Computational Optimization
(MATP 4820/6610 or DSES 4780)
Spring 2008

Welcome to Computational Optimization. This course is all about making mathematical programming and optimization work for you. Models, methods, algorithms, and computer techniques for nonlinear optimization will be studied. You will investigate contemporary optimization methods using a hands on implementation approach. Our emphasis will be on practical computational aspects versus the theory of mathematical programming. Non-majors wishing to gain practical optimization skills are welcomed in this course. A course project will allow students to explore optimization methods and practical problems directly related to your interests. The course may be taken for graduate or undergraduate credit. Graduate students will pursue a more indepth and mathematical understanding of the subject through additional assignments and readings, and a more comprehensive course project.

Instructor:	Professor Kristin Bennett
Office Hours:	Tuesday 10:15-11:30 PM, Thursday 10:15-11:30 PM or by appointment. Office: 329 Amos Eaton, phone 276-6899. Email: bennek@rpi.edu
Class Meets:	Lecture : Tuesday and Friday 8:00-9:50, VCC South.
Textbook:	*Numerical Optimization* by Nocedal and Wright, Springer, 2006 (2nd edition).
Reserved Text:	*AMPL A Modeling Language for Mathematical Programming*, by Fourer, Gay and Kernighan, The Scientific Press, 1993. *Nonlinear Programming*, Bertsekas, Aethna Scientific, 1995. *Nonlinear Programming Theory and Algorithms*, by Bazaraa, Sherali, Shetty, 1993. *Linear and Nonlinear Programming,* by Luenberger, Addison-Wesley, 1984. *Practical Optimization* by Gill, Murray, and Wright, Academic Press, 1981. *Linear and Nonlinear Programming*, by Nash and Sofer, Mcgraw-Hill, 1997.
Web Materials:	Additional course materials will be made available via the course webpage: http://www.math.rpi.edu/˜bennek/compopt/. An excellent online resource is the text Convex Optimization by Boyd and Vandenberge (http://www.stanford.edu/∼boyd/cvxbook/).
Course Objectives:	Upon completion of this course, the student will

1. Understand standard methods and algorithms used to solve continuous nonlinear programming problems,
2. have experience in both developing and using nonlinear optimization to solve various problems with computers,
3. have been exposed to the resources available for researchers and practitioners of nonlinear programming.

Academic Policies: Students are expected to attend class and are responsible for all material assigned and covered in class. Class slides will be made available via the course web page, but they do not contain all of the material covered in class and **students are responsible for all materials discussed in class even if they are not in the slides.** Discussion between students is encouraged on all aspects of the class except exams. Exams must be completed by each student individually. Collaborations on exams will at a minimum result in 0 for the exam grade. Assignments are due at the beginning of class on the date due. Late assignments will not be accepted. A group of two students may be formed to complete an assignment, and a single copy of the assignment may be turned in by the group. Projects should be original works by the student. Plagiarism will not be tolerated. Cheating on exams or projects are grounds for failure of the class.

Evaluation: The course grades will be based on two exams, a project, homework, and class participation. Students wishing to receive graduate credit from the course are required to do some supplementary homework problems, a more extensive project that includes an computer implementation and to give a research presentation either during the last week of the course or in the Math Graduate or other seminar. Undergraduates can receive extra credit by giving a class presentation and/or completing extra problems assigned to graduate students.

The relative importance of these items is listed below:

For Undergraduate Credit:

exams	30%
project	35%
homework, labs, and class participation	35%
presentation	5% extra credit

For Graduate Credit:

exams	35%
project + presentation	30%
homework, labs, and class participation	35%

The biweekly homework will be a combination of theoretical, WWW, MATLAB exercises.

For the project, the student will design a research project according to his/her interest. Undergraduates may form groups of two to work on the project provided the work is scaled accordingly. The project must involve a computational component such as an implementation of an algorithm using AMPL or MATLAB programming languages or experimentation with a nonlinear code available on the internet. For example a project could involve implementation of an algorithm in the MATLAB language and a comparison of the algorithm with other solvers available on NEOS, MATLAB or AMPL. Another possible project is to solve a real-world application using the algorithms developed in class. Graduate projects must include implementation of an algorithm.

For the research presentation, the student must select a topic of interest to him/her which is relevant to this course and their project but not covered in lecture, locate and read two or more papers on this topic, and make a presentation to the class. Graduate students should include project results in their presentation.

A tentative course outline is as follows. Please see course notes for more detailed reading assignments. We will probably need to schedule an extra evening class for extra-credit undergraduate class presentations.

COURSE OUTLINE

Start Date	Topics	Readings
1/15	Overview	Chapter 1
1/18	Golden Section Search	
	Issues in Optimization Algs.	Chapter 2
1/22	Rates of convergence/Matlab practice	
1/25	Fundamentals	Chapter 2, Appendix
1/29	Unconstrained Optimality Conditions	Chapter 2
2/1	Line Search Algorithms/Newton's Method	Chapter 3
2/5	Steepest Descent	Chapter 3
2/8-22	Conjugate Gradient +BFGS	Chapter 5,6
2/19	No Class	
2/26-29	Large Scale	Chapter 7
2/29	Take home available	
3/7	Take Home Exam Due	
3/10-14	Spring Break	
3/3-3/7	Constrained Optimization Models	Chapter 12
3/21	Project Proposal due	
3/18	Optimality Conditions for Constrained Optimization	Chapter 12
3/21-4/1	Fundamentals of NLP algorithms	Chapter 15
4/4-8	QP and Active Set Methods	Chapter 16
4/15-18	Penalty and Augmented Lagrangians	Chapter 17
4/22-29	Advanced Topics and Presentations	
4/25	Projects due	
	In Class Final Exam during Finals Week May 5-9	