ELE539A: Optimization of Communication Systems
Princeton University, Spring 2007

Basic Information:
Instructor: Professor Mung Chiang
Office Hour: W 2:00-3:00pm, or by email appointment
Office: B328, Engineering Quad

Lecture Time: MW (and some F) 11:00am-1:00pm
Lecture Venue: E Quad, Room J323

Email: chiangm@princeton.edu
Website: www.princeton.edu/~chiangm/class.html

Special note:
This is the fourth offering of this course at Princeton University, and represents a new format. Both content and presentation will be slightly different from previous years, following a flow that will be followed in the graduate textbook being co-written by the instructor.

Description:
Study how optimization provides a modeling, analysis, proof, conceptual, design, and solution tool to problems in both point-to-point and networked communication systems, covering both classic results and current research.

Sample application topics: information-theoretic and queuing-theoretic problems, detection and estimation problems, wireless transceiver design and multiple antenna beamforming, network flow problems, network resource allocation and utility maximization, optical network topology design, wireless network power control, medium access control, IP routing, TCP congestion control, layering as optimization decomposition.

Sample optimization topics: linear programming, convex optimization, quadratic programming, geometric programming, semidefinite programming, nonconvex optimization, integer programming, robust optimization, Pareto optimization, dynamic programming, Lagrange duality, KKT optimality condition, gradient methods, interior point algorithms, distributed algorithms, decomposition methods.

Objectives:
1. Provide students with the tools and mentality of optimization.
2. Present classic and recent research topics in optimization of communication systems.
3. Introduce the tools just in time for the application topics.
4. Train the ability to do original research in academia or industry through final projects that are closely related to students' own research interests.

Reading List:
1. M. Chiang
ELE539 Lecture Notes 2006 and Drafts of *Optimization of Communication Systems*

2. S. Boyd and L. Vandenberghe
Convex Optimization (Cambridge University Press 2004)

3. About 15 journal/conference papers to be distributed in class

Prerequisite:
Students are expected to know advanced calculus and basic digital communication. However, previous exposure to optimization or networking is NOT required. Basic working knowledge of Matlab.

Draft Course Schedule:
These are 2 hour lectures, with some Friday lectures, in order to finish all lecture materials early enough so that students can concentrate on some meaningful projects in April and May.

Date	*Lect.*	*Topic*	*HW Out*	*HW In*	*Exams*
2.5	1	Introduction, Convexity			
2.7	2	Convex Optimization and Duality			
2.12	3	Linear Program, Network Flow Problems	1		
2.14	4	Geometric Program and Applications			
2.16	5	Decomposition and distributed algorithms			
2.19	6	TCP congestion control			
2.21	7	Switching, Scheduling, Random access	2	1	
2.23	8	Layering as decomposition I			
2.26	9	Layering as decomposition II			
2.28	10	IP routing I			
3.2	11	IP routing II	3	2	
3.5	12	Wireless cellular power control			
3.7	13	DSL broadband access			
3.9	14	Last year's project presentations		3	
3.10-11					Midterm
3.12	15	Signal processing with SDP	4		
3.14	16	Nonconvex optimization and applications			
3.17-25		Spring Break			
3.26	17	Stochastic optimization and applications		4	
3.27					Proposal
3.28	18	Interior point algorithm			
4.22					Interim
5.17					Present
5.24					Report

Grading:

Homework:	20%
Take-home Midterm:	25%
Project Report:	40%
Project Presentation:	15%