Math 6366 Optimization Theory

Fall 2019, MWF 12:00 pm–1:00 pm

Course Math 6366: Optimization Theory (Sections: 16772)

Instructor Andreas Mang

✉ andreas@math.uh.edu

☎ 713.743.7409

https://www.math.uh.edu/~andreas

Office PGH 614

Office Hours MW 01:00 pm–02:00 pm or by appointment (andreas@math.uh.edu)

Class Time and Place MWF 12:00 pm–01:00 pm in AH301

Course Website https://www.math.uh.edu/~andreas/teaching/math6366-FA19

Information contained in this syllabus is subject to change without notice. This syllabus provides a general guideline for the course; deviations may be necessary. Students are expected to be aware of any additional course policies presented by the instructor during the course.

1 Prerequisites

Credit for or concurrent enrollment in MATH 4331 and MATH 4377, or consent of instructor. Students are expected to have a good grounding in basic real analysis and linear algebra.

2 Textbooks

This course will be based on the following textbook:

- Convex Optimization by S. Boyd and L. Vandenberghe. Cambridge University Press 2004.

This book can be downloaded here: http://stanford.edu/~boyd/cvxbook/. Additional reading materials are:

- Introduction to Nonlinear Optimization by A. Beck. SIAM 2014.
- Numerical Optimization by J. Nocedal and S. J. Wright. Springer 2006.

3 Course Description

This course will introduce the theoretical foundations of optimization and strategies to its numerical solution. Starting from first principles we will discuss how to design and analyze simple iterative methods for efficiently solving a broad class of optimization problems. While the field of optimization is vast, there exists a small set of methods that achieve optimal performance. We will assess the efficiency of these techniques on prototypical

optimization problems. This class will walk through classic results and provide a gateway to cutting edge research in the field.

4 Course Content

Course material will be made available section by section on **blackboard**. This is the first semester of a two-semester course. The focus in this semester will be on convex optimization. The tentative content of this course is as follows:

§1 Convex set.

- affine and convex sets
- examples for convex sets
- operations that preserve convexity
- generalized inequalities

§2 Convex functions.

- basic properties
- operations that preserve convexity
- quasiconvex functions

§3 Convex optimization problems.

- optimization problems
- convex optimization and linear optimization problems
- quadratic optimization problems & geometric programming

§4 Duality.

- the lagrange dual function
- saddle-point interpretation
- optimality conditions

§5 Unconstrained and Equality Constrained Minimizations.

- unconstrained minimization problems
- gradient descent
- newton's method
- equality constrained minimization
- newton's method with equality constraints
- infeasible start newton method

§6 Interior-Point Methods.

- inequality constrained minimization problems
- barrier method
- primal-dual interior point methods

§7 Selected Topics (if time permits).

5 Attendance Policy

Attendance is not required, but strongly encouraged. Coming to class late or leaving early is disruptive and thus discouraged.

6 Dropping Policy

09/04/19	Official reporting day (ORD); drop a course without receiving a grade.
10/31/19	Last day to drop a course or withdraw with a 'W'.

7 Homework Assignments

If not noted differently, homework assignments will be made available two weeks before the designated due date on **blackboard**. The homework has to be submitted on the designated due date. The deadline for handing in your homework will be 12:50 pm sharp (i.e., before I leave the classroom). Late homework will **not** be accepted. The homework will be a combination of practical (computing) exercises and analysis. Computing will be done in Matlab (https://www.mathworks.com/products/matlab.html). If desired, solutions in Julia (https://julialang.org) or Python (https://www.python.org) are also acceptable. There will be a total of six to seven homework assignments. Homework scores cannot be changed after one week after they have been returned.

It is expected that you express your ideas clearly, legibly, and completely, which often requires complete English sentences (i.e., a justification) rather than a long string of equations or unconnected mathematical expressions. Homework can and should be worked on and discussed with others. Collaboration is a big part of learning and of scholarship in general. I strongly encourage you to participate in study groups with fellow students attending this course. However, the write-up of the homework has to be independent, and in your own words. Your homework needs to be complete, neatly written, and stapled. If you use any external source (e.g., books or internet) you must acknowledge the source in your submission. Penalty for not reporting your sources will be a score of zero for the homework. Your coding solutions have to be submitted by email as instructed in the homework assignments. I reserve the right to deduct points if these rules are not followed.

