# CSCI5254: Convex Optimization and Its Applications

**Course Description**

This course discusses basic convex analysis (convex sets, functions, and optimization problems), optimization theory (linear, quadratic, semidefinite, and geometric programming; optimality conditions and duality theory), some optimization algorithms (descent methods and interior-point methods), basic applications (in signal processing, machine learning, statistics, control, communications, networks, circuit design, mechanical engineering, and finance, etc), and some advanced topics (distributed decomposition, exact convex relaxation, and parsimonious recovery, if time permits). The objective is to give students the theoretical tools and training to recognize and formulate convex optimization problems that arise in engineering and applied science as well as the understanding of how such problems are solved, and to give students the background required to use the tools and methods of optimization in their own applications and researches.

**Time and Location**

TTH 8:00AM - 9:15AM; ECCR 105

**Instructor**
Lijun Chen (lijun.chen@colorado.edu)
Office hours: TUE 10:00AM-12:00PM
Office: ECOT335; Ext. 4384

**Textbook**
S. Boyd and L. Vandenberghe, *Convex Optimization*, Cambridge University Press, 2004. (This book is available on-line, but I strongly recommend to buy a hardcopy).

**Optional or Other References**
D. Bertsekas, A. Nedic, and A. Ozdaglar, *Convex Analysis and Optimization*, Athena Scientific, 2003.
About 5 papers to follow.

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**Lectures**
This is a tenetaive outline of the topics we will cover and will likely change as the semester goes by.

- Introduction (Jan 16)
  Lecture Notes
  Reading: Boyd and Vandenberghe, Chapter 1.

- Convex sets (Jan 18, 23 & 25)
  Lecture Notes
  Reading: Boyd and Vandenberghe, Chapter 2.

- Convex Functions (Jan 30, Feb 1 & 6)
  Lecture Notes
  Reading: Boyd and Vandenberghe, Chapter 3.

- Convex Optimization Problems (Feb 6, 8, 13 & 15)
  Lecture Notes
  Reading: Boyd and Vandenberghe, Chapter 4.

- Duality (Feb 20, 22, 27 & Mar 1)
  Lecture Notes
  Reading: Boyd and Vandenberghe, Chapter 5.1-5.7, 5.9.

- Approximation and Fitting (Mar 6 & 8)
  Lecture Notes
  Reading: Boyd and Vandenberghe, Chapter 6.

- Statistical Estimation (Mar 13 & 15)
  Lecture Notes
  Reading: Boyd and Vandenberghe, Chapter 7.

- Geometric Problems (Mar 20 & 22)
  Lecture Notes
  Reading: Boyd and Vandenberghe, Chapter 8.

- Algorithms (Apr 3, 5, 10, 12, 17, 19, 24 & 26)
  Lecture Notes(Unconstrained problems)
  Lecture Notes(Equality constrained problems)

Lecture Notes(Interior-point methods)
Reading: Boyd and Vandenberghe, Chapter 9, 10, 11.

- Structural Signal Recovery (May 1 & 3)
  Lecture Notes

**Grading**
This is a preliminary breakdown that may change during the semester.

- Homework -- 40%
- Final -- 50%
- Participation -- 10%

**Homeworks**
There will be about eight to ten homework sets, due in class on Thursdays. Students are strongly encouraged to collaborate on homeworks, but should make sure to fully understand the problems and solutions and must write down solutions independently.

- Homework 1 (Due Jan 30)
- Homework 2 (Due Feb 13)
- Homework 3 (Due Mar 1)
- Homework 4 (Due Mar 15)
- Homework 5-6 (Due Apr 5)
- Homework 7 (Due Apr 24)
- Homework 8 (Due May 3)

**Final**
There will be a 24-hour take home final exam.

**Acknowledgement**

- The lecture slides are adopted from Dr. Stephen Boyd's letcture notes on Convex Optimization at Standord University. Thank Dr. Boyd for his kind help and support.

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**Accommodations for Disability**
If you qualify for accommodations because of a disability, please submit to your professor a letter from Disability Services in a timely manner (for exam accommodations provide your letter at least one week prior to the exam) so that your needs can be addressed. Disability Services determines accommodations based on

documented disabilities. Contact Disability Services at 303-492-8671 or by e-mail at dsinfo@colorado.edu.

If you have a temporary medical condition or injury, see Temporary Medical Conditions: Injuries, Surgeries, and Illnesses guidelines under Quick Links at Disability Services website and discuss your needs with your professor.

**Religious Observances**
Campus policy regarding religious observances requires that faculty make every effort to deal reasonably and fairly with all students who, because of religious obligations, have conflicts with scheduled exams, assignments or required attendance. In this class, we accommodate the absences of the class and delay in homeworks and project due to religious observances, upon notifying the instructor one week ahead. See full details at http://www.colorado.edu/policies/fac_relig.html.

**Classroom Behavior**
Students and faculty each have responsibility for maintaining an appropriate learning environment. Those who fail to adhere to such behavioral standards may be subject to discipline. Professional courtesy and sensitivity are especially important with respect to individuals and topics dealing with differences of race, color, culture, religion, creed, politics, veteran's status, sexual orientation, gender, gender identity and gender expression, age, disability, and nationalities. Class rosters are provided to the instructor with the student's legal name. I will gladly honor your request to address you by an alternate name or gender pronoun. Please advise me of this preference early in the semester so that I may make appropriate changes to my records. See policies at http://www.colorado.edu/policies/classbehavior.html and at http://www.colorado.edu/studentaffairs/judicialaffairs/code.html#student_code.

The instructor reserves the right to adjust grades as he sees needed, in response to the student behavior issues.

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All students of the University of Colorado at Boulder are responsible for knowing and adhering to the academic integrity policy of this institution. Violations of this policy may include: cheating, plagiarism, aid of academic dishonesty, fabrication, lying, bribery, and threatening behavior. All incidents of academic misconduct shall be reported to the Honor Code Council (honor@colorado.edu; 303-735-2273). Students who are found to be in violation of the academic integrity policy will be subject to both academic sanctions from the faculty member and non-academic sanctions (including but not limited to university probation, suspension, or expulsion). Other information on the Honor Code can be found at http://www.colorado.edu/policies/honor.html and at http://www.colorado.edu/academics/honorcode/.