Course syllabus

Introduktion till maskininlärning, system och reglering
Introduction to Machine Learning, Systems and Control

FRTF25, 7,5 credits, G2 (First 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: MMSR1
Language of instruction: The course will be given in English

Aim

The course provides a review of concepts and methods needed for the master's programme in Machine Learning, Systems and Control. The focus lies on control systems fundamentals, statistics and linear system theory. The aim is that the students leave the course with a sufficient background for subsequent courses of the program. The course also aims to give the students a general introduction to studying in Lund, working in groups and presenting results orally and in writing. Furthermore, students are given an introduction to ethical aspects of AI and machine learning.

Learning outcomes

Knowledge and understanding
For a passing grade the student must

- understand that their professional work has ethical and societal consequences.
- know the fundamentals of control systems, with focus on interconnection and analysis of linear systems.
- be able to describe and use the concepts of linearity, time and space invariance, stability, causality, impulse response and transfer function, in

continuous time.
- be able to calculate the relationship between covariance properties in the time domain and spectral properties in the frequency domain for processes.
- understand how to formulate linear filters using covariance and spectral properties.

Competences and skills
For a passing grade the student must

- be able to problematize around an ethical scenario arising from an application of engineering.
- be able to synthesize and evaluate a control system in simulation, as well as on a cyber-physical system.
- be able to identify natural phenomena which can be modelled using deterministic or stochastic mathematical models.
- be able to communicate results and discuss them in writing.

Judgement and approach
For a passing grade the student must

- demonstrate the ability to formulate dynamic and statistical models and utilize these models for both analysis and synthesis.
- solve mathematical and control-related problems using programming.
- show ability for teamwork and collaboration at laboratory exercises.
- demonstrate ability to reflect on the ethics of an engineering application.
- in connection with problem solving, be able to demonstrate the ability to integrate knowledge from the different parts of the course.

Contents

The course commences with a general and practical introduction to the study environment at LTH, and to working in groups with other students.

A large portion of the course revolves around a cyber-physical laboratory process. The students work in small groups to complete laboratory exercises aimed at demonstrating the link between theory and practice, and providing an opportunity to obtain knowledge through hands-on experience.

The technical content of the course, covered through exercises and laboratory work, reviews concepts and topics, which students are expected to have some familiarity with from previous studies. These include: models for stochastic dependence; concepts and models for description, characterising, and handling of stationary stochastic processes; time and frequency domain description of stationary stochastic processes; covariance and effect spectrum; stochastic processes in linear filters; describing dynamical systems using time-invariant ordinary differential equations; transfer functions, frequency responses, Bode and Nyquist diagrams; stability assessment through poles and through the Nyquist criterion; robustness margins; synthesis and implementation of controllers.

Examination details

Grading scale: UG - (U,G) - (Fail, Pass)
Assessment: Written and peer-reviewed report; two blocks of laboratory exercises completed in groups of approximately 4 students; individually completed preparatory exercises (mathematics and programming) for each laboratory exercise block.

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:** Group Work.
Credits: 1,5. **Grading scale:** UG. **Assessment:** Inlämning, kamratgranskning och revision av rapport.
Code: 0220. **Name:** Laboratory Work.
Credits: 3. **Grading scale:** UG. **Assessment:** Completion of preparatory exercises and laboratory work.
Code: 0320. **Name:** Ability Test 1.
Credits: 1,5. **Grading scale:** UG. **Assessment:** Computer based test and computer exercise.
Code: 0420. **Name:** Ability Test 2.
Credits: 1,5. **Grading scale:** UG. **Assessment:** Computer based test and computer exercise.

Admission

Assumed prior knowledge: Courses equivalent to the admission criteria for the master programme in Machine Learning, Systems and Control.
The number of participants is limited to: No
The course overlaps following course/s: FRTF05, FRTN25, FRTF10

Reading list

- Åström KJ, Murray RM: Feedback systems, Princeton 2008. Freely available: http://www.cds.caltech.edu/~murray/amwiki.
- Online resources provided through the course webpage (Canvas).

Contact and other information

Director of studies: Björn Olofsson, bjorn.olofsson@control.lth.se
Course coordinator: Johan Eker, johan.eker@control.lth.se
Course homepage: http://www.control.lth.se/course/FRTF25
Further information: The course in open only to the students at the master´s program in Machine Learning, Systems and Control.