If you are considering to take the prelim, I strongly encourage you to work on all homework assignments. It is your responsibility to be well prepared for the exams and the prelim.

8 Exams

During the semester there will be two in class midterm exams and one *cumulative* final exam. The exams will contain a mixture of computational and conceptual problems. Some of them will resemble problems you have seen in your homework, while some may be brand new to you. Exams shall be worked on independently and without the use of your textbook, homework, and class notes. There will be **no makeup exams** (see §9 and §10 for details). Exam grades can be disputed until one week after they have been returned. After that your grade cannot be changed. The exam period for the final exam is **December 3–11, 2019**. The last day of class is November, 26, 2019. The tentative schedule for the exams is:

	date	time	duration	place
Midterm 1	10/04/19	12:00 pm – 12:50 pm	50 min	AH301 (in class)
Midterm 2	10/28/18	12:00 pm – 12:50 pm	50 min	AH301 (in class)
Final	11/25/19	12:00 am – 12:50 pm	50 min	AH301 (in class)

The intention of the exams is to develop a theoretical foundation and prepare math majors for the prelim. There will be the possibility to work on a final project, too.

9 Grading

The final grade for the class will be determined as follows:

category	percentages	score
homework	30%	$y_3 = 150$
midterm 1	20%	$y_1 = 100$
midterm 2	20%	$y_2 = 100$
final exam	30%	$y_4 = 150$
total	100%	500

These weights are approximate; I reserve the right to change them later. The letter grade of the course will be assigned based on the percentage $x = 100\% \left(\frac{1}{500} \sum_{i=1}^{4} y_i \right)$ of all points (semester score) earned.

letter grade	percentage	letter grade	percentage
A	$93\% \leq x \leq 100\%$	C	$73\% \leq x < 77\%$
A−	$90\% \leq x < 93\%$	C−	$70\% \leq x < 73\%$
B+	$87\% \leq x < 90\%$	D+	$67\% \leq x < 70\%$
B	$83\% \leq x < 87\%$	D	$63\% \leq x < 67\%$
B−	$80\% \leq x < 83\%$	D−	$60\% \leq x < 63\%$
C+	$77\% \leq x < 80\%$	F	$x < 60\%$

10 Makeup Policy

Not turning in homework by the assigned due date or not being present for an exam results in a **score of zero**. There will be **no makeup assignments**. Technology failures will not be accepted as reason for missed assignment due dates. Therefore, do not leave anything to the last minute. It is the student's responsibility to identify alternative ways to complete or submit an assignment.

Exceptions are possible in the case of extreme circumstances, such as a documented, serious illness. In the event that a student cannot be present to turn in homework or take an exam on the day it is held the student needs to speak to me in advance, and make every attempt to do the work before (and not after) the rest of the class.

11 Academic Honesty/Honor Code

Plagiarism and cheating are serious offenses. The University policies on academic dishonesty will be strictly enforced (see Catalog/Student Handbook for more details; http://www.uh.edu/provost/policies-resources/honesty/).

12 Students Disability Services/Special Needs

Whenever possible, and in accordance with 504/ADA guidelines, the University of Houston will attempt to provide reasonable academic accommodations to students who request and require them. Please call 713.743.5400 for more assistance. If a student has a disability and would like to request classroom accommodations, please see me after class or during office hours to discuss arrangements as soon as possible (see contact information above).

13 Mental Health/CAPS Statement

Counseling and Psychological Services (CAPS) can help students who are having difficulties managing stress, adjusting to college, or feeling sad and hopeless. You can reach CAPS (http://www.uh.edu/caps) by calling 713-743-5454 during and after business hours for routine appointments or if you or someone you know is in

crisis. No appointment is necessary for the ''Let's Talk'' program, a drop-in consultation service at convenient locations and hours around campus. http://www.uh.edu/caps/outreach/lets_talk.html.

14 Help

The instructor is available for help during office hours. All the information about this course will be posted regularly on the course website. Material and homework assignments will be posted on blackboard. *Please check these sites often*.

15 Cell Phones and Electronic Devices

During class and exam periods, all cell phones and other electronic devices must be turned off and kept in a secure location away from the students immediate view. The use of laptop computers in class is only permitted if students are using the computers to take notes or for purposes related to the class.