SF2852 Optimal Control Theory 7.5 credits

Optimal styrteori

This is a translation of the Swedish, legally binding, course syllabus.

Establishment

Course syllabus for SF2852 valid from Autumn 2007

Grading scale

A, B, C, D, E, FX, F

Education cycle

Second cycle

Main field of study

Mathematics

Specific prerequisites

Differential equations and transforms and a basic course in Optimization.

Language of instruction

The language of instruction is specified in the course offering information in the course catalogue.

Intended learning outcomes

The **overall goal** of the course is to provide an understanding of the main results in optimal control and how they are used in various applications in engineering, economics, logistics, and biology.

Measurable goals:

To pass the course, the student should be able to do the following:

- Describe how the dynamic programming principle works (DynP) and apply it to discrete optimal control problems over finite and infinite time horizons,
- Use continuous time dynamic programming and the associated Hamilton-Jacobi-Bellman equation to solve linear quadratic control problems,
- Use the Pontryagin Minimum Principle (PMP) to solve optimal control problems with control and state constraints,
- Use Model Predictive Control (MPC) to solve optimal control problems with control and state constraints. You should also be able understand the difference between the explicit and implicit MPC control and explain their respective advantages.
- Formulate optimal control problems on standard form from specifications on dynamics, constraints and control objective. In addition be able to explain how various control objectives affect the optimal performance.
- Explain the principles behind the most standard algorithms for numerical solution of optimal control problems and use Matlab to solve fairly simple but realistic problems.

To receive the highest grade, the student should in addition be able to do the following:

- Integrate the tools learnt during the course and apply them to more complex problems.
- Explain how PMP and DynP relates to each other and know their respective advantages and disadvantages. In particular, be able to describe the difference between feedback control versus open loop control and also be able to compare PMP and DynP with respect to computational complexity.
- Combine the mathematical methods used in optimal control to derive the solution to variations of the problems studied in the course.

Course contents

Dynamic programming in continuous and discrete time. Hamilton-Jacobi-Bellman equation. Theory of ordinary differential equations. The Pontryagin maximum principle. Linear quadratic optimization. Model predictive control Infinite horizon optimal control problems. Sufficient conditions for optimality. Numerical methods for optimal control problems.

Course literature

Lecture notes from the department.

Examination

- HEM1 - Exercises, 0.0 credits, grading scale: A, B, C, D, E, FX, F
- TEN1 - Examination, 7.5 credits, grading scale: A, B, C, D, E, FX, F

Based on recommendation from KTH’s coordinator for disabilities, the examiner will decide how to adapt an examination for students with documented disability.

The examiner may apply another examination format when re-examining individual students.

If the course is discontinued, students may request to be examined during the following two academic years.

Other requirements for final grade

A written examination.
Optional homework sets that give bonus credit on the exam.

Ethical approach

- All members of a group are responsible for the group's work.
- In any assessment, every student shall honestly disclose any help received and sources used.
- In an oral assessment, every student shall be able to present and answer questions about the entire assignment and solution.