Math 484: Spring 2024 Syllabus

1. Summary

This class covers various nonlinear optimization problems, including optimization of convex functions, optimization of quadratic forms, and optimization of more general functions, subject to constraints. More generally, the topics of this class aim to train an intuitive understanding of multidimensional space, along with applications of basic analysis and linear algebra to minimization and maximization problems.

2. Course information

Instructor: Peter Bradshaw
Location: 150 English Building
Time: MWF 11:00 AM - 11:50 AM
Review session: Lincoln 1022, Monday 3 PM - 4:50 PM
My office: Computer Applications Building, Room 70 (in the basement)
Textbook: *The Mathematics of Nonlinear Programming* by Peressini, Sullivan, and Uhl. The textbook is on course reserve in the library.
Scope of class: Chapters 1-6 of the textbook.

This course has a Canvas webpage (canvas.illinois.edu)
Please do not hesitate to contact me with questions (pb38@illinois.edu)

3. Grading

Homework: 20%
Semi-weekly quizzes: 10%
Midterms: 15% + 15% + 15%
Final exam: 25%

The lowest homework score and quiz score will be dropped. Midterm exam scores will not be dropped or replaced except in extenuating circumstances. I reserve the right to change this policy in the future.

Grading thresholds are as follows:

90% guarantees an A.
87% guarantees an A-.
75% guarantees a B-.
65% guarantees a C-.
50% guarantees a D-.

I reserve the right to lower (but not raise) the grade thresholds.

On graded work, the expectation is that you not only find the correct answer to the problems, but that you also write solutions with a sufficient level of clarity that a motivated student in this class could understand your work. In particular, it is not sufficient just to write an answer, or to write a series of calculations without any explanation. Spelling and grammar mistakes will never be penalized unless they interfere with a reader's ability to understand a solution.

4. Quizzes

There will be a quiz every other Monday at the end of class. You will need to bring your own paper for each quiz. You will be mainly tested on definitions and basic applications of the topics learned in class.

5. Homework

Homework will be submitted on Gradescope (ID: 696508, Entry code: RK27DW). Homework will be due every Wednesday at 11:59 pm unless otherwise specified. Homework written in LaTeXwill receive a 10% bonus. Figures do not need to be typed. The lowest homework score will be dropped.

I encourage group work on assignments, but all solutions submitted for a grade must be written individually, with no exceptions. All collaboration must be acknowledged with a statement such as *"I worked on Problem 1 with XYZ and received a hint on Problem 2 from ABC."* These statements will never incur a penalty, but failure to include them may be treated as academic dishonesty or plagiarism.

Any use of materials apart from the main textbook must be acknowledged with a similar statement, such as *"I found a key idea for the proof of Problem 1 on StackExchange."* Even when external sources are consulted, all solutions submitted for a grade must be written individually. Again, these statements will never incur a penalty, but failure to include them may be treated as academic dishonesty or plagiarism.

6. Exams

The course will have three midterm exams and one final exam. The midterm exam dates are **February 20, March 28, and April 25**. The exams will take place from **7 PM to 8:30 PM**. The exams will take place in **Gregory Hall 213**.

The final exam will take place according to the university schedule, on **Thursday, May 9 at 8:00 AM, in TBD.**

I tend to be generous in giving partial credit. **Please do not leave answers blank on exams.**

7. Accommodations

If you need a reasonable accommodation, please let me know as soon as possible. In my experience, DRES paperwork takes a long time to process, so if you plan on using DRES accommodations, you should request them as soon as possible.

8. Makeup policy

If a medical emergency prevents you from taking a midterm exam, then your final exam score will replace that midterm score. If a medical emergency prevents you from taking the final exam at the normal time, then a makeup exam will be offered.

9. Content schedule

We will aim to cover the following content according to the schedule on the following page. Due to evening exams, classes will be cancelled on two days in addition to what is shown below. These cancelled classes have not yet been determined. I reserve the right to change the schedule for classes and homework.

Wednesday, January 17	Section 1.1: 1D Optimization	
Friday, January 19	Section 1.4: Coercive functions and existence of minimizers	
Monday, January 22	Section 1.2: Geometry of $\mathbb{R}^n$	
Wednesday, January 24	Section 1.2: Topology of $\mathbb{R}^n$	Homework 1 due
Friday, January 26	Section 1.2: Critical points in $\mathbb{R}^n$	
Monday, January 29	Section 1.3, 1.5: Positive definite matrices	Quiz 1
Wednesday, January 31	Section 1.3: Sylvester's criterion	Homework 2 due
Friday, February 2	Section 2.1: Convex sets	
Monday, February 5	Section 2.3: Convex functions	
Wednesday, February 7	Section 2.3: Building convex functions	Homework 3 due
Friday, February 9	Section 2.3: Jensen's inequality	
Monday, February 12	Section 2.4: AM-GM inequality	Quiz 2
Wednesday, February 14	Section 2.5: Geometric programming	Homework 4 due
Friday, February 16	Section 2.5: Solving the dual GP	
Monday, February 19	Section 4.1: Interpolation and best-fit lines	
Tuesday, February 20	**Midterm exam 1, 7 PM - 8:30 PM**	Gregory Hall 213
Wednesday, February 21	Section 4.2: Least-squares fit and projections	
Friday, February 23	Section 4.1: Orthogonal matrices	
Monday, February 26	Section 4.3: Minimum-norm solutions	Quiz 3
Wednesday, February 28	Section 4.4: Generalized inner products	Homework 5 due
Friday, March 1	Section 5.1: The obtuse angle criterion	
Monday, March 4	Section 5.1: The separation theorem	
Wednesday, March 6	Section 5.1: The support theorem; subgradients	Homework 6 due
Friday, March 8	Section 5.2: Convex programming	
Monday, March 11	**Spring break, no class**	
Wednesday, March 13	**Spring break, no class**	
Friday, March 15	**Spring break, no class**	
Monday, March 18	Section 5.2: The KKT theorem	Quiz 4
Wednesday, March 20	Section 5.2: KKT, gradient form	Homework 7 due
Friday, March 22	Section 5.4: KKT duality	
Monday, March 25	Section 5.3: Finding dual constraints	
Wednesday, March 27	Section 5.3: Geometric programming revisited	
Thursday, March 28	**Midterm exam 2, 7 PM - 8:30 PM**	Gregory Hall 213
Friday, March 29	Section 6.1: Intro to penalty methods	
Monday, April 1	Section 6.2: Guaranteeing optimality	Quiz 5
Wednesday, April 3	Section 6.2: More on coercive functions	Homework 8 due
Friday, April 5	Section 6.3: KKT and the penalty method	
Monday, April 8	Equality constraints	
Wednesday, April 10	Section 3.1: Newton's method	Homework 9 due
Friday, April 12	Section 3.1: Newton's method in $\mathbb{R}^n$	
Monday, April 15	Section 3.2: The steepest descent method	Quiz 6
Wednesday, April 17	Section 3.3: More general descent methods	Homework 10 due
Friday, April 19	Section 3.3: Using descent methods	
Monday, April 22	Section 3.4: Broyden's method	
Wednesday, April 24	KKT for local minimizers	
Thursday, April 25	**Midterm exam 3, 7 PM - 8:30 PM**	Gregory Hall 213
Friday, April 27	Exam review	
Monday, April 30		Quiz 7 (Makeup quiz)
Wednesday, May 1		Homework 11 due
Tuesday, May 9	**Final exam, 8:00 AM - 11:00 AM**	**TBD**