IE406: Introduction to Mathematical Programming
Syllabus

Dr. Ted Ralphs

Fall 2007

1 Miscellaneous Course Information

Instructor:	Dr. Ted Ralphs
Office:	473 Mohler Lab
Phone:	8-4784
E-mail:	tkr2
Office Hours:	MW 4:00-5:00 or by appointment
Web page:	http://www.lehigh.edu/~tkr2
Course web page:	http://www.lehigh.edu/~tkr2/teaching/ie406/
Course meeting time:	MW 6:00-7:15

2 Description of Course

This course will be an introduction to mathematical programming, with an emphasis on techniques for the solution and analysis of deterministic linear models. The primary types of models to be addressed will be linear programming, network flow, and integer linear programming. However, the course will touch on more complex models, such as those incorporating nonlinear constraints or uncertainty. The main emphasis will be on solution techniques and on analysis of the underlying mathematical structure of these models. As a supporting theme, the course will also emphasize effective modeling techniques, the use of modeling languages, such as AMPL, and the use of commercial solvers.

3 Course Objectives

The goals of this course are for students to:

1. Improve their ability to rigorously prove mathematical statements.
2. Cultivate an ability to analyze the structure of and mathematically model various complex system occurring in industrial applications.
3. Develop knowledge of the mathematical structure of the most commonly used deterministic linear optimization models.

4. Develop an understanding of the techniques used to solve linear optimization models using their mathematical structure.
5. Develop an understanding of the use of modeling languages for expressing and solving optimization models.
6. Develop knowledge of existing solvers for linear optimization.

4 General Course Requirements

4.1 Prerequisites

I expect you to have a good undergraduate mathematics background, especially in linear algebra. I expect some familiarity with logic and proof techniques, as well as basic knowledge of computer programming. Experience with mathematical modeling is a plus.

4.2 Recommended Primary Text

D. Bertsimas and J.N. Tsitsiklis, *Introduction to Linear Optimization*, Athena Scientific (1997).

4.3 Reading

There will be required readings associated with each lecture. Most readings will be from the course text, but students are encouraged to seek supplementary material. Links to supplementary reading material can be accessed from the course page.

4.4 Lectures

You are expected to attend and participate in the lectures. Part of the grade will be determined by overall class participation. Lecture materials will be available for reference before the lecture on the course web page.

4.5 Assignments

Assignments will be given according to the course timeline below. There will be nine problem sets and a final project.

4.6 Exams

There will be two quizzes and a final. All exams will be open book and open notes.

5 Course Timeline

The following timelines are subject to change.

5.1 Schedule of Homeworks and Quizzes

Homework/Quiz	Date
Homework #1	Sept 5
Homework #2	Sept 12
Homework #3	Sept 19
Homework #4	Sept 26
Quiz #1	Oct 3
Homework #5	Oct 17
Homework #6	Oct 24
Homework #7	Nov 31
Quiz #2	Nov 7
Homework #8	Nov 14
Homework #9	Nov 28
Final Project	??
Final Exam	??

5.2 Schedule of Topics

Topic	Lectures
Review of Modeling	2
The Geometry of Linear Models	4
The Simplex Method	4
Modeling Languages	1
Duality Theory	4
Sensitivity Analysis	2
Large-scale Linear Programming	2
Interior Point Methods	2
Network Flow Models	4
Integer Programming Models	2
Advanced Models and Methods	1

5.3 Textbook Coverage

Primary chapters/sections to be covered in lecture:

Chapter 1	Sections 1, 4
Chapter 2	Sections 1-6
Chapter 3	Sections 1-3, 5
Chapter 4	Sections 1-6, 8
Chapter 5	Sections 1-5
Chapter 6	Sections 1-3
Chapter 7	Sections 1-5, 8-10
Chapter 9	Section 1, 3-5
Chapter 10	Section 1-3
Chapter 11	Section 1-2, 4

Suggested supplementary reading:

Chapter 1	Section 2-3, 5-6
Chapter 2	Sections 7-8
Chapter 3	Section 6, 7
Chapter 4	Sections 7, 9-10

6 Course Policies and Procedures

6.1 Referencing the Work of Others

You should attempt the problem sets on your own before consulting outside references. However, I encourage the use of research materials as a way to supplement your understanding of the course material, as long you heed the following common-sense ground rules. First, you may not consult my solutions or the problems sets of other students from previous offerings of this course. Second, external sources may be used only to improve your own understanding. You may not quote directly from any source and you should not write down anything that you do not understand. When you write your solutions, you should do it on your own without the direct help of any external sources. If you do use external references in improving your understanding, please cite them! Failure to cite references will be treated as cheating and will not be tolerated. If you are diligent about citing references, you will come out ahead in the end. Please ensure that you understand the spirit and the letter of these rules before beginning any class work.

