IE 510-Spring 2024
Applied Nonlinear Programming

TR 2:00 pm-3:20 pm
Classroom: 106B6 Engineering Hall

Instructor: **Rasoul Etesami**, *(etesami1@illinois.edu)*
Office Hours: 4:00 pm-5:00 pm on Tuesdays in 143 CSL

Suggested Textbooks: *Nonlinear Programming* by Dimitri Bertsekas
Linear and Nonlinear Programming by David Luenberger and Yinyu Ye

NOTE: The classes will be in-person. Lecture notes will be posted weekly in the Canvas. However, please feel free to take notes during the lectures as more details may be discussed in the class.

Canvas Link: https://canvas.illinois.edu/courses/45033

Course Description: The course covers the fundamentals of nonlinear optimization. Starting with simple techniques such as bisection and curve fitting, the course builds up to cover more advanced algorithms such as Conjugate Gradient, Newton and Quasi-Newton Methods, Penalty methods, and Augmented Lagrangians. KKT conditions and duality theory in nonlinear optimization are also covered, along with their algorithmic applications. To the extent possible, the course will cover more recent results of nonlinear programming in convex and online optimization. Applications are discussed, ranging from network optimization to learning theory.

TENTATIVE COURSE OUTLINE:

Topics	Lectures
Introduction to NLP, Formulation, and Preliminaries	Weeks 1
Gradient Methods for Unconstrained Problems	Weeks 2-3
Newton's Method, Conjugate Methods	Week 4
Quasi-Newton Method, Coordinate Descent, Incremental Methods	Weeks 5-6
Feasible Direction Methods, Conditional Gradient Method, Gradient Projection Method	Weeks 7-8
Proximal Algorithms, Block Coordinate Descent	Weeks 9-10
Lagrange Multiplier Theory, Necessary/Sufficient Optimality Conditions, Sensitivity	Weeks 11-12
Penalty and Augmented Lagrangian Methods, Multipliers Methods and Duality	Week 13-14
Convex Optimization and Duality, ADMM and Dual Methods	Week 15

Mathematical maturity at the level of a beginning graduate student will be assumed. Familiarity with reading and writing mathematical proofs and basic knowledge in Linear Algebra are required. Prior coursework in Calculus, Linear Algebra, and Linear Programming will be very helpful.

Assignments and Exams:

- There will be 5 homework assignments, which will be posted approximately every two/three weeks. Homework assignments and their solutions will be posted in Canvas.
- You should upload your homework solutions in Canvas before the due date. **NO** late homework will be accepted.
- No collaboration or other solution sources are allowed on the problems assigned for homework or exams. It is important to explain your solutions clearly as it may affect your grades.
- There will be one in-class midterm exam. **TENTATIVE DATE: March 19**.
- There will be one take-home final exam and a final project in May. The exact due date will be determined later.

Course Grade Composition:

Item	% of grade
Homework Problem Sets	50%
Midterm Exam	20%
Final Exam & Project	30%