



MATH 6367 | Optimization Theory

Section: 17410 | Face-to-Face

Instructor Information

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Office Hours

Tuesdays 4:30pm-5:30pm

General Course Information

Course Meeting Time: Tuesdays and Thursdays 2:30-4:00pm

Course Meeting Location: Lucile Melcher Hall 116

Course 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.

Course Objectives and Student Learning Outcomes

Optimization is now a fundamental subject that is at the center of many applications in areas such as engineering, operation research,

finance and more recently machine learning. This course aims at introducing more advanced and modern concepts and methods in the field.

Building up on reminders from convex analysis and optimization for smooth convex functions, we shall first delve into optimization frameworks for nonsmooth finite-dimensional convex problems. Such problems include for instance LASSO regression in statistics or sparse approximation in imaging and compressed sensing. We shall specifically discuss and analyze the convergence of proximal, splitting, primal dual and Bergman iterative methods.

Following this, the course will provide a brief introduction to optimization in infinite dimension, otherwise known as calculus of variations. We shall then specifically focus on the study of problems from the field of optimal control for continuous and discrete dynamical systems, emphasizing key theoretical results in both the linear and nonlinear setting. We shall also tackle the numerical side by looking into methods such as path-straightening, shooting and dynamic programming. The last topic to be covered is the extension of these analytical and algorithmic approaches to discrete stochastic systems, in which we shall also provide some introduction to the very active research area of reinforcement learning.

This course will combine mathematical analysis with computational aspects and some coding in MATLAB or Python. The course objective is to acquire some proficiency in both components, although each student will be left free to put more emphasis on one aspect over the other.

Required Instructional Materials

Students will need the following equipment to be able to follow classes:

- Access to internet and ability to log in to Canvas and MS Teams for all communication related to the class
- Scanner or smartphone apps to convert assignment papers into

PDF format

- Working version of MATLAB or Python for code implementation

No textbook purchase is required. Course notes/slides will be made available on Canvas/MS Teams. Here are however a few additional references that can be useful as complement:

1. Convex Optimization. S. Boyd and L. Vanderberghe. Cambridge University Press, 2004
2. Numerical Optimization. J. Nocedal and S. Wright. Springer, 2006
3. Proximal Methods. N. Parikh and S. Boyd. Foundations and Trends in Optimization, 2013
4. Optimal Control: An Introduction to the Theory with Applications. L. Hocking. Oxford Applied Mathematics and Computing Science Series, 1991
5. Dynamic Programming and Optimal Control. D. P. Bertsekas. Athena, 2017.

Course Schedule, Assignments, and Assessments

This course will be delivered face-to-face (in person). In between class meetings, there may also be asynchronous activities to complete (e.g., homework assignments or small projects).

Attendance is not required, but strongly encouraged. Regular class attendance, participation, and engagement in coursework are important contributors to student success.

Evaluation for this course is solely based on homework assignments and small project presentations. Note that the following information is only provisional and subject to future changes.

Assignments will be given on a roughly bi-weekly basis. There should be a total of approximately 5 or 6 homeworks by the end of the semester, each of which will primarily consist of mixed list of mathematical and computational problems. Digital copies of your completed homework assignments have to be uploaded on Canvas at the specified deadline.

The final course grade will be then computed as the average over all the semester's assignments.

Discussion and Lecture Topics

The following is a provisional list of topics to be covered by the course:

- Reminders on convex sets and functions, differential calculus, convex optimization problems and methods...
- Nonsmooth convex functions and optimization: subgradient, subgradient descent method, primal-dual scheme, proximal operator and proximal methods, splitting schemes...
- Intro to calculus of variations: existence of solutions, first-order optimality conditions...
- Optimal control for systems governed by linear dynamical systems: controllability conditions, linear quadratic problems...
- Nonlinear optimal control: Pontryagin maximum principle, Hamilton-Jacobi equations, direct and indirect numerical schemes, dynamic programming...
- Optimal control for stochastic systems and connection to reinforcement learning.

Grading Rubrics and Weights

Final grade will be given as the average of all homework assignment grades plus potential in class presentations (if applicable).

Course Policies and Procedures

The materials provided by the instructor in this course are for the use of the students in the course only. Course materials and course recordings (if permission was warranted) may not be further disseminated without instructor permission. This includes sharing content to commercial course material suppliers or public domain platforms. Students are also prohibited from sharing materials derived from the instructor's content (e.g., a student's lecture notes).

When it comes to assignments, while it is not prohibited for students to work on the problems in small groups or teams, each submission should be personal and not the exact copy of another student's paper. Similarly, while the use of AI tools is not strictly prohibited, answers to problems should not be a direct copy and paste from the outputs of such softwares.

University Policies and Student Support Resources

Mental Health and Wellness Resources

The University of Houston has a number of resources to support students' mental health and overall wellness, including [CoogsCARE](#) and the [UH Go App](#). [UH Counseling and Psychological Services \(CAPS\)](#) offers 24/7 mental health support for all students, addressing various concerns like stress, college adjustment and sadness. CAPS provides individual and couples counseling, group therapy, workshops and connections to other support services on and off- campus. For assistance visit uh.edu/caps, call 713-743-5454, or visit a [Let's Talk](#) location in-person or virtually. Let's Talk are daily, informal confidential consultations with CAPS therapists where no appointment or paperwork is needed.

