OPTIMAL CONTROL THEORY

METU EE554 - SPRING 2023

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Scope: This course aims to expose the student to the fundamentals of Optimal Control Theory, providing introductory-level theory and examples on Dynamic Programming, Hamilton-Jacobi-Bellman (HJB) Equation, Pontryagin's Minimum Principle, Linear Quadratic Regulation (LQR), Least Squares Estimation, and Model Predictive Control.

Prerequisite: Some knowledge of Linear Systems Theory (EE502) is assumed.

Textbook: D.E. Kirk. *Optimal Control Theory: An Introduction.* Dover, 2004.

Tentative course outline:

I. *Chapters 1-3 (Kirk)*

- Optimal control problem (definition and applications)
- Principle of optimality and dynamic programming
- HJB equation
- LQR

II. *Chapter 4 (Kirk)*

- Calculus of variations
- Euler-Lagrange equation
- Conditions of optimality for various cases

III. *Chapter 5 (Kirk)*

- Hamiltonian formulation and minimum principle
- LQR revisited
- Minimum time problem and other examples

IV. *Infinite-horizon LQR*

- Algebraic Riccati Equation
- Hamiltonian matrix
- Conditions for the existence of solutions

V. *Optimization-based feedback for discrete-time systems*

- Least squares estimation
- Minimum energy control
- Model predictive control