ME/EE 239 – Optimal Control (4 units)

Lectures: MW 9:30-10:50
Online via Zoom
Office Hours (Discussion): W 11-11:50
Online via Zoom

Description: This is a moderate to advanced course on model-based and model-free methods for optimal control of dynamical systems. Prior knowledge of linear dynamical systems is required. Topics include parametric and non-parametric methods of system identification, model predictive control, and model-free methods for (optimal) controller design.

Instructor: Erfan Nozari

References (optional, though highly recommended):
1. **T1:** Lennart Ljung, "System Identification, Theory for the User", 2nd Ed.
2. **T2:** Grune & Pannek, "Nonlinear Model Predictive Control, Theory and Algorithms"
3. **T3:** Mauroy et. al., "The Koopman Operator in Systems and Control"
4. **T4:** Markovsky & Dörfler, "Behavioral systems theory in data-driven analysis, signal processing, and control", 2021

Course objectives: The overall objective of this course is to provide the students with a theoretical understanding and practical toolbox that they can use to design controllers for complex real-world systems. The specific learning objectives for the student are to:

- Understand the different approaches to the (optimal) control of dynamical systems
- Learn the fundamentals of linear system identification theory
- Learn the fundamentals of model predictive control
- Learn the fundamentals of behavioral systems theory
- Learn the fundamentals of Koopman theory

Evaluation method:
1. Homeworks: 20%
2. Final Project: 80%
3. Final Project Competition: extra 20%

Tentative Schedule

Week	Topic	Reference
1	Linear Discrete-Time Systems	T1 Ch. 2, T2 Ch. 2
2	Model Predictive Control	T2 Ch. 3
3	Simulation & Prediction, Models of LTI Systems	T1 Ch. 3, 4
4	Correlation Analysis and Parameter Estimation Methods	T1 Ch. 6, 7
5	Experiment Design & Model Validation	T1 Ch. 13, 16
6	Subspace Methods	T1 Ch. 7, 10
7	Koopman Theory	T3 Ch. 1, 6, 9
8	Behavioral Systems Theory	T4
9	Additional Topics	TBD
10	Final Project Presentations	N/A