton problems in transportation	**2**
27th Unconstrained optimization	**3**	29th Line search techniques	**4**
$\boxed{\text{Feb 3rd}}$ Simulated annealing	**5**	5th Genetic algorithms	**6**
10th Network concepts	**7**	12th Algorithms and complexity	**8**
17th Minimum spanning trees	**9**	19th Shortest paths	**10**
24th Shortest paths	**11**	26th Maximum flow problem	**12**
$\boxed{\text{Mar 3rd}}$ Maximum flow problem	**13**	5th Minimum-cost flow	**14**
10th Minimum-cost flow	**15**	12th **Midterm Exam**	**16**
17th **No class: Spring break**		19th **No class: Spring break**	
24th Linear programming geometry	**17**	26th Linear programming algebra	**18**
31st Simplex method	**19**	$\boxed{\text{Apr 2nd}}$ Simplex tableau	**20**
7th Sensitivity analysis	**21**	9th Convex sets and functions	**22**
14th Lagrange multipliers	**23**	16th First-order conditions	**24**
21st Frank-Wolfe algorithm	**25**	23rd Dynamic programming concepts	**26**
28th Value iteration	**27**	30th Policy iteration	**28**
$\boxed{\text{May 5th}}$ Project presentations	**29**	7th Project presentations	**30**