Semidefinite programming (SDP) and the closely related Second Order Cone Programming (SOCP) are a relatively new topic in optimization theory that emerged in early nineties. They have attracted considerable attention for several reasons. First they are natural models that pop up in diverse application areas from combinatorial optimization and graph theory, to statistics, to many areas of engineering. Second the underlying problems are now fairly well-understood and it is possible to come up with both theoretically and pragmatically efficient algorithms. Third, the subject has intellectual appeal in that methods from several areas of mathematics come together to form an elegant theory.

In this course we present a rather comprehensive survey of the subject. Here is a list of topics we hope to cover.

1. Overview of SDP and SOCP, duality theory, nondegeneracy and strict complementarity
2. Algebraic Foundation: An introduction to Euclidean Jordan algebras and connection between SDP and SOCP
3. A review of interior point algorithms for SOCP and SDP
4. Problems that can be expressed as SDP and SOCP, eigenvalue optimization
5. Applications in combinatorial optimization: Lovász-Schrijver lift and project method, Lovász $\vartheta$ function, Goemans-Williamson approximation algorithms and related topics
6. Moment problems, nonnegative polynomials, approximation and regression analysis, design of experiments and other applications in statistics
7. Applications in engineering: Truss topology, control theory and LMI, etc.

Almost all preliminary mathematical material will be covered.

**Prerequisites** Ph.D. standing and the proverbial “mathematical maturity” are the only prerequisites. Knowledge of linear programming will be quite helpful though strictly speaking not required. Knowledge of basic linear algebra is essential.

**Student Requirements:** Each student is required to take turn and jot down notes during the lectures and then transcribe them into $\LaTeX$. The notes will then be posted in the course web page. In addition each student is required to prepare a 40 minute talk which can be either presentation of a research paper by others or it can be a project that he/she has conducted in the course.

**Reading** There is no official textbook. Relevant papers will be made available in the course home page.

**Course home page:**

http://www.ieor.columbia.edu/~alizadeh/CLASSES/01fallSDP/

All up-to-date information including class date and location will be posted in this page.