Math 484 - Nonlinear Programming

Spring 2021

Instructor:	Reuven Hodges	**Time:**	MWF 11:00 – 11:50am
Email:	rhodges@illinois.edu	**Place:**	Online

Course Information

Objectives: The aim of this course is to give an introduction to nonlinear optimization problems. We emphasize techniques as well as proofs of theorems. A few of the most important topics covered are: iterative and analytical solutions of constrained and unconstrained problems of optimization; gradient and conjugate gradient solution methods; Newton's method, Lagrange multipliers, duality and the Karush-Kuhn-Tucker theorem; and quadratic, convex, and geometric programming. Most of the class will follow the textbook.

Four Credits: It is possible to take the course for 4 credits rather than 3, at the cost of extra homework questions and more difficult exams. If you are interested in doing this you need to email me about it very soon after the start of the course.

Resources: The website is on the Learn@Illinois Moodle Service at `https://learn.illinois.edu/`.

Prerequisites: Math 241 (Calculus III); Math 347 (Fundamental Mathematics) or Math 348(Fundamental Mathematics ACP) or equivalent; Math 415 (Applied Linear Algebra) or equivalent; or consent of instructor.

Lectures: 50 minute video lectures (with lecture notes) will be posted to the website by 12PM CST, MWF.

Textbook: A. Peressini, F. Sullivan and J. Uhl: The Mathematics of Nonlinear Programming

Office Hours: M,W,F 11:00 – 12:00pm online using Zoom. A permanent Zoom link will be established once the course starts. You may also schedule a meeting at other times via email.

Grading

Homework: There will be 9 homework assignments during the semester. The 2 lowest scoring homework will automatically be dropped. Homework will be posted on the Moodle class website and is due at 6PM CST on the due date. Homework will not be accepted after the due date for any reason (this is why we drop the two lowest). I will send you an invite by email to a Box folder, you will submit homework to this folder. Only you (and the TA/Professor) will have access to your folder, and your graded assignment will be placed in your folder once grading is complete.

Exams: There will be three take home midterm exams. They are scheduled for **Feb. 12th**, **Mar. 15th**, **Apr. 23rd**. The exams will be set up so that they should take between 1.5 and 2 hours, and you will have between 3 and 4 hours from the time they are posted to submit your solutions. You will submit the solutions to these exams in the exact same fashion as the homework.

Make-up exams: Make-up exams will only be given to students in the event of a valid illness, accident, or family crisis. You must inform the instructor as soon as you know that you are going to miss an exam and schedule a make-up. This **must** be done before the exam takes place.

Grade breakdown: Homework (25%), Three midterm exams (45%), Final exam (30%).

Grades: Grades will be posted online on the Moodle class website. At the end of the semester final grades will be assigned by rounding your numeric grade to the nearest whole number and then assigning a letter grade according to the following scale: F 0-59, $D-$ 60-62, D 63-66, $D+$ 67-69, $C-$ 70-72, C 73-76, $C+$ 77-79, $B-$ 80-82, B 83-86, $B+$ 87-89, $A-$ 90-92, A 93-96, $A+$ 97-100.

Tentative Schedule

Below you will find a tentative schedule. Expect minor changes as we get further into the semester.

Date	Section	Homework/Exam
Jan 25 (M)	Section 1.1 Functions of One Variable	
Jan 27 (W)	Section 1.2 Functions of Several Variables	
Jan 29 (F)	Section 1.2 Functions of Several Variables	
Feb 1 (M)	Section 1.3 Positive/Negative Definite Matrices	
Feb 3 (W)	Section 1.3 Positive/Negative Definite Matrices	HW1 Due (1.1 - 1.2)
Feb 5 (F)	Section 1.4 Coercive Functions and Global Minimizers	
Feb 8 (M)	Section 1.5 Eigenvalues and Positive Definite Matrices	
Feb 10 (W)	Section 2.1 Convex Sets	HW2 Due (1.3 - 1.5)
Feb 12 (F)	**Exam 1**	
Feb 15 (M)	Section 2.3 Convex Functions	
Feb 17 (W)	**University break: No class**	
Feb 19 (F)	Section 2.3 Convex Functions	
Feb 22 (M)	Section 2.3 Convex Functions	
Feb 24 (W)	Section 2.4 Convexity and A-G Mean Inequality	HW3 Due (2.1 - 2.3)
Feb 26 (F)	Section 2.5 Unconstrained Geometric Programming	
Mar 1 (M)	Section 2.5 Unconstrained Geometric Programming	
Mar 3 (W)	Section 4.1 Least Squares Fit	HW4 Due (2.4 - 2.5)
Mar 5 (F)	Section 4.1 Least Squares Fit	
Mar 8 (M)	Section 4.2 Subspaces and Projections	
Mar 10 (W)	Section 4.3 Minimum Norm Solutions	
Mar 12 (F)	Section 4.4 Generalized Inner Products and Norms	HW5 Due (4.1 - 4.3)
Mar 15 (M)	**Exam 2**	
Mar 17 (W)	Section 5.1 Separation/Support Theorems - Convex	
Mar 19 (F)	Section 5.1 Separation/Support Theorems - Convex	
Mar 22 (M)	Section 5.1 Separation/Support Theorems - Convex	
Mar 24 (W)	**University break: No class**	
Mar 26 (F)	Section 5.2 Convex Programming: KKT Theorem	
Mar 29 (M)	Section 5.2 Convex Programming: KKT Theorem	
Mar 31 (W)	Section 5.2 Convex Programming: KKT Theorem	
Apr 2 (F)	Section 5.3 The KKT Theorem and Constrained GP	HW6 Due (5.1 - 5.2)
Apr 5 (M)	Section 5.3 The KKT Theorem and Constrained GP	
Apr 7 (W)	Section 5.4 Dual Convex Programs	
Apr 9 (F)	Section 6.1 Penalty Functions	HW7 Due (5.3 - 5.4)
Apr 12 (M)	Section 6.2 The Penalty Method	
Apr 14 (W)	Section 6.2 The Penalty Method	
Apr 16 (F)	Section 6.3 Applications of Penalty Functions	
Apr 19 (M)	Section 6.3 Applications of Penalty Functions	
Apr 21 (W)	Section 3.1 Newton's Method	HW8 Due (6.1 - 6.3)
Apr 23 (F)	**Exam 3**	
Apr 26 (M)	Section 3.1 Newton's Method	
Apr 28 (W)	Section 3.2 The Method of Steepest Descent	
Apr 30 (F)	Section 3.3 Beyond Steepest Descent	
May 3 (M)	Section 3.3 Beyond Steepest Descent	HW9 Due (3.1 - 3.2)
May 5 (W)	Section 3.4 Broyden's Method	