

ISE 496: Convex Analysis and Optimization, Fall 2014

Course Information:

Lectures: Thursdays, 4:10pm-7:00pm, Mohler 453
Office Hours: Thursdays, 2:00pm-4:00pm, Mohler 475

Instructor Information:

Name: Frank E. Curtis
Office: Mohler 475
Phone: +1 (610) 758-4879 (Office)
+1 (646) 789-5490 (Mobile)
E-mail: frank.e.curtis@gmail.com
frank.e.curtis@lehigh.edu
IM: frank.e.curtis (Google)
frank.e.curtis (Skype)
Web: <http://coral.ie.lehigh.edu/~frankecurtis>

Description: Convexity, as it is defined for sets and functions, is of fundamental importance in the study of mathematical optimization. The purpose of this course is to provide a rigorous introduction to the rich field of convex analysis, particularly as it relates to optimization and duality theory. In addition to more formal analytical tools and concepts, emphasis is placed on developing a geometric and visually intuitive understanding of convex objects, optimization problems, and duality concepts.

Course Objectives: The objectives of this course are for students to do the following:

- Understand the central role of convexity in optimization theory.
- Learn basic concepts related to convex sets and functions.
- Explore important special types of convexity, such as polyhedral convexity.
- Gain a fundamental understanding of duality via insights provided by geometric arguments.
- Investigate concepts related to conjugacy and the calculus of subdifferentiable functions.
- Develop a mathematically rigorous understanding of an important area of research.
- Be able to apply course concepts in other areas of scientific research.

Prerequisite Topics: Mathematical Logic, Multivariable Calculus, Linear Algebra, and Real Analysis. Please see the *Mathematical Background* document provided on Course Site.

Office Hours: Please come to office hours if you have any questions about the course. I am also available through e-mail (always) and on Google Talk (often). If I do not respond to an e-mail within 24 hours, then please assume that I have not received it and send a follow-up e-mail. If I do not respond on Google Talk, then I am either busy or you are contacting me too late in the day, in which case you can try again the next day (during work hours) or send an e-mail instead. I am also willing to meet at other times, but in such cases please e-mail me in advance to set up a mutually convenient time.

Course Site: Lecture notes will be posted on Course Site prior to each lecture. Homework assignments, solutions, announcements, and other important material will also be posted on Course Site. Important information, corrections, and updates about the course may also be sent by e-mail (via Course Site).

Textbook: The primary textbook for the course is the following:

- Dimitri P. Bertsekas, *Convex Analysis and Optimization*, Athena Scientific, Nashua, NH, USA, 2009.

Reading the textbook is not required, but it is recommended. You are not responsible for textbook material that is not covered in lecture. Course material also will be derived from the following recommended textbooks:

- Frank H. Clarke, *Optimization and Nonsmooth Analysis*, Canadian Mathematical Society Series of Monographs and Advanced Texts, Wiley-Interscience, New York, NY, USA, 1983.
- Jean-Baptiste Hiriart-Urruty, Claude Lemaréchal, *Convex Analysis and Minimization Algorithms I*, Springer Series of Comprehensive Studies in Mathematics, Springer, New York, NY, USA, 1993.
- R. Tyrrell Rockafellar, *Convex Analysis*, Princeton University Press, Princeton, NJ, USA, 1970.
- R. Tyrrell Rockafellar, Roger J-B. Wets, *Variational Analysis*, Springer Series of Comprehensive Studies in Mathematics, Springer, New York, NY, USA, 1998.
- Andrzej Ruszczyński, *Nonlinear Optimization*, Princeton University Press, Princeton, NJ, USA, 2006.

Expected Schedule:

Week	Date	Lecture Topic(s)	Note(s)
1	08/28	Course Overview and Introduction	
2	09/04	Convex Sets and Functions	
3	09/11	Characterizing Convexity and Closedness	
4	09/18	Projections, Hulls, Interiors, and Closures	
5	09/25	Recession Cones and Functions	
6	10/02	Hyperplanes and Conjugacy	
7	10/09	Polyhedral Convexity	
8	10/16	(No lecture)	Midterm Exam
9	10/23	Fundamentals of Convex Optimization	
10	10/30	Geometric Duality Framework	
11	11/06	Convex Optimization Duality	
12	11/13	Subdifferential Theory	
13	11/20	Additional Topics	
14	11/27	(No lecture)	Thanksgiving Break
15	12/04	Review	
16		(No lecture)	Final Exam

L^AT_EX: All work must be submitted as documents produced with L^AT_EX. There are no exceptions to this requirement. Assistance for learning L^AT_EX will be given in the form of the source for documents produced for the course. I will also provide a template for homework solutions. It is not required that you use the provided template, but it is highly recommended, especially if you are unfamiliar with L^AT_EX.

Grading: Your grade will be calculated as follows.

Homework:	30%
Midterm Exam:	30%
Final Exam:	30%
Participation:	10%

Homeworks: There will be regular homework assignments throughout the semester, generally assigned and due every few weeks. Each homework must be submitted electronically via Course Site. No credit will be given for any late assignment. You are free to consult with other students when working on homework, but the work you turn in must be your own. *Please cite any references you use, including fellow students.*

Exams: Both exams will be cumulative, closed-book, closed-notes, in-class, *written* exams.

Participation: Attendance will not be taken. However, participation will factor into your grade. If you are unable to participate in lecture, then participation entails being a presence online—via e-mail or Course Site—or in office hours. In short, if by the end of the semester we have not had any one-on-one discussions about the course and/or course material, then your participation grade will suffer.

Collaboration Policy: The sharing of ideas is educationally useful and you are encouraged to discuss assignments with other students. However, *plagiarism* of any kind is destructive, fraudulent, and unacceptable. You are *strictly* forbidden to copy another student's written work, whole or in part, and submit that work under your name. You are also *strictly* forbidden to make trivial or mechanical changes to another student's written work and submit that work under your name. Note that while electronic plagiarism is easier to perform (via copy-and-paste), it is also easier to detect. Plagiarized work will receive no credit and repeat offenses will result in more severe action. A sure way to avoid this issue is to discuss the assignments with fellow students, but then write your solutions individually and independently.

Emergencies: Everyone is responsible for all material covered and announcements made in lecture. If you believe you will miss a long period of time in the course due to illness, a family emergency, etc., then please contact me as early as possible. Under no circumstances will credit be given for missed work unless you have discussed your absence with me in advance.

Regrade Requests: If you disagree with a grade you receive, then you may submit a regrade request. This request must be written and submitted no more than 48 hours after you receive the grade.

Recording Devices: Voice and/or video recording devices may be used only with the approval of everyone in the classroom. Please let me know in advance if you wish to use these types of devices.

Students with Disabilities: If you have a disability for which you are or may be requesting accommodations, please contact me and the Office of Academic Support Services, University Center C212 (+1 (610) 758-4152) as early as possible in the semester. You must have documentation from Academic Support Services before accommodations can be granted.

Equitable Community Principles: Lehigh University endorses The Principles of Our Equitable Community (<http://www4.lehigh.edu/diversity/principles>). We expect each member of this class to acknowledge and practice these Principles. Respect for each other and for differing viewpoints is a vital component of the learning environment inside and outside the classroom.