FSF3832 Mathematical Systems Theory 7.5 credits

Matematisk systemteori

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

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

Establishment

Course syllabus for FSF3832 valid from Spring 2015

Grading scale

Education cycle

Third cycle

Specific prerequisites

A Master degree including at least 30 university credits (hp) in in Mathematics (Calculus, Linear algebra, Differential equations and transform method), and further at least 6 hp in Mathematical Statistics, 6 hp in Numerical analysis and 6 hp 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 basic ingredients of linear systems theory and how these are used in analysis and design of control, estimation and filtering systems. In the course we take the state-space approach, which is well suited for efficient control and estimation design.

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

- Analyze the state-space model with respect to minimality, observability, reachability, detectability and stabilizability.
- Explain the relationship between input-output (external) models and state-space (internal) models for linear systems and derive such models from the basic principles.
- Derive a minimal state-space model using the Kalman decomposition.
- Use algebraic design methods for state feedback design with pole assignment, and construct stable state observers by pole assignment and analyze the properties of the closed loop system obtained when the observer and the state feedback are combined to an observer based controller. Apply linear quadratic techniques to derive optimal state feedback controllers. Design a Kalman filter for optimal state estimation of linear systems subject to stochastic disturbances.
- Solve the Riccati equations that appear in optimal control and estimation problems.
- Apply the methods given in the course to solve example problems, including to use the Control System Toolbox in Matlab.
- Integrate the tools learnt during the course and apply them to more complex problems.
- Explain how the above results and methods relate and build on each other.
- Explain the mathematical (mainly linear algebra) foundations of the techniques used in linear systems theory and apply those techniques flexibly to variations of the problems studied in the course.
- Solve fairly simple but realistic control design problems using the methods in the course.

Course contents

Linear control systems: reachability, observability, stability, realization theory, minimality, feedback, pole-assignment, observers. Linear-quadratic optimal control, matrix Riccati equation and theory for the algebraic Riccati equation. Kalman filtering.

Course literature

Compendiumfrom the department.

Examination

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.

Project, Written examination, Exercises

Other requirements for final grade

Project, Written examination, Optional homeworks give bonus credits on written examination

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.