NONLINEAR PROGRAMMING – MATH 582 – TERM 251

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Office Hours **Face-Face:**
Sun, Tue & Thu (13:00-13:50)
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Textbook:

Mokhtar S. Bazaraa, Hanif D. Sherali, C.M. Shetty. Nonlinear Programming: Theory and Algorithms, Third Edition. John Wiley & Sons, Inc., 2006.

Description:

An advanced introduction to theory of nonlinear programming, with emphasis on convex programs. First and second order optimality conditions, constraint qualifications, Lagrangian convexity and duality. Penalty function methods.

Theory and algorithms of main computational methods of nonlinear programming. Representative applications of nonlinear programming in Economics, Operations Research and Mathematics.

Course Main Objectives

(1) Study the properties of convex sets, separation and support of convex sets, polyhedral sets, and convex functions. **(2)** Study the generalizations of convex functions and their interrelationships. **(3)** Study the optimality conditions for nonlinear programs. **(4)** Study the Lagrangian Duality Theorem and saddle point optimality conditions. **(5)** Learn algorithms for solving both unconstrained and constrained nonlinear programming

Student Learning Outcomes:

After completion of the course, the students should be able to:

1) Derive necessary and sufficient optimality conditions for nonlinear programs.
2) Derive optimality conditions for nonlinear programs under various constraints qualifications.
3) Construct the Lagrangian dual problem of a nonlinear program and list some of its basic properties.
4) Discuss main algorithms to solve nonlinear programs.
5) Solve different classes of nonlinear programs using the main computational procedures.
6) Define the Penalty Functions of certain nonlinear programs.
7) Use the method of penalty functions to solve nonlinear programs.

Grading Policy:

- 10%: Homework & Programming Assignments
- 20%: Project
- 20%: Exam 1
- 20%: Exam 2
- 30%: Final comprehensive exam

Evaluation:

Final grade is according to the scale.

GRADE	RANGE
A+	[90%, 100%]
A	[80%, 90%)
B+	[75%, 80%)
B	[70%, 75%)
C+	[65%, 70%)
C	[55%, 65%)
D+	[50%, 55%)
D	[45%, 50%)
F	[0%, 45%)

Numerical Computation

In this course, implementation and programming assignments will be carried out through Julia programming language

Julia Resources

1. Ben Lauwens and Allen B. Downey. Think Julia. O'Reilly Media, June 2019.
2. Other Books can be found here.

Project Guidelines:

Form teams of three students and select a project topic. If you encounter difficulties in finding a suitable project, please consult with me, and I will provide suggestions.

- **Week 3**: Submit a one-page project proposal.
- **Week 8**: Submit a one-page progress report.
- **Week 14**: Deliver a 20-minute presentation of your project to the class.
- **Week 15**: Submit the final report, which should not exceed 20 pages. Ensure that the report's similarity index is below 20%.

Course Schedule:

Week	Date	Topic		Notes
1	Aug 24–28	**Chapter 2**	Convex Hulls, Closure and Interior of a Set, Weierstrass's Theorem	
2	Aug 31–Sep 4	**Chapter 2**	Separation and Support of Sets, Convex Cones and Polarity,	
3	Sep 7–11	**Chapter 3**	Definitions and Basic Properties, Subgradients of Convex Functions	**Project Proposal**
4	Sep 14–18	**Chapter 3**	Differentiable Convex Functions, Minima and Maxima of Convex	
5	Sep 21–25	**Chapter 3**	Generalizations of Convex Functions	**National Day (23)**
6	Sep 28–Oct 2	**Chapter 4**	Unconstrained Problems, Problems Having Inequality Constraints	**Exam 1 (Ch 2-Ch 3)**
7	Oct 5–9	**Chapter 4**	Problems Having Inequality and Equality Constraints	
8	Oct 12–16	**Chapter 4**	Second-Order Necessary and Sufficient Optimality Conditions for Constrained Problems	**Project Progress Report**
9	Oct 19–23	**Chapter 5**	Cone of Tangents, Other Constraint Qualifications, Other Constraint Qualifications	
	Oct 26–30	Midterm Break		
10	Nov 2–6	**Chapter 6**	Lagrangian Dual Problem, Duality Theorems and Saddle Point	
11	Nov 9–13	**Chapter 6**	Properties of the Dual Function, Formulating and Solving the Dual Problem	
12	Nov 16–20	**Chapter 6**	Getting the Primal Solution	
13	Nov 23–27	**Chapter 8**	[Line Search Methods] [without derivative]	**Exam 2 (Ch 4-Ch 6)**
14	Nov 30–Dec 4	**Chapter 8**	[Line Search Methods] [with derivative]	
15	Dec 7–11	**Chapter 9**	Concept of Penalty Functions, Exterior Penalty Function Methods	**Project Final Report**
16	Dec 16	Review		

FINAL EXAM – See Registrar website.