EN.530.626: Trajectory Generation for Space Systems

Instructor: Prof. Abhishek Cauligi

Semester: Fall 2025

Course Description

This course will provide an introduction to trajectory design techniques for aerospace and spacecraft robotic systems. We will place a heavy emphasis on optimization-based techniques and study optimal control formulations for solving trajectory optimization and model predictive control problems. Applications of interest will include interplanetary trajectory optimization, rocket entry-descent-landing, asteroid proximity operations, and planetary rover path planning. A strong emphasis will be placed on practical applications through coding implementations in Python and evaluation in simple simulation environments. Finally, a course project will be included to allow students to gain further experience on an algorithm or application of their choice.

Prerequisites: A strong foundation in linear algebra and differential equations and experience with a high-level programming language such as Python or Julia will be assumed.

Instructor

Abhishek Cauligi
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Teaching Assistants

Mark Gonzales
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Lectures

Tuesday and Thursday, 1:30-2:45PM

Textbook

There is no required textbook for this class.

Office Hours

To be announced.

Grading Policy

- Assignments: 40%
- Midterm Exam: 30%
- Final Project: 30%

Course Policies

Late Assignments: Late submissions will be penalized by 10% per day.

Academic Integrity: All students must adhere to university policies on plagiarism and cheating.

Attendance: Regular attendance is expected and lectures will not be recorded.

Course Schedule

Week	Lecture	Date	Topics Covered	
1	1	08/26	Intro: linear algebra & differential equations review	
	2	08/28	Linear systems theory	HW1 Released
2	3	09/02	Nonlinear optimization theory	
	4	09/04	Constrained optimization (Pt. 1)	HW1 Due, HW2 Released
3	5	09/09	Pontryagin's maximum principle and indirect methods	
	6	09/11	Constrained optimization (Pt. 2)	
4	7	09/16	Constrained optimization (Pt. 3)	Form project groups
	8	09/18	Constrained optimization (Pt. 4)	HW2 Due, HW3 Released
5	9	09/23	Planetary entry, descent, and landing	
	10	09/25	The two-body problem (Pt. 1)	Final project proposal due
6	11	09/30	The two-body problem (Pt. 2)	
	12	10/02	Optimum orbital transfer	HW3 Due, HW4 Released
7	13	10/07	Rigid bodies and Euler's equation	
	14	10/09	Planning with attitude	
8	15	10/14	Sampling-based motion planning	
	16	10/16	Derivative-free methods for trajectory optimization	HW4 Due, HW5 Released
9	17	10/21	Surface rover path planning	
	18	10/23	Long and short range planner hierarchies	
10	19	10/28	Uncertainty propagation	
	20	10/30	Stochastic optimal control (Pt. 1)	HW5 Due, HW6 Released
11	21	11/04	Stochastic optimal control (Pt. 2)	
	22	11/06	**Midterm Exam**	
12	23	11/11	Learning value functions (Pt. 1)	
	24	11/13	Learning value functions (Pt. 2)	HW6 Due
13	23	11/18	Guest lecture (TBD)	
	24	11/20	Guest lecture (TBD)	
14	23	11/25	No Lecture (Thanksgiving Break)	
	24	11/27	No Lecture (Thanksgiving Break)	
15	25	12/02	Final project presentations	
	26	12/04	Final project presentations	