Syllabus

ELEC-C8201: Control and Automation

Abstract

This document describes the course ELEC-C8201, Periods III and IV 2020/2021. Any changes to the information in this document will be announced on the course's website, which is found at MyCourses.

Contents

1 General Information

Literature

[1] The main reference book for the Control Engineering part of this course is *"Modern Control Systems"* by Richard C. Dorf and Robert H. Bishop. The book (12th edition) is available online and in the university's libraries.

[2] The main reference book for the Automation part of the course is: *"IEC 61499 Function Blocks for Embedded and Distributed Control Systems Design* (Instrumentation Society of America, USA, October, 2015, Third edition, ISBN: 978-1-941546-72-7) by Valeriy Vyatkin.

Lecturers

1) Kai Zenger (Control Engineering)
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Office hours: Agree by email
Zoom link: https://aalto.zoom.us/j/68997335681?pwd=aE5JcXhTNmNBam1ISVNBQllGM0tGdz09

2) Themistoklis Charalambous (Control Engineering)
Room: I306a, I3 Wing, Otakaari 5
Office hours: Agree by email
Zoom link: https://aalto.zoom.us/j/62901624962?pwd=NUw4Q3lwWGJiOFZBc1RzRmErNUE3UT09

3) Valeriy Vyatkin (Automation)
Room: 3575 (3rd floor), TUAS Building
Office hours: Contact by email
Contact via Microsoft Teams, use the courses's team.

Teaching assistants

Exercise sessions & Homework (Control Engineering):

Jani Arponen,
Room: Distant
Office hours: Agree by email
Zoom link: https://aalto.zoom.us/j/65158424802?pwd=K1dveUZGdVRjbHdwTmlnRXh4NzhaUT09

Exercise sessions & Homework (Automation):

Udayanto Dwi Atmojo,
Room: Distant
Office hours: Agree by email

Pranay Jhunjhunwala,
Room: Distant
Office hours: Agree by email

Additional material: Additional material (e.g., material on pre-requisites, extra exercises, scientific papers) will be made available to download from MyCourses.

Exercise Sessions: There are 12 exercise sessions (8 for the Control Engineering part and 4 for the Automation part); details are found below in Section 5.

Homework: There are 6 homework assignments (4 for the Control Engineering part and 2 for the Automation part); details are found below in Section 6.

Quizzes: There are 12 quizzes (8 for the Control Engineering part and 4 for the Automation part); details are found below in Section 7.

Written Exam: There will be a written exam at the end of the course; details are found below in Section 8.

2 Aim and Learning Outcomes

The main aim of the course is to help students acquire in-depth knowledge of control, the design of feedback control systems, and their use in various engineering applications, ranging from control to medicine and biology.

After completing the course the students will:

- understand the general approach to designing and building a control system;
- understand the basic principles of frequency- and time-domain design techniques;
- be able design, analyze, and simulate controllers (for example PID or state feedback controllers).

3 Prerequisites

- *Control Engineering:* Basic university mathematics, signals and systems, matrix algebra, MATLAB.
- *Automation:* Basics of programming, Boolean algebra.

4 Tentative Weekly Plan

A tentative week plan follows below. Changes to the plan will be posted on MyCourses. For the moment it is believed that the whole course is taught remotely (Distant mode, Zoom sessions). If that will change during spring, that will be announced in teaching sessions and in MyCourses.

