EE 407 Process Control
Fall 2018

Instructor:

Assoc. Prof. Dr. Afşar SARANLI,
Room: EZ-10; **Phone:** 210-4529; **e-mail:** afsars@metu.edu.tr

Assistants:

Murat Kumru
Office: D-226, Phone: 210-4583
e-mail: kumru@metu.edu.tr

Elif Sarıtaş
Office: C-206, Phone: 210-4419
e-mail: esaritas@metu.edu.tr

Lab Engineer:

Mesut Ozer,
Office: F-Block, Phone: 210-4516
e-mail: mesutozer0646@gmail.com

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.
- P.C.Chao, “Process Control: A First Course With Matlab”, Cambridge Press, 2002.
- http://controlguru.org (Practical Process Control)
- D.J.Cooper, *Practical Process Control*, On-Line Book, http://apmonitor.com/che436/uploads/Main/PPC_Textbook.pdf
- Youtube channel:Gregory Reeves(e.g. https://youtu.be/vHHOlJMac4c)
- K. Ogata, *Modern Control Engineering*, 4th Edition, 2009,
- E.Tulunay, “Process Control I: Fundamentals of Process Control” Lecture Notes, METU 1990.

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:

Order (Apprx. Week)	SUBJECT
1	Introduction, Motivations for a second course. Different physical process systems and their models, some examples.
2	Lumped Parameter process models: First examples. Different types of of models.
3	Model examples continued. Overview of practical control system design.
4	Liquid level system examples. Discretization and simulation of models. System identification using the FOPDT model. Generalization of models for different physical systems. The heat transfer process.
5	Example: Simplified model of an economy. Nonlinear systems, operating point and linear approximations around op. points.
6	Modes of control. on-off, proportional, integral, derivative and combinations of modes (PID). Review of Root-locus to understand PID controllers.
7	Practical/experimental design of PID controllers. Short overview of Optimization based controllers. Examples from industry.
8	"Reaction Curve" (step response) based design formulas. Where do they come from? Derivation using Direct Design Method. Representing pure time delay and Pade Approximation.
9	Closed-loop experimental design: Zygler-Nichols continuous oscillations method.
10	Distriubuted parameter models and lumpled parameter approximations. Heat transfer example.
11	Multi-loop systems: Architectures (types) of control. Feedback, disturbance feedforward, cascade control. Examples.
12	Dealing with the effects of time-delay: The Smith Predictor.

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.

• Attendance & Homeworks	% 10
• Midterm Exam	% 20
• Term Project	% 15
• Laboratory Work & Quizzes	% 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. Homeworks will be solved by teams of two students. For each homework, the best team 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. 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,
Elif Sarıtaş,
Mesut Özer

EE 407 PROCESS CONTROL
TENTATIVE LIST OF LABORATORY EXPERIMENTS

Exp. #1

Name: Heating Process and Thermocouple Characteristics

Objective: (1) To investigate the transient behavior of thermocouple by observing their responses to various inputs and to improve these responses by passive compensation. (2) Using the thermocouple characteristics obtained, 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: Electronic Level Control Using PID

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

Exp. #4

Name: Lumped Approximations

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

Exp. #5

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. #6

Name: Controller Design: 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.