Need Support Now? If you or someone you know is struggling or in crisis, help is available. Call CAPS crisis support 24/7 at 713-743-5454, or the National Suicide and Crisis Lifeline: call or text 988, or chat 988lifeline.org.

Title IX/Sexual Misconduct

Per the UHS Sexual Misconduct Policy, your instructor is a "responsible employee" for reporting purposes under Title IX regulations and state law and must report incidents of sexual misconduct (sexual harassment, non-consensual sexual contact, sexual assault, sexual exploitation, sexual intimidation, intimate partner violence, or stalking) about which they become aware to the Title IX

office (known at UH as the Equal Opportunity Services office or "EOS"). Please know there are places on campus where you can make a report in confidence. You can find more information about resources on the UH [Title IX/Sexual Misconduct Resources page](#). Please note that you may also report concerns of discrimination based on your protected class identity to EOS.

Reasonable Academic Adjustments/Auxiliary Aids

The University of Houston is committed to providing an academic environment and educational programs that are accessible for its students. Any student with a disability who is experiencing barriers to learning, assessment or participation is encouraged to contact the Justin Dart, Jr. Student Accessibility Center (Dart Center) to learn more about academic accommodations and support that may be available to them. Students seeking academic accommodations will need to register with the Dart Center as soon as possible to ensure timely implementation of approved accommodations. Please contact the Dart Center by visiting the website: <https://uh.edu/accessibility/> calling (713) 743-5400, or emailing jdcenter@Central.UH.EDU.

The [Student Health Center](#) offers a Psychiatry Clinic for enrolled UH students. Call 713-743-5149 during clinic hours, Monday through Friday 8 a.m. - 4:30 p.m. to schedule an appointment.

The [A.D. Bruce Religion Center](#) offers spiritual support and a variety of programs centered on well-being.

The [Center for Student Advocacy and Community \(CSAC\)](#) is where you can go if you need help but don't know where to start. CSAC is a "home away from home" and serves as a [resource hub](#) to help you get the resources needed to support academic and personal success. Through our [Cougar Cupboard](#), all students can get up to 30 lbs of FREE groceries a week. Additionally, we provide 1:1 appointments to get you connected to on- and off-campus resources related to essential needs, safety and advocacy, and more. The [Cougar Closet](#) is a registered student organization advised by our office and offers free

clothes to students so that all Coogs can feel good in their fit. We also host a series of cultural and community-based events that fosters social connection and helps the cougar community come closer together. Visit the CSAC homepage or follow us on Instagram: @uh_CSAC and @uhcupbrd. YOU belong here.

Cougar Parent and Family Engagement Office

This office, under the Dean of Students Office (<https://www.uh.edu/dos/>), coordinates resources for Pregnant and Parenting Students (<https://www.uh.edu/dos/parenting-students/>), Parents and Family members of UH students (<https://www.uh.edu/dos/parents/>), and Sexual Misconduct Support Services (<https://www.uh.edu/dos/sexual-misconduct-support-services/>). A description of available support and resources are provided on the respective web pages. The Cougar Parent and Family Engagement Office is located in Student Center South, room B12. Additional announcements will be provided in late Jan 2026.

Academic Honesty Policy

High ethical standards are critical to the integrity of any institution, and bear directly on the ultimate value of conferred degrees. All UH community members are expected to contribute to an atmosphere of the highest possible ethical standards. Maintaining such an atmosphere requires that any instances of academic dishonesty be recognized and addressed. The [UH Academic Honesty Policy](#) is designed to handle those instances with fairness to all parties involved: the students, the instructors, and the University itself. All students and faculty of the University of Houston are responsible for being familiar with this policy.

Excused Absence Policy

Regular class attendance, participation, and engagement in coursework are important contributors to student success. Absences may be excused as provided in the University of Houston

[Undergraduate Excused Absence Policy](#) and [Graduate Excused Absence Policy](#) for reasons including medical illness of student or close relative, death of a close family member, legal or government proceeding that a student is obligated to attend, recognized professional and educational activities where the student is presenting, and University-sponsored activity or athletic competition. Under these policies, students with excused absences will be provided with an opportunity to make up any quiz, exam or other work that contributes to the course grade or a satisfactory alternative. Please read the full policy for details regarding reasons for excused absences, the approval process, and extended absences. Additional policies address absences related to [military service](#), [religious holy days](#), [pregnancy and related conditions](#), and [disability](#).

Recording of Class

Students may not record all or part of class, livestream all or part of class, or make/distribute screen captures, without advanced written consent of the instructor. If you have or think you may have a disability such that you need to record class-related activities, please contact the [Justin Dart, Jr. Student Accessibility Center](#). If you have an accommodation to record class-related activities, those recordings may not be shared with any other student, whether in this course or not, or with any other person or on any other platform. Classes may be recorded by the instructor. Students may use instructor's recordings for their own studying and notetaking. Instructor's recordings are not authorized to be shared with anyone without the prior written approval of the instructor. Failure to comply with requirements regarding recordings will result in a disciplinary referral to the Dean of Students Office and may result in disciplinary action.