Faculty of Engineering
Mechanical Engineering-GENIE

Control Systems
MCG3307A00
Davide Spinello
2017 Winter Term

Course Hours

Monday 14:30 - 16:00
Location: DMS1160
Type:

Thursday 16:00 - 17:30
Location: DMS1160
Type:

Professor

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Course Description

Feedback theory. Time and frequency domain analysis of feedback control systems. Stability criteria. Design of simple feedback control systems and compensation techniques. Statespace analysis of systems. Laboratory experiments.

General and Specific Objectives

This course presents the concepts of transient and steady-state response analysis for control systems, assess the stability of control systems, and teaches methods for designing controllers that correspond to desired system behaviours. Students will develop the capability of analyzing the stability of a system and of designing simple controllers to regulate systems behaviour.

Required Material

The textbook in the Section "Monographies" is mandatory. In the course calendar, sections of the book that cover lectures' material are referenced by numbers in square brackets.

Evaluations

Problem Set

Evaluation Date: Ongoing
Evaluation Percentage: 8

The homework assignments are individual and they are instrumental to prepare for exams, as they cover in an advanced way topics addressed in class. There are 3 assignments during the term, collectively weighting 8% of the final grade.

Written exam (e.g. exam, long answer)

Evaluation Date: Thursday 2 March, 2017
Evaluation Percentage: 24

Midterm exam. The exam is in class, open book and open notes. Electronic devices are not allowed. The exam covers the material developed in class up to Lecture 10. For additional information, see the course calendar.

Written exam (e.g. exam, long answer)

Evaluation Date: Tuesday 19 April, 2016
Evaluation Percentage: 60

Final exam: 125 University (GYM) E, 14:00-17:00. The exam is open book and open notes. Electronic devices are not allowed. The exam will may cover all material developed in class.

Project

Evaluation Date: Ongoing
Evaluation Percentage: 8

The project is based on the implementation of a control system with an Arduino device, and it will be evaluated via an individual written report.

Course Calendar

Date	Content / Activity / Event / Evaluation
09/01/2017	**Lecture 1** • Course introduction and overview. • Second order systems [5-3].
12/01/2017	**Lecture 2** • Second order systems with velocity feedback [5-3].
16/01/2017	**Lecture 3** • Stability of closed loop systems [5-4].

19/01/2017 **Lecture 4**

- Stability of closed loop systems [5-4].

23/01/2017 **Lecture 5**

- Routh's stability criterion [5-6].

26/01/2017 **Lecture 6**

- Routh's stability criterion [5-6].

30/01/2017 **Lecture 7**

- System performance: effect of derivative and integral control actions [5-7].

02/02/2017 **Lecture 8**

- System performance: effect of derivative and integral control actions [5-7].

06/02/2017 **Lecture 9**

- Steady-state errors in unity-feedback control systems [5-8].

09/02/2017 **Lecture 10**

- The concept of root-locus; root-locus plots [6-1, 6-2].

13/02/2017 **Lecture 11**

- Root-locus plots [6-1, 6-2].

16/02/2017 **Lecture 12**

- Root locus plots: examples.

27/02/2017 **Lecture 13**

- Root-locus plots: examples.

02/03/2017 **Lecture 14**

- **Midterm exam.**

06/03/2017 **Lecture 15**

- Root-locus plots; gain selection with root-locus plots [6-1; 6-2].

09/03/2017 **Lecture 16**

- Control systems design by the root locus approach [6-5].
- Lead compensation [6-6].

13/03/2017 **Lecture 17**

- Lead compensation [6-6].

16/03/2017 **Lecture 18**

- Lag compensation [6-7].

20/03/2017 **Lecture 19**

- Bode diagrams [7-2].

23/03/2017 **Lecture 20**

- Bode diagrams; resonant behaviour [7-2].

27/03/2017 **Lecture 21**

- General procedure to plot Bode diagrams; Minimum phase and non-minimum phase systems; Transport lag [7-2].