#	Day, Time	Activity	Content	Comments
2	Jan 12, 10:15-12:00 Jan 14, 10:15-12:00	Lecture 1 Exercise 1	1. Introduction, models of physical systems, Laplace transforms and block diagram algebra	Ch 1 & 2 (§2.2-2.6)
3	Jan 19, 10:15-12:00 Jan 21, 10:15-12:00	Lecture 2 Exercise 2	2. State-space representation, relation between state-space and transfer function representations	Ch 3
4	Jan 26, 10:15-12:00 Jan 28, 10:15-12:00	Lecture 3 Exercise 3	3. Stability, poles, zeros, performance, steady-state error	Ch 5
5	Feb 2, 10:15-12:00 Feb 4, 10:15-12:00	Lecture 4 Exercise 4	4. The Routh-Hurwitz Stability Criterion	Ch 6 (§6.1-6.2)
6	Feb 9, 10:15-12:00 Feb 11, 10:15-12:00	Lecture 5 Exercise 5	5. The Root Locus Method & PID Controllers	Ch 7 (§7.1-7.6)
7	Feb 16, 10:15-12:00 Feb 18, 10:15-12:00	Lecture 6 Exercise 6	6. Frequency Response Methods	Ch 8 (§8.1-8.5)
8	Evaluation & examination week			
9	Mar 2, 10:15-12:00 Mar 4, 10:15-12:00	Lecture 7 Exercise 7	7. The Nyquist Stability Criterion	Ch 9 (§9.1-9.4)
10	Mar 9, 10:15-12:00 Mar 11, 10:15-12:00	Lecture 8 Exercise 8	8. Controllability and Observability	Ch 11 (§11.1-11.5)
11	Mar 16, 10:15-12:00 Mar 18, 10:15-12:00	Lecture 9 Exercise 9	9. Industrial Automation Software	
12	Mar 23, 10:15-12:00 Mar 25, 10:15-12:00	Lecture 10 Exercise 10	10. Programming in IEC 61499	
13	Mar 30, 10:15-12:00 Apr 1, 10:15-12:00	Lecture 11 Exercise 11	11. State machine design and implementation	
14	Apr 6, 10:15-12:00 Apr 8, 10:15-12:00	Lecture 12 Exercise 12	12. Design of Automation Applications	
15	Evaluation & examination week			
	April 13, 09:00-12:00	Final exam	All the material covered during the course	Online

5 Exercise Sessions

The purpose of the Exercise Sessions is *not* to solve a lot of standard problems at high speed. The purpose is to facilitate learning and understanding of the course material. The ability to solve standard problems does not imply understanding; however, understanding gives problem-solving skills.

It is important that you come prepared to the exercises, i.e., that you have read the relevant material, and perhaps also solved some of the suggested exercise problems.

It is also important that you are active during the exercises. Always try to understand what aspects of control theory the problems are treating. If you cannot see the point with a certain problem, ask the teaching assistant! There is a meaning behind every problem in this course.

A typical Exercise Session will start with a short review of the theory and a motivation why the theory is of use for an engineer. The teaching assistant solves the problems on the board.

6 Homework

There will be 6 homework assignments (1 every 2 weeks roughly) that you will have to solve and submit your solutions in MyCourses. More details will be given during the course. The purpose of the exercises in the homework is to make you assess whether you have understood the main principles taught during the lectures.

7 Quizzes

There will be 12 quizzes during the course, each accounting 1 point. In the Control Engineering part of the course, each quiz will be available online in MyCourses 24 hours before the lecture starts (starting from lecture 2 onwards and it will expire 15 minutes before the lecture starts. It will cover material on the previous lecture.

In the Automation part, quiz will be open on MyCourses after each lecture and will remain open for 24 hours after the lecture. It will cover the material of the lecture.

The purpose of the quiz is to *(i)* motivate the students to revise the material of the previous lecture and be prepared for the next, and *(ii)* emphasize some key ideas of the previous lecture.

8 Written Exam

The course will be concluded with a 3-hour written exam with 6 problems (4 for Control Engineering and 2 for Automation). An erroneous answer, incomplete or badly motivated solutions will result in point reductions. As a general rule, bad motivation or errors that relate to fundamental principles of the course will lead to large point deductions. Computational errors that do not lead to unreasonable answers generally give smaller point deductions.

The purpose of all exam problems is to assess to what degree the students have reached the aims and objectives (see Section 2 on *Aims and Learning Outcomes*).

Exam date and venue: April 13, 09:00-12:00 Online.

Re-take exams: Organized online. Dates for the exams are:

- Monday, 17 May 2021, 16.30-19.30.

9 Final Grades

Assessment	Points
Control Engineering	
Homework: 4 homework sheets - 6p per homework	24
Quiz: 8 quizzes (online available 24h before the lecture) - 1p per quiz	8
Automation	
Homework: 2 homework sheets - 6p per homework	12
Quiz: 4 quizzes (online available 24h before the lecture) - 1p per quiz	4
Control Engineering & Automation	
Exam: 3-hour exam on April 13, 09:00-12:00, Distant,	60
Feedback: At the end of the course, the university asks for your feedback - *bonus* points to those who provide feedback	3

$$\text{Final score} = \underbrace{\text{Quiz} \times \frac{10}{12}}_{10\%} + \underbrace{\text{Homework} \times \frac{30}{36}}_{30\%} + \underbrace{\text{Exam}}_{60\%} + \underbrace{\text{Feedback bonus}}_{3\%}$$

The final score will decide the grade according to the following table:

Total score	0-39	40-49	50-59	60-69	70-79	≥ 80
Grade	Fail	1	2	3	4	5