CS 521: LINEAR PROGRAMMING, Fall 2010

INSTRUCTOR: Bahman Kalantari (kalantar@cs.rutgers.edu), 444 Hill, Tel: 445-2001, Ext 3542.

LECTURE: M 3:20-6:20 PM, Hill Center-254, Busch

OFFICE HOURS: M 1-3.

TA: Rajat Mittal (ramittal@cs.rutgers.edu), Hill Center 204, Tel: 445-2001, Ext 9613

OFFICE HOURS: W 2:00-4:00.

PREREQUISITES: Calculus and linear algebra.

GRADING: Homework assignments (written and MATLAB programming) %30, and the better of (I): midterm %30; final %40; and (II) final %70.

EXAM DATES: Midterm: October 25, FINAL: December 20.

LECTURE DATES: Sept 8,13,20,27; Oct 4, 11, 18, 25; Nov 1,8,15, 29; Dec 6, 13.

COURSE OUTLINE: Linear inequalities and the feasibility problem. Linear programming (LP). Gordan theorem, the associated convex-hull problem and the quadratic feasibility problem. Farkas lemma, geometric interpretations. Examples of linear programming: shortest paths, mean cycle, max flows, bipartite and general matching, min-cost and multicommodity flows. Convex sets and convex functions. Taylor theorem. Polyhedra and polyhedral cones, extreme points, extreme directions, recession directions, edges, facets, basic feasible solutions. Fourier-Motzkin elimination method for solving systems of linear inequalities and its worst-case complexity. Representation theorems: Caratheodory, Farkas-Minkowski-Weyl, and Helly theorems. Dantzig's simplex method. The revised simplex method. Phase I and Phase II methods, degeneracy, cycling, Bland's rule, finite termination, Klee-Minty worst-case examples. Sensitivity analysis and parametric LP. Lagrange multipliers and Karush-Kuhn-Tucker optimality conditions. Duality theorems, complementary slackness. The fundamental theorem of LP. The dual simplex method. The primal-dual method for LP and some applications. Game theory and von Neumann's min-max theorem. Orthogonal projection matrix, rank-one update formula, and inverse of partitioned matrices. Notions of size of LP, rounding, precision, and polynomial-time algorithms. Karmarkar's canonical LP, potential function and the logarithmic barrier function. Karmarkar's algorithm and variations. The positive semidefinite matrix scaling problem and the associated scaling dualities. Potential-reduction and path-following Newton methods for matrix scaling/linear programming problems. Khachiyan's ellipsoid method for LP. Strongly polynomial-time algorithms. Total unimodularity. Magic labeling problems.

TEXT: Lecture notes will be made available. Additionally, a very highly recommended book to own: Chvátal, Linear Programming, Freeman and Company, 1983.

OTHER REFERNCES: Bazaraa, Jarvis and Sherali, Linear Programming and Network Flows, Wiley, 1990; Schrijver, Theory of Linear and Integer Programming, Wiley, 1986; Papadimitriou and Stieglitz, Combinatorial Optimization: Algorithms and Complexity, Prentice-Hall, 1982; as well as article.