Math 484 - Nonlinear Programming

Fall 2021

Instructor:	Avery St. Dizier	**Time:**	MWF 10:00–10:50
Email:	stdizie2@illinois.edu	**Place:**	245 Altgeld Hall

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 anlytical solutions of constrained and unconstrained optimization problems; 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.

Office Hours: MWF from 11:00–11:50 in 145 Altgeld Hall. Possible additional hours by appointment.

Resources: See the course Compass page for homework, solutions, grades, and course notes.

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.

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

Four Credits: It is possible to take this 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 must email me about it very soon after the start of the course.

Disability Accommodations: To obtain disability-related academic adjustments aids, students with disabilities must contact the instructor and Disability Resources and Educational Services ASAP.

Grading

Homework: There will be nine homework assignments during the semester. The two lowest scoring homeworks will automatically be dropped. Homework assignments will be posted on the Compass page. Homework *must* be submitted electronically through the Compass page. Homework is due at 11:59PM(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).

Exams: There will be three in-class exams. They are scheduled for September 13th, October 11th, and November 15th.

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 to 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 Compass class page. 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 approximately 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

Date	Section	Homework
Aug 23(M)	§1.1 Functions of One Variable	
Aug 25(W)	§1.2 Functions of Several Variables	
Aug 27(F)	§1.2 Functions of Several Variables	
Aug 30(M)	§1.3, 1.5 Positive/Negative Definite Matrices	
Sep 1(W)	§1.3 Positive/Negative Definite Matrices	HW1 Due (§1.1-§1.2)
Sep 3(F)	§1.4 Closed and Bounded sets	
Sep 6(M)	**Labor Day**	
Sep 8(W)	§1.4 Coercive Functions	
Sep 10(F)	§2.1 Convex Sets	HW2 Due (§1.3-§1.4)
Sep 13(M)	**Exam 1**	
Sep 15(W)	§2.3 Convex Functions	
Sep 17(F)	§2.3 Convex Functions	
Sep 20(M)	§2.3 Convex Functions	
Sep 22(W)	§2.4 Convexity and A-G Mean Inequality	HW3 Due (§2.1-§2.3)
Sep 24(F)	§2.5 Unconstrained Geometric Programming	
Sep 27(M)	§2.5 Unconstrained Geometric Programming	
Sep 29(W)	§4.1 Least Squares Fit	HW4 Due (§2.4-§2.5)
Oct 1(F)	§4.1 Least Squares Fit	
Oct 4(M)	§4.2 Subspaces and Projections	
Oct 6(W)	§4.3 Minimum Norm Solutions	
Oct 8(F)	§4.4 Generalized Inner Products and Norms	HW5 Due (§4.1-§4.3)
Oct 11(M)	**Exam 2**	
Oct 13(W)	§5.1 Convex Separation and Support Theorems	
Oct 15(F)	§5.1 Convex Separation and Support Theorems	
Oct 18(M)	§5.1 Convex Separation and Support Theorems	
Oct 20(W)	§5.2 Convex Programming: KKT Theorem	
Oct 22(F)	§5.2 Convex Programming: KKT Theorem	
Oct 25(M)	§5.2 Convex Programming: KKT Theorem	HW6 Due (§5.1-§5.2)
Oct 27(W)	§5.3 The KKT Theorem and Constrained GP	
Oct 29(F)	§5.3 The KKT Theorem and Constrained GP	
Nov 1(M)	§5.4 Dual Convex Programs	HW7 Due (§5.3)
Nov 3(W)	§6.1 Penalty Functions	
Nov 5(F)	§6.2 The Penalty Method	
Nov 8(M)	§6.2 The Penalty Method	
Nov 10(W)	§6.3 Applications of Penalty Functions	
Nov 12(F)	§6.3 Applications of Penalty Functions	HW8 Due (§6.1-§6.3)
Nov 15(M)	**Exam 3**	
Nov 17(W)	§3.1 Newton's Method	
Nov 19(F)	§3.1 Newton's Method	
Nov 22(M)	**Fall Break**	
Nov 24(W)	**Fall Break**	
Nov 26(F)	**Fall Break**	
Nov 29(M)	§3.2 The Method of Steepest Descent	
Dec 1(W)	§3.3 Beyond Steepest Descent	
Dec 3(F)	§3.3 Beyond Steepest Descent	HW9 Due (§3.1-§3.2)
Dec 6(M)	§3.4 Broyden's Method	
Dec 8(W)	§3.4 Broyden's Method	