

EE 588: Optimization for the Information and Data Sciences

Units 4

Spring 2021

Lecture Time & Venue: Tue./Thu, 12-1:50pm - Online and SLH 100

Zoom Link: <https://usc.zoom.us/j/96292866059>

Discussion Section: TBA

Office Hours: Tue./Thu, 2-3pm, via Zoom (in person only by appointment)

Zoom: <https://usc.zoom.us/my/rahuljai>

Course page: <http://www.rahuljain.net/teaching>

Instructor: Prof. Rahul Jain, EEB 328, rahul.jain@usc.edu

TA: Rodrigo Lobos, rlobos@usc.edu

Course Description:

This course will focus on optimization problems and algorithms that arise in many science and engineering applications. Fundamental topics include convex sets, convex functions, generalized inequalities, least-squares, linear and quadratic programs, semidefinite programming, optimality conditions and duality theory. The course also covers optimization methodology with a focus on first order methods. Sample topics include: efficient first-order algorithms for smooth and non-smooth optimization, accelerated schemes, Newton and quasi-Newton methods, iterative algorithms and non-convex optimization. Some applications to signal processing, control, machine learning and statistics will be presented. Students will learn to identify and solve convex optimization problems. They will learn to use optimality conditions and duality theory for optimization. They will be exposed to numerous applications of convex optimization in different fields and the basics of optimization algorithms.

Pre-requisites: EE510 (Linear Algebra), recommended preparation EE 503 (Probability)

Grading: Exam (50%), Home-works (40%), and Class Participation (10%)

Final Exam: The Final exam will happen as per University Final Exam Calendar.

Homework submission policy: There will roughly be on homework every 10 days. They have to be submitted by the due date. Late homework will not be accepted. The lowest grade among all the homeworks will be dropped.

Course Schedule: A Tentative Weekly Plan

Week	Topics	Reading	HW
Week 1	Introduction to mathematical optimization, sample examples and applications, Mathematical background	Textbook Chapter 1, Textbook Appendix	
Week 2	Affine and Convex sets, geometric of convex sets, operations preserving convexity	Textbook Chapter 2,	HW #1
Week 3	Convex functions, basic properties and examples, operations preserving convexity, conjugate function, Quasi-convex functions, log-concave and log-convex functions	Textbook Chapter 3, Sections 3.1-3.5	
Week 4	Convex Optimization Problems, linear and quadratic optimization problems	Textbook Chapter 4, Sections 4.1-4.4	HW #2
Week 5	Geometric programming, Generalized inequality constraints, semidefinite programming, Pareto optimality	Textbook Chapter 4, Sections 4.5-4.7	
Week 6	Duality, Lagrange dual function, Dual problem, Weak and strong duality, optimality conditions, applications of duality, applications in information and game theory, Perturbation and sensitivity analysis, Examples, Theorems of alternatives, duality for generalized inequalities	Textbook Chapter 5, Sections 5.1-5.9	HW #3
Week 7	Norm approximation and least norm problems, Robust approximation, function fitting and interpolation, optimal input design	Textbook Chapter 6	
Week 8	Applications in machine learning: Maximum likelihood estimation, exponential families, regression and classification		HW #4
Week 9	Applications in Statistics: Hypothesis testing, Chebyshev and Chernoff bounds	Textbook Chapter 7	
Week 10	Geometric problems, projection on a set, distance between sets, centering, placement and facility location	Textbook Chapter 8, Sections 8.1-8.6	HW #5

Week	Topics	Reading	HW
Week 11	Descent algorithms and line search methods		
Week 12	Acceleration, momentum, and conjugate gradients, Newton and Quasi-Newton methods		HW #6
Week 13	Coordinate descent, Stochastic and incremental gradient methods		
Week 14	Non smooth optimization, Subgradient methods, proximal algorithms, Projected gradient methods		
Final	Date: For the date and time of the final for this class, consult the USC <i>Schedule of Classes</i> at www.usc.edu/soc .		

Statement on Academic Conduct and Support Systems

Academic Conduct:

Plagiarism – presenting someone else’s ideas as your own, either verbatim or recast in your own words – is a serious academic offense with serious consequences. Please familiarize yourself with the discussion of plagiarism in *SCampus* in Part B, Section 11, “Behavior Violating University Standards” policy.usc.edu/scampus-part-b. Other forms of academic dishonesty are equally unacceptable. See additional information in *SCampus* and university policies on scientific misconduct, <http://policy.usc.edu/scientific-misconduct>.

Support Systems:

Student Counseling Services (SCS) – (213) 740-7711 – 24/7 on call

Free and confidential mental health treatment for students, including short-term psychotherapy, group counseling, stress fitness workshops, and crisis intervention. engemannshc.usc.edu/counseling

The Office of Disability Services and Programs

Provides certification for students with disabilities and helps arrange relevant accommodations. dsp.usc.edu

USC Emergency Information

Provides safety and other updates, including ways in which instruction will be continued if an officially declared emergency makes travel to campus infeasible. emergency.usc.edu

USC Department of Public Safety – UPC: (213) 740-4321 – *HSC:* (323) 442-1000 – 24-hour emergency or to report a crime. Provides overall safety to USC community. dps.usc.edu