ÇANKAYA UNIVERSITY

Department of Industrial Engineering

Spring, 2026

IE 507 Nonlinear Optimization Methods

(3 0 3 credits – 7.5 ECTS)

Instructor Dr. Ahmet KABARCIK

Course Description:

Review of convex sets and convex functions, local and global optima, basics of unconstrained optimization, Newton's method, steepest descent, quasi-Newton, and gradient methods for unconstrained problems, optimality conditions for constrained problems, Kuhn-Tucker conditions and Lagrangian duality, interior-point, penalty, and barrier methods for constrained optimization.

Course Objective:

The main aim of this course is:

- To develop the knowledge of understanding and formulating nonlinear optimization problems.
- To develop skills in understanding optimality conditions.
- To provide methods and techniques in solving unconstrained optimization problems
- To provide methods and techniques in solving constrained optimization problems

Learning Outcomes:

1. Further knowledge and understanding of the basics of optimization, convexity, local and global optima
2. Ability in constructing and analyzing nonlinear optimization models
3. Understanding of optimality conditions for unconstrained and constrained problems
4. Skills in applying unconstrained optimization methods such as steepest descent, quasi-Newton, and gradient methods
5. Understanding of Kuhn-Tucker theory and Lagrangean duality
6. Skills in solving constrained optimization problems using penalty and barrier, and Lagrangean methods

Textbook:

- S.G. Nash and A. Sofer, *Linear and Nonlinear Programming*, McGraw-Hill, 1996.

Reference Books:

- M.S. Bazaraa, H.D. Sherali, and C.M. Shetty, *Nonlinear Programming* (2nd ed.), Wiley, 1993.
- D.P. Bertsekas, *Nonlinear Programming*, Athena Scientific, 1995.
- J. Shapiro, *Mathematical Programming*, Wiley, 1979.
- R.L. Rardin, *Optimization in Operations Research*, Prentice-Hall, 1998.

Weekly Course Schedule:

Week	Topic(s)
1	Review of Fundamentals of Optimization, Feasibility, Optimality, Convexity, Min-Max-Saddle points
2	Introduction to nonlinear optimization, local and global optima, examples of nonlinear optimization problems
3	Basics of Unconstrained Optimization, Necessary and Sufficient Conditions for Optimality
4	Steepest Descent Method
5	Newton's method
6	Modified Newton Method and Line Search Algorithms
7	Quasi-Newton Methods
8	Gradient Methods
9	Basics of Constrained Optimization, Kuhn-Tucker Conditions
10	Optimality Conditions for Linear Equality and Inequality Constraints
11	Optimality Conditions for Nonlinear Constraints
12	Lagrange Multipliers and Lagrangean Function
13	Feasible Point Methods
14	Penalty and Barrier Methods

Computer Usage:

Students should be able to use packages such as MATLAB, LINGO, and GAMS, as well as the programming language PYTHON, which will be required for homework assignments.

Grading:

HW Assignments	30%
Midterm :	30%
Final:	40%
Total:	**100%**

Lecture Hours:

Thursday 18:00—20:50