EE 231 Convex Optimization in Engineering Applications

(Winter 2014)

Instructor:

Dr. Hamed Mohsenian-Rad
Assistant Professor, Department of Electrical Engineering, University of California at Riverside
Office: WCH 436
Email: Hamed @ee.ucr.edu

Course Purpose:

Recognizing and solving convex optimization problems that arise in engineering applications. Convex sets, functions, and optimization problems. Basics of convex analysis. Least-squares, linear and quadratic programs. Optimality conditions, duality theory. Gradient, Steepest Descent, and Newton's Methods. Applications in engineering.

Textbook:

S. Boyd and L. Vandenberghe, Convex Optimization, Cambridge University Press, 2004.

Course Topics:

1. Introduction [Chapter 1 & Appendix A]:
    - Mathematical optimization
    - Linear programming
    - Convex optimization

2. Convex Sets [Chapter 2]:
    - Affine and convex sets
    - Examples: Hyperplanes, halfspaces, Ellipsoids, Norms, Polyhedra, PSD cones
    - Operations that preserve convexity

3. Convex Function [Chapter 3]:
    - Basic properties and examples
    - Operations that preserve convexity
    - Log0concave and log0convex functions
    - Composition theorem and examples

4. Convex optimization problems [Chapters 4 and 6]:
    - Convex optimization problems
    - Linear optimization problems
    - Quadratic optimization problems
    - Approximations and Fitting

5. Duality [Chapter 5]
    - The Lagrange dual function
    - The Lagrange dual problem
    - Geometric interpretation
    - Optimality (KKT) conditions

6. Solving Convex Optimization Problems - Part I [Papers & CVX Manual]:
    - Introduction to CVX
    - Using CVX to solve multiple engineering optimization problems

7. Solving Convex Optimization Problems - Part II [Chapters 9011]:
    - Gradient Descent Method
    - Steepest Descent Method
    - Newton's Method for Unconstrained Optimization
    - Newton's Method for Equality Constrained Optimization

Prerequisites:

EE 230: Mathematical Methods for Electrical Engineering

Note: Similar courses in other departments will be accepted upon the instructor's approval.

Grading (Percentage):

Homework - 25%
Midterm Exam: 25%
Final Exam - 40%
Final Project Report and MATLAB code* - 10%

*This course includes a final project for which each student should formulate and solve a convex optimization problem related to the student's field of study or research. To earn the grade for this part of the course, the student should mathematically formulate the target optimization problem, prove that the formulated optimization problem is problem, and then write a program in MATLAB using MATLAB's CVX toolbox to numerically solve the formulated optimization problem and present the solution. The MATLAB program along with a written report showing the problem formulation and numerical solutions will have to be submitted by the Final Project Report deadline.