IE 601: Optimization Theory
Spring 2022

Instructor: Burak Kocuk (burakkocuk@sabanciuniv.edu)

Lecture Hours: Wednesday 14:40–16:30 (FENS L027), Thursday 16:40–17:30 (FENS 2019).

Office Hours: Wednesday 9:00–10:00 (FENS 2095) or by appointment.

Pre-requisite: IE 501.

Catalog Description: Convex optimization and functional analysis; theory of duality; iterative methods and convergence proofs; interior point methods for linear programming; computational complexity of mathematical programming problems; extensions of linear programming.

Course Topics: This course will cover five main topics:

1. **Background Material**: Basic convex analysis (convex sets, convex functions, regular cones), linear programming (polyhedral representability, duality, Farkas Lemma), convex programming (duality, optimality conditions).

2. **Conic Programming Theory**: Duality, tractable conic programs (second-order cone programming, semidefinite programming), conic representability, other useful cones (exponential cone, power cone).

3. **Conic Programming Applications**: Conic programming relaxations of non-convex optimization problems, applications in robust optimization, portfolio optimization, power systems optimization, statistics/machine learning.

4. **Complexity**: Computational complexity of linear programming, interior-point methods.

5. **Advanced Topics**: Sum-of-squares/moment relaxations for polynomial optimization problems, copositive programming (if time permits).

Software: A Python-based modeling system for convex optimization called CVXPY will be used for the examples discussed in class and homework assignments. Please install CVXPY from https://www.cvxpy.org/.

You are also recommended to install the conic programming solver MOSEK and use it in conjunction with CVXPY. The details can be found from https://www.cvxpy.org/install/index.html.

Reference Books:

- Lectures on Modern Convex Optimization, A. Ben-Tal and A. Nemirovski (SIAM).
Grading: Midterm (20%), Final (30%), Homework (30%), Final Project (20%).

Homework: There will be four homework assignments, each featuring some theoretical as well as computer-based questions. Students are allowed to work together as long as they submit their own homework and acknowledge who they have worked with.

Exams: There will be two open-notes (closed-homeworks) exams (tentative dates: April 13th, June 13th).

Project: Students are expected to read at least one paper involving a conic programming application and develop a basic implementation. Students will submit a report explaining their findings by June 26th. Students can choose their own topics in consultation with the instructor, or from the following list:

- Second-order cone/semidefinite programming relaxations.

- Sparsity exploitation in semidefinite programming.

- Scaled diagonally dominant restrictions in semidefinite programming.

- Applications in discrete optimization.


- **Copositive programming relaxations.**

- **Applications in power systems.**

- **Applications in finance.**

- **Applications in statistics/machine learning/signal processing.**