

# 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  
Email: [mgonza60@jhu.edu](mailto:mgonza60@jhu.edu)

Arnab Chatterjee  
Email: [achatt13@jhu.edu](mailto:achatt13@jhu.edu)

## Lectures

Tuesday and Thursday, 1:30-2:45PM in Hodson 216.

## Textbook

There is no required textbook for this class.

## Office Hours

Office hours will begin in the second week of the semester.

Prof. Cauligi's office hours are on Tuesdays 1:00pm to 2:00pm in Hackerman 117.

Arnab Chatterjee's office hours are on Mondays 3-4PM.

Mark Gonzales's office hours are on Thursdays 11AM-12PM.

## 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                                 |                            |
| 2    | 3       | 09/02 | Optimization fundamentals                             | HW1 Released               |
|      | 4       | 09/04 | Constrained optimization (Pt. 1)                      |                            |
| 3    | 5       | 09/09 | Constrained optimization (Pt. 2)                      |                            |
|      | 6       | 09/11 | Constrained optimization (Pt. 3)                      | HW1 Due, HW2 Released      |
| 4    | 7       | 09/16 | Calculus of variations                                | Form project groups        |
|      | 8       | 09/18 | Pontryagin's maximum principle and indirect methods   |                            |
| 5    | 9       | 09/23 | Off-the-shelf trajectory optimization                 |                            |
|      | 10      | 09/25 | Planetary entry, descent, and landing                 | Final project proposal due |
| 6    | 11      | 09/30 | Rigid bodies and Euler's equation                     |                            |
|      | 12      | 10/02 | Planning with attitude                                | HW2 Due, HW3 Released      |
| 7    | 13      | 10/07 | Combinatorial planning via integer programs           |                            |
|      | 14      | 10/09 | Sampling-based motion planning                        |                            |
| 8    | 15      | 10/14 | Inverse classroom (mid-semester checkpoint)           |                            |
|      | 16      | 10/16 | <b>No lecture (Fall Break)</b>                        | HW3 Due, HW4 Released      |
| 9    | 17      | 10/21 | Surface rover path planning                           |                            |
|      | 18      | 10/23 | Long and short range planner hierarchies              |                            |
| 10   | 19      | 10/28 | Derivative-free methods for trajectory optimization   |                            |
|      | 20      | 10/30 | Uncertainty propagation                               | HW4 Due, HW5 Released      |
| 11   | 21      | 11/04 | Stochastic optimal control                            |                            |
|      | 22      | 11/06 | <b>Midterm Exam</b>                                   |                            |
| 12   | 23      | 11/11 | Guest lecture (Dr. Bobby Braun)                       |                            |
|      | 24      | 11/13 | Differentiable MPC                                    | HW5 Due                    |
| 13   | 23      | 11/18 | Learning value functions                              |                            |
|      | 24      | 11/20 | Guest lecture (TBD)                                   |                            |
| 14   | 23      | 11/25 | <b>No Lecture (Thanksgiving Break)</b>                |                            |
|      | 24      | 11/27 | <b>No Lecture (Thanksgiving Break)</b>                |                            |
| 15   | 25      | 12/02 | Final project presentations                           |                            |
|      | 26      | 12/04 | Final project presentations                           | Final project report due   |