Course syllabus

Processreglering
Automatic Process Control

FRTN25, 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

Elective for: B4-pt, K4-p, MBIO1
Language of instruction: The course will be given in English

Aim

The course, which is elective, is intended for students in year 3-4 in the Chemical Engineering and Biotechnology programmes. The aim is to give an overview of control engineering, its concepts, methods, and applications in chemical engineering.

After the couse the students should be able to formulate and understand mathematical models for dynamical systems, analyse dynamical systems, and design controllers for dynamical systems. The course is divided into three modules: modeling, analysis, and synthesis.

Control plays a major role in most parts of our society. In earlier courses the students have learnt how to model and understand system behaviour. The aim of this course is to learn the students how to make a system operator more reliable, in a more environment-friendly way, with better precision, or in a more economical way, in spite of external disturbances acting on the system. The word system has a very general interpretation. It can, for example, be a reactor, a heat exchanger, or a waste water treatment plant. The course teaches a systems-oriented way of thinking which the students can make use of in their future careers, independent of the actual application area.

Learning outcomes

Knowledge and understanding
For a passing grade the student must

- understand what a linear time-invariant dynamical systems is
- be able to grasp the basic concepts of control
- understand how a dynamical system can be modeled using different model representations, for example transient responses, transfer functions, differential equations on state-space form and input-output form, and frequency responses described using Bode or Nyquist diagrams
- have knowledge about the concepts that are used to describe the performance of a dynamical system, for example stability and stationary characteristics
- have knowledge about the most common controller types and their mathematical basis
- understand the advantages and disadvantages of different controller structures

Competences and skills
For a passing grade the student must

- be able to use basic concepts of control in written and oral form
- be able to approximate a nonlinear system with a linear system through linearisation
- be able to describe a dynamical system in different forms, including transient responses, transfer functions, state-space models, and differential equatons on input-output form and state-space form
- be able to compute the relationships between different model representations
- be able to analyse dynamical systems and reason about their behaviour
- be able to design controllers and controller structures from given specifications
- be able to use modern computer tools for control tasks
- be able to write simple sequence control programs
- be able to perform simple control experiments on laboratory setups in order to derive a system that behaves according to specifications
- be able to present project results in oral and written form

Judgement and approach
For a passing grade the student must

- understand the relations and limitations when simple models are used to describe complex dynamical systems
- be capable of solving new previously unknown controller problem of smaller size
- be able to communicate in a professional way with persons working with control
- show the ability for team work and cooperation in laboratory exercises, hand-in problems, and project work

Contents

Course modules:

- Introduction
- Modelling
- Dynamical systems
- Feedback
- PID design
- Controller structures
- Frequency domain analysis
- Systems with multiple inputs and outputs
- Discrete-time and sequence control

The course contains laboratory exercises that are connected to the main topics of the course.

Examination details

Grading scale: TH - (U,3,4,5) - (Fail, Three, Four, Five)
Assessment: Written exam (5 hours), two laboratory exercises, two hand in problems, and one small project. In the 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: 0115. **Name:** Examination.
Credits: 5,5. **Grading scale:** TH. **Assessment:** Passed exam.
Code: 0215. **Name:** Laboratory Work 1.
Credits: 0,5. **Grading scale:** UG. **Assessment:** Preparation exercises and approved participation in laboratory.
Code: 0315. **Name:** Laboratory Work 2.
Credits: 0,5. **Grading scale:** UG. **Assessment:** Preparation exercises and approved participation in laboratory.
Code: 0415. **Name:** Hand In Problem 1.
Credits: 0. **Grading scale:** UG.
Code: 0515. **Name:** Hand-in problem 2.
Credits: 0. **Grading scale:** UG.
Code: 0615. **Name:** Small Project.
Credits: 1. **Grading scale:** UG. **Assessment:** Written report and oral presentation.

Admission

Assumed prior knowledge: FMAA20 Linear Algebra with Introduction to Computer Tools, FMAB65 Calculus in One Variable B1, FMAB70 Calculus in One Variable B2, FMAB30 Calculus in Several Variables.
The number of participants is limited to: No
The course overlaps following course/s: FRT010, FRT110, FRT081

Reading list

- Systems Engineering and Process Control - Lecture Notes (Kompendium). KFS.
- Exercises in Systems Engineering and Process Control (Kompendium), Reglerteknik, KFS.

Contact and other information

Director of studies: Björn Olofsson, bjorn.olofsson@control.lth.se
Course coordinator: Pontus Giselsson, pontus.giselsson@control.lth.se
Course homepage: http://www.control.lth.se/course/FRTN25
Further information: May not be part of an exam together with FRTF05, FRT081 or FRTF10.