THE UNIVERSITY OF TEXAS AT AUSTIN

Department of Aerospace Engineering and Engineering Mechanics
ASE 381P.3 – Optimal Control Theory
Spring 2024

SYLLABUS

General Information

Unique Number: 14200

Instructor: Efstathios Bakolas, PhD
Office: ASE 4.232, Phone: (512) 471-4250,
Email: bakolas@austin.utexas.edu

Time: TTH 11:00-12:30 **Location:** ETC 2.102
Web Page: http://canvas.utexas.edu/ (Canvas)

Catalog Description
Unconstrained and constrained finite-dimensional optimization, necessary and sufficient conditions for optimality, Pontryagin's Maximum Principle, minimum-time control, linear quadratic optimal control theory, dynamic programming, Hamilton-Jacobi-Bellman equation, introduction to linear model predictive control.

Course Objectives
Introduce students to the fundamental elements of optimal control theory and its applications in modern science and engineering problems.

Prerequisites
Good familiarity with state-space control systems is expected (ASE 381P.1: Linear Systems Analysis or equivalent). Familiarity with the material covered in ASE 381P.2 (Multi-variable Control Systems) may also be helpful but is not required.

Topics
- Unconstrained finite-dimensional optimization
- Constrained finite-dimensional optimization (Introduction to Nonlinear Programming)
- Introduction to optimal control problems (classical, variational approach)
- Pontryagin's Maximum Principle

- Linear Quadratic (LQ) optimal control theory
- Minimum-time problems for linear dynamical systems
- Discrete-Time Optimal Control
- Dynamic programming, Hamilton-Jacobi-Bellman equation
- Introduction to Linear Model Predictive Control

Professionalism Topics

Discussion of ethics and teamwork based on instructor's professional experience will be given periodically throughout the semester.

Laboratory Assignments

There will be no laboratory assignments.

Computer

Students are strongly encouraged to use computers to become familiar with the computational techniques for the numerical solution of optimal control problems for dynamical systems.

Text

The following textbook is recommended but not required: Liberzon, D. "Calculus of Variations and Optimal Control Theory: A Concise Introduction," Princeton University Press, 2012.

A short list of other useful references for this course is the following:

1. Athans, A. and Falb, P.L. "Optimal Control: An introduction to the theory and applications," Dover Publications, 2006.
2. Speyer, J. L. and Jacobson, D. H. "Primer on Optimal Control Theory," SIAM, 2010.
3. Kirk, D. E. "Optimal Control Theory: An Introduction," Dover Publication, 2004.
4. Naidu, D. S. "Optimal Control Systems," CRC Press, 2002.
5. Bryson, A. E. Jr. and Ho, Y. C. "Applied Optimal Control: Optimization, Estimation and Control," CRC Press, Revised Edition, 1975.
6. Anderson, B. D. O. and Moore, J. B. "Optimal Control: Linear Quadratic Methods," Dover Publications, 2007.
7. Borrelli, Francesco, Alberto Bemporad, and Manfred Morari. "Predictive control for linear and hybrid systems,". Cambridge University Press, 2017.
8. Bertsekas, D. "Nonlinear Programming," Athena Scientific, 1999.
9. Luenberger, D. G. and Ye, Y. "Linear and nonlinear programming," Springer 1984.

Class Format: Lecture format (two 1 1/2hr lectures per week). This is an in-person class. Classes designated as in-person are those for which there is at least some material critical for the class that cannot be acquired without in-person attendance. Most of these classes involve learning skills or using equipment that would not be available remotely. In-person classes may have some content presented online, but students who register for classes without coming to campus cannot take these classes

Grading Policy

2 mid-semester exams (in-class and/or take-home):	2x20=40%
Homework & Projects:	22%
Class participation:	3%
Final Exam (in-class or take-home):	35%

Note: This course will adopt the Plus/Minus Grading Policy.

Homework Policy

There will be six to eight homework assignments during the semester. No late homework will be accepted unless I give permission in exceptional circumstances (advance notice for this is required).
-You will have to submit your homework assignments electronically in Canvas.
-The homework should be well organized, clearly demonstrating the student's work. Points will be deducted for sloppiness.

Examinations

There will be two mid-semester exams and a final exam (take-home or in-class). The first mid-term exam will take place before spring break and the second exam after the spring break (exact dates will be determined later in the semester). Details on the final exam will be provided later in the semester. If I decide that the final exam will be an in-class exam, then it will take place on Friday, May 3rd, 1:00pm-3:00pm (default final exam time). For further information please visit the following website: https://registrar.utexas.edu/schedules/242/finals

Policy on Academic Integrity

Students who violate University rules on scholastic dishonesty are subject to disciplinary penalties, including the possibility of failure in the course and/or dismissal from the University. Since such dishonesty harms the individual, all students, and the integrity of the University, policies on academic dishonesty will be strictly enforced. For further information please visit the Student Judicial Services web site: http://deanofstudents.utexas.edu/sjs/

Office hours

Instructor's office hours: Office hours will be held on Tuesdays, 1:00pm-2:00pm (subject to change). The easiest way to reach me is via e-mail.

A notice regarding accommodations for religious holidays

By UT Austin policy, a student must notify me of his/her pending absence at least fourteen days prior to the date of observance of a religious holy day. If the student must miss a class, an examination, a work assignment, or a project in order to observe a religious holy day, he/she

will be given an opportunity to complete the missed work within a reasonable time after the absence.

Special Notes

The University of Texas at Austin provides upon request appropriate academic adjustments for qualified students with disabilities. For more information, contact the Office of the Dean of Students at 471-6259, 471-4641 TDD or the College of Engineering Director of Students with Disabilities at 471-4321.

Evaluation

Measurement and Evaluation Center forms for the College of Engineering will be used during the scheduled time (typically the last week of class) to evaluate the course and the instructor.

Sharing of Course Materials is Prohibited

No materials used in this class, including, but not limited to, lecture hand-outs, videos, assessments (quizzes, exams, papers, projects, homework assignments), in-class materials, review sheets, and additional problem sets, may be shared online or with anyone outside of the class unless you have my explicit, written permission. Unauthorized sharing of materials promotes cheating. It is a violation of the University's Student Honor Code and an act of academic dishonesty. I am aware of the sites used for sharing materials, and any materials found online that are associated with you, or any suspected unauthorized sharing of materials, will be reported to Student Conduct and Academic Integrity in the Office of the Dean of Students. These reports can result in sanctions, including failure in the course.

Class Recordings

Class recordings are reserved only for students in this class for educational purposes and are protected under FERPA. The recordings should not be shared outside the class in any form. Violation of this restriction by a student could lead to Student Misconduct proceedings. Guidance on public access to class recordings can be found here.

Revised by Efstathios Bakolas on January 05, 2024