6.2 Respect for Intellectual Property

In both your classwork and your research, it is important that you be aware of and respect the intellectual property rights of others. Unless explicitly stated otherwise, all materials available on the Internet, in libraries, and elsewhere are considered intellectual property and can only be used with the permission of the owner. Please be aware of the license you are being granted when you use these materials and what you are and are not allowed to do with them.

6.3 Group Work

You are encouraged to work together on problem sets, especially those designated as group work. However, unless the problem set is specifically designated as group work, you must ultimately demonstrate your understanding of the material by writing up your own solutions without the help of other students or their written work. If you consult with other students (or faculty) on a problem set, this should be considered equivalent to consulting any other reference and should be cited appropriately. This policy will be strictly enforced.

6.4 Turning in Assignments

All assignments should be submitted electronically by e-mailing a PDF file to the instructor by the beginning of the class period in which the assignment is due. The official turn-in time of the assignment will be the time stamp on the e-mail. The PDF file should have the name `<Network ID>-HW*.pdf` where the "*" is replaced by the assignment number and the subject of the e-mail should be “IE406 Assignment *,” where “*” is replaced by the assignment number. If the assignment is a group assignment, then the mail ID of all the group participants should be listed in the file name separated by hyphens. LaTex is strongly recommended for producing your solutions, but Microsoft Word or other WYSIWYG software is acceptable.

6.5 Lateness

I will allow a total of 7 days of lateness on laboratory assignments throughout the semester. These 7 days can be split up in any way you choose. In other words, you can have one assignment late by 7 days or 7 assignments each late by one day. After that, there is a penalty of 10% off per late-day on each assignment. No assignment will be accepted more than 7 days late. Exceptions to this rule will be made on a case-by-case basis. Please let me know if you will be turning in an assignment late.

6.6 Grading

I believe your grade should reflect the actual learning that took place in the course and not be solely the result of a simple formula. The way to maximize your grade in this course is to learn and understand the material. Most formulaic grading systems allow you (even encourage you) to maximize your grade without necessarily maximizing your learning. I want to discourage you from disconnecting these two goals.

Higher learning involves not just acquiring knowledge, but developing the ability to ”know what you don’t know.” Among other things, this involves the ability to know when you do and do not have a rigorous proof or an accurate answer. One of the goals of this course is to cultivate your ability to perform an accurate self-assessment of your work. Hence, you are encouraged to think about and state accurately not only the parts that you do understand from each homework, but also the parts that you do not. Please do not muddle your way through proofs and other exercises in the hope that I will not read them carefully. You will get additional credit for an accurate self-assessment of your answer or approach. If you have gotten most of the way through a proof and just cannot complete the last step or even if you are missing a step in the middle but know how to do the rest, just try to write down what you have done so far and what it is that you don’t know how to do. This will help me to better gauge where your understanding is incomplete so that we can review these areas in class. It will also demonstrate your understanding of your own work.

Effective learning also involves knowing where to go to get help when you realize that your knowledge or understanding of a topic is incomplete. This could mean asking a classmate some questions, consulting external references, or coming to office hours. It can also mean asking a question in class when you don’t understand part of the lecture. Chances are, other people don’t understand it either. These are important aspects of class participation.

You will be evaluated on the level of detail and rigor in your proofs and homework answers. In general, you should err on the side of giving too much detail in your written work. One common mistake is the assumption that if I assigned the problem, I must know every possible approach to solving it. Many times, however, I will not have thought of the approach you are using and will therefore need some help in understanding your thought process. The more explicit you are, the easier it will be for me to grade and the more you will demonstrate your understanding. If you spend hours coming up with the answer to a problem, don’t short-change yourself by spending only a few minutes writing it down. Take some time to think about how best to present your thoughts. Do not write your problem sets as if you are space constrained.

You will be graded as much as possible according to my overall assessment of your learning in the course and your understanding of the course material. This includes your ability to perform self-assessment, your ability to ask questions to increase your understanding, and your ability to express your ideas in written form rigorously and with an appropriate level of detail. I grade randomly selected problems from each problem set. However, I will distribute detailed solutions to all problems. You are strongly encouraged to evaluate your own work by comparing it to the solutions. For those who would like a formula, the approximate grading scheme is as follows:

25% Homework
20% Quizzes (each)
5% Final Project
20% Final Exam
10% Class Participation

6.7 Learning Styles

There are many different styles of learning. Some people gain better understanding from listening to something being explained orally. Some get better understanding from written material. Some like a combination of both. I do my best to accommodate various styles of learning. However, feel free to let me know what your learning style is so that I can take that into account when determining the future direction of the course.

6.8 Office Hours and Appointments

I very much appreciate and enjoy getting as much feedback from my students as possible, even if it is not all positive. Please don't be afraid to tell me what you think. If you want to just stop by to chat, feel free. My door is usually open, but if you could utilize office hours as much as possible, I would appreciate it. If you would like to make an appointment outside office hours, just call or send an e-mail.