EE 407 Process Control
Fall 2017

Instructor:

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Main text: None.

Relevant References:

- L. Ljung, T. Glad, "Modeling of Dynamic Systems", Prentice Hall, 1994.
- J.Mikles, M. Fikar, "Process Modeling, Identification and Control", Springer, 2007.
- E.Tulunay, "Process Control I: Fundamentals of Process Control" Lecture Notes, METU 1990.
- P.C.Chao, "Process Control: A First Course With Matlab", Cambridge Press, 2002.
- K. Ogata, *Modern Control Engineering*, 4th Edition, 2009,
- http://controlguru.org (Practical Process Control)
- Additional references will be suggested as integrated into the course.

Course Objectives:

From previous courses and EE302 in particular, you are familiar with models of electrical and electro-mechanical systems and the fundamentals of basic feedback control. However, there are many other exciting applications of Control Theory in engineering, some inter-disciplinary and requiring specialized study. The objective of this course is to give you a taste of different types of physical systems that can be encountered by a practicing Electrical and Electronics Engineer. Some of these systems are still linear and lumped parameter but some others may require studying distributed models and their approximations, nonlinearity and time-delay. The course aims to give you the ability to make informed decisions about the use of the controller "modes" as well as other control structures (types) for such systems. In the existance of approximate models, you often need experimental determination of model parameters (identification) as well as tuning of the parameters of controllers to achieve stability and acceptable control performance.

Tentative Course Schedule:

Week	SUBJECT
1	Introduction, Motivations for a second course. Different physical process systems and their models, some examples.
2,3	Lumped Parameter models for Liquid Level, Flow and Thermal Systems
4,5	Distributed Parameter System Models, Lumped Parameter Approximations
6	Nonlinear systems and their linear approximations
7	Pure Time Delay and its Approximations
8,9	Modes (on-off, proportional, integral, derivative and combinations) and Types (feedback, feedforward, cascade and combinations) of Control
10,11	Experimental tuning of PID controllers
12,13	Introduction to system identification
14,15	Sensor and actuator models, calibration and identification

COURSE POLICIES AND GUIDELINES

Professional Behavior:

This is a senior level course. We will treat you as professionals and will expect to see ethical and professional behavior in return. Students in violation of ethic behavior will be dealt with accordingly.

Class Web Site and Resources:

The class will have a web site in Odtu-Class: http://odtuclass.metu.edu.tr Registered students will have access to notices, homeworks and additional materials. Check the web-site to make sure you have access (raise the issue in course if you cannot access after a week or so) and check periodically so that you do not miss anything. You may use the discussion forums to communicate with your fellow students. Same professional behavior is expected in these forums as would be expected in-class.

Grading:

The contribution of the course work to grading is given below.

- Homeworks and attendance: % 10
- Midterm Exam   % 20
- Term Project   % 15
- Laboratory Work   % 25
- Final Exam   % 30

Make-Up Policy:

One Make-up exam will be given only in the case the student has an official excuse (such as a medical report given by the university health center). It will replace one exam that is missed by the student. Same applies to one lab session that can be recovered by a make-up.

Homeworks:

There will be up to 4 Homeworks. For each homework, the best student attempt will be posted in odtu-class. It will also be a partial solution to the homework.

Laboratory:

Laboratory sessions will be conducted in the Control Laboratory (F-Block) which is a separate building of our department. This term, we will be sharing the lab also with Circuit and Electronics Laboratories due to the construction in A-Block. These are set-up in the higher floors of the laboratory. There will be up to 7 experiments.

Term Project:

There will be a term project that will be completed by each student group. The candidates for projects will be made available in the coming weeks.

Good wishes note:

Control Theory is an exciting and inter-disciplinary field of engineering that is not limited to electrical engineering applications. We are excited to show you other applications, models, problems that you may face in your engineering careers. I hope that you will have an enjoyable term. Good luck and have fun.

Afsar Saranlı,
Murat Kumru,
Mehmet Çetinkaya,
Mesut Özer

Exp. #1

Name: Heating Process and Thermocouple Characteristics

Objective: To investigate the transient behavior of thermocouple by observing their responses to various inputs and to improve these responses by passive compensation. Having understood the thermocouple characteristics, to investigate the characteristics of an electric furnace and to see the effect of on-off control on the process output.

Exp. #2

Name: Temperature Control with an Electronic PID Controller

Objective: To investigate the operation of an electronic PID controller in a closed loop control system and to get familiar with the arrangement and modeling of various system elements, such as thermocouple as a measuring element and triac as a final control element in a temperature control loop.

Exp. #3

Name: Pneumatic Level Control Using PID

Objective: To investigate pneumatic control loop elements in liquid level control.

Exp. #4

Name: Electronic Level Control Using PID

Objective: To investigate electronic control loop elements in liquid level control.

Exp. #5

Name: Lumped Approximations

Objective: An electrical lumped parameter model which approximates the dynamics of a distributed parameter system is investigated.

Exp. #6

Name: Systems with Time Delay

Objective: To investigate the effect of time delay in practical systems and to deal with methods of control for this type of systems.

Exp. #7

Name: Adjustment of Controller Parameters

Objective: To investigate two basic methods of controller parameter adjustment methods, namely, continuous cycling and reaction curve methods. Performance of the two methods on the controlled system dynamics will be investigated. In the experiment, MATLAB will be used to simulate the controller and the system.