



LTH

FACULTY OF
ENGINEERING

Course syllabus

Reglerteknik, fortsättningskurs Automatic Control, Advanced Course

FRTN55, 7,5 credits, A (Second Cycle)

Valid for: 2023/24

Faculty: Faculty of Engineering, LTH

Decided by: PLED F/Pi

Date of Decision: 2023-04-18

General Information

Main field: Machine Learning, Systems and Control.

Compulsory for: MMSR2

Elective for: B5-pt, C4, D4-ssr, E4-ra, F4, F4-r, I4, I4-pvs, K5, M4, N4, Pi4-ssr

Language of instruction: The course will be given in English

Aim

The course gives an in-depth treatment of design of linear control systems with limitations. Special attention is given to design trade-offs and fundamental limitations, and how mathematical optimization can be used as a design tool, both offline and online. The course covers both continuous-time and discrete-time control systems.

Learning outcomes

Knowledge and understanding

For a passing grade the student must

- be able to translate between, and intelligently select among, different representations for continuous-time and discrete-time systems, in particular transient responses, transfer functions, and state-space descriptions.
- be able to derive properties of interconnected systems from the properties of their subsystems, and to characterize and quantify the role of the different subsystems.
- be able to formulate constraints on input signals and output signals of a control system and to relate these to conditions on the matrices that describe

the system.

- be able to analyse how process characteristics put limitations on the control performance that can be achieved.

Competences and skills

For a passing grade the student must

- be able to independently formulate technical specifications based on understanding of the control system should be used and interact with the external environment.
- be able to select control design methods and model structures, and translate specifications into mathematical optimization problems to be solved online or offline.
- draw conclusions from numerical calculations about the correctness of models and specifications, and about the consequences for the interaction between the system and the environment.

Judgement and approach

For a passing grade the student must

- understand relationships and limitations when simplified models are used to describe a complex and dynamic reality
- show ability to teamwork and group collaboration at laboratories.

Contents

The control design process, stability, sensitivity, robustness, the small-gain theorem, transfer function matrices, non-minimum-phase systems, disturbance models in the time domain and frequency domain, frequency-domain specifications, fundamental limitations and trade-offs, controller structures, the Youla parameterization and internal model control, sampled-data control, linear-quadratic optimization of state feedback and Kalman filter, model-predictive control, controller synthesis using convex optimization.

Examination details

Grading scale: TH - (U,3,4,5) - (Fail, Three, Four, Five)

Assessment: Written exam (5 hours), three laboratory exercises, one hand-in assignment. In case of less than 5 registered students the retake exams may be given in oral form.

The examiner, in consultation with Disability Support Services, may deviate from the regular form of examination in order to provide a permanently disabled student with a form of examination equivalent to that of a student without a disability.

Parts

Code: 0120. **Name:** Examination.

Credits: 5,5. **Grading scale:** TH. **Assessment:** Passed exam

Code: 0220. **Name:** Laboratory Work 1.

Credits: 0,5. **Grading scale:** UG. **Assessment:** Preparation exercises and approved participation in laboratory work

Code: 0320. **Name:** Laboratory Work 2.

Credits: 0,5. **Grading scale:** UG. **Assessment:** Preparation exercises and approved participation in laboratory work

Code: 0420. **Name:** Laboratory Work 3.

Credits: 0,5. **Grading scale:** UG. **Assessment:** Preparation exercises and approved participation in laboratory work

Code: 0520. **Name:** Handin Assignment.

Credits: 0,5. **Grading scale:** UG. **Assessment:** Approved handin assignment, submitted before the deadline.

Admission

Assumed prior knowledge: FRTF05 Automatic Control, Basic Course or FRTN25 Automatic Process Control.

The number of participants is limited to: No

The course overlaps following course/s: FRT020, FRTN10

Reading list

- Lecture slides, exercise material and laboratory manuals are available on the course homepage.
- Lecture Notes in Automatic Control, Advanced Course. Department of Automatic Control, LTH (compendium).
- Torkel Glad, Lennart Ljung: Control Theory: Multivariable and Nonlinear Methods, Taylor & Francis, 2000, ISBN 0748408789 (optional reading).

Contact and other information

Director of studies: Björn Olofsson, bjorn.olofsson@control.lth.se

Course coordinator: Richard Pates, richard.pates@control.lth.se

Course homepage: <http://www.control.lth.se/course/FRTN55>