Optimal Control

Dates and time

26-05-2025
02-06-2025
16-06-2025
23-06-2025

from 10:15 – 12:30 hrs

Course location

Cursus- en vergadercentrum Domstad, Utrecht

ECTS

3 ECTS if homework is completed successfully

1 ECTS for auditing the course

Lecturers

Gjerrit Meinsma, University of Twente

Arjan van der Schaft, University of Groningen

Objective

The course teaches the mathematical theory of optimal control for finite-dimensional deterministic systems. A succinct, but mathematically self-contained, treatment of the celebrated Minimum Principle will be given, starting from the classical Calculus of Variations. Next, the Dynamic Programming approach to optimal control is treated, culminating in the Hamilton-Jacobi-Bellman equations. Emphasis of the course is on the mathematical understanding of the subject, motivated and illustrated by a broad range of illustrative examples and applications. The text of the course includes many exercises, together with complete solutions for the odd-numbered ones.

Contents

Lecture 1: CALCULUS OF VARIATIONS. Euler-Lagrange equation,

Beltrami identity, Legendre second-order condition, convexity

conditions, higher-order EL, relaxed boundary conditions

Lecture 2: OPTIMAL CONTROL --- MINIMUM PRINCIPLE. Lagrange multipliers,

Hamiltonian equations, costate, first-order conditions,

Pontryagin's minimum principle

Lecture 3: OPTIMAL CONTROL --- MINIMUM PRINCIPLE & DYNAMIC PROGRAMMING.

Constancy of the Hamiltonian, final constraints, free final time,

principle of optimality, Hamilton-Jacobi-Bellman (HJB) equation

Lecture 4: OPTIMAL CONTROL --- DYNAMIC PROGRAMMING.

Connection between HJB and the minimum principle, infinite horizon, a glimpse of Linear Quadratic (LQ) optimal control for linear systems in continuous time.

Course material

G. Meinsma and A. van der Schaft. *A Course on Optimal Control*. Springer Undergraduate Texts in Mathematics and Technology. Springer, 2023.

Prerequisites

Basic linear algebra, calculus, ordinary differential equations, a first course on systems theory.

Homework assignments

Two homework sets will be distributed via the course website. Homework is graded on a scale from 1 to 10. This is a math course, and the homework problems require math (not software).