30/03/2017 **Lecture 22**

- Experiemental determination of transfer functions [7-9].

03/04/2017 **Lecture 23**

- Control system analysis in state-space. State-space representations:controllable canonical form [9-2].
- Stability in state-space [9-2].

06/04/2017 **Lecture 24**

- Control systems design in state space.
- Pole placement [10-2].

Other Information

- At the beginning of the course the students are assumed to be familiar with the theory of ordinary differential equations, Laplace transforms, Fourier transforms, basic complex numbers algebra, and most importantly with material covered in MCG3305 and MCG3306. You are strongly encouraged to review the related material from pre-requisite courses.
- Suggested problems:
    - **Chapter 5:** B-5-2, B-5-5, B-5-8, B-5-20, B-5-21, B-5-23, B-5-27, B-5-28.
    - **Chapter 6:** B-6-1, B-6-3, B-6-4, B-6-6, B-6-10, B-6-15, B-6-18, B-6-19, B-6-20, B-6-23, B-6-26.
    - **Chapter 7:** B-7-2, B-7-5, B-7-9, B-7-11, B-7-23, B-7-26, B-7-30, B-7-32, B-7-34.
    - **Chapter 9:** (ignore parts regarding observability) B-9-1, B-9-3, B-9-4.
    - **Chapter 10:** B-10-3, B-10-4, B-10-5, B-10-6, B-10-7, B-10-8.

Monographs

Ogata, K.: *Modern control engineering - Fifth edition.* Prentice Hall, 2009.

Documents and Articles on the Web

- Arduino Starter Kit Manual by M. McRoberts. Usage is permitted under Creative Commons Attribution-NonCommercial-NoDerivs 3.0 Unported (see https://creativecommons.org/licenses/by-nc-nd/3.0/). Available in pdf version from Virtual Cammpus (Blackboard). Web link: https://archive.org/details/ArduinoStarterKitManual
- Arduino web resouces:
  - General: http://playground.arduino.cc//Main/ManualsAndCurriculum
  - Projects: http://playground.arduino.cc/projects/ideas
- Matlab:
  - Tutorial: https://matlabacademy.mathworks.com/
  - Control Systems: https://www.mathworks.com/academia/student_center/tutorials/controls-tutorial-launchpad.html

Plagiarism

Beware of academic fraud!

Academic fraud is an act by a student that may result in a false evaluation (including papers, tests, examinations, etc.). It is not tolerated by the University. Any person found guilty of academic fraud will be subject to severe sanctions.

Here are some examples of academic fraud:

- Plagiarism or cheating of any kind;
- Present research data that has been falsified;
- Submit a work for which you are not the author, in whole or part;
- Submit the same piece of work for more than one course without the written consent of the professors concerned.

Please consult this webpage: it contains regulations and tool to help you avoid plagiarism.
An individual who commits or attempts to commit academic fraud, or who is an accomplice, will be penalized. Here are some examples of possible sanctions:

- Receive an “F” for the work or in the course in question;
- Imposition of additional requirements (from 3 to 30 credits) to the program of study;
- Suspension or expulsion from the Faculty.

You can refer to the regulations on this webpage.

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Academic Writing Help Centre
At the AWHC you will learn how to identify, correct and ultimately avoid errors in your writing and become an autonomous writer.
In working with our Writing Advisors, you will be able to acquire the abilities, strategies and writing tools that will enable you to:

- Master the written language of your choice
- Expand your critical thinking abilities
- Develop your argumentation skills
- Learn what the expectations are for academic writing

Career Services
Career Services offers various services and a career development program to enable you to recognize and enhance the employability skills you need in today's world of work.

Counselling Service
There are many reasons to take advantage of the Counselling Service. We offer:

- Personal counselling
- Career counselling
- Study skills counselling

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Last updated: Wednesday 12 April, 2017