FEL3340 Introduction to Model Order Reduction 7.0 credits

Introduktion till modellreduktion

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

Establishment

Course syllabus for FEL3340 valid from Spring 2019

Grading scale

P, F

Education cycle

Third cycle

Specific prerequisites

Language of instruction

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

Intended learning outcomes

After the course, the student should:

- be able to distinguish between difficult and simple model-reduction problems;

· have a thorough understanding of Principle Component Analysis (PCA) and Singular Value Decomposition (SVD);

· understand the interplay between linear operators on Hilbert spaces, controllability, observability, and model reduction;

· know the theory behind balanced truncation and Hankel-norm approximation;

· be able to reduce systems while preserving certain system structures, such as interconnection topology;

· be able to reduce linear feedback controllers while taking the overall system performance into account; and

· to understand, and be able to contribute to, current research in model order reduction.

Course contents

Linear time-invariant systems, state space, truncation, residualization/singular perturbation, projection, Kalman decomposition, norms, Hilbert spaces L2 and H2, H∞ space, POD, SVD, PCA, Schmidt-Mirsky theorem, optimization in Hilbert spaces, reachability and observability Gramians, matrix Lyapunov equations, balanced realizations, error bounds, frequency-weighted model reduction, balanced stochastic truncation, controller reduction, small-gain theorem, empirical Gramians, Hankel-norm, Nehari theorem, Adamjan-Arov-Krein lemma, optimal Hankel-norm approximation

Disposition

Lectures, exercises, homework problems, special focus lectures or participant conducts a project, 24 h take-home exam

Course literature

Lecture notes, research papers, and part of the books

· Obinata, G. and Anderson, B.D.O., "Model Reduction for Control System Design", Springer-Verlag, London, 2001.

· Luenberger, D.G., “Optimization by Vector Space Methods”, Wiley, 1969.

· Green, M. and Limebeer, D.J.N, “Linear Robust Control”, Dover, 2012.

Examination

• EXA1 - Examination, 7.0 credits, grading scale: P, 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

- 75 % on homework problems
- 50 % on take-home exam
- Participation in special focus lectures alt. conducts a project

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.