MCE 309
System Dynamics and Control

Tuesday 9:30 - 11:20 (A-414)
Thursday 8:30 - 10:20 (Online)

Fall 2021

Instructor Information:

Name	Dr. Tolga Özaslan
e-mail	tozaslan@ybu.edu.tr
Office Location	Virtual office
Office Hours	by appointment

Course Contents

Introduction to system dynamics and control. Transfer functions of linear systems. Linearization of nonlinear system dynamics. Transient response analysis. Frequency response analysis. Stability analysis. Basic control algorithms and structures. Basic controller design methods and examples. PID controller tuning methods.

Course Objective

This course aims to equip mechanical engineering students with the basic knowledge on system dynamics and automatic control. Students are exposed to mathematical foundations required for modeling dynamics of 1^{st} and 2^{nd} order systems and linear controller design for these systems.

Learning Outcomes & Competences

At the end of the semester the students are expected to be equipped with the following:

- General knowledge on control system structure.
- Modeling and analysis of 1st and 2nd order dynamical systems.
- Transient response analysis of linear systems.
- Application of basic control algorithms and PID tuning methods.
- Stability analysis of dynamic systems.
- Learn basic design methods for frequency response.
- Gain experience on controller design over industrial application examples.

Course Books

1. Katsuhiko, Ogata. *Modern Control Engineering*. Prentice Hall, 2010.

Reference Books

1. Nise, Norman S., *Control Systems Engineering,* John Wiley & Sons.
2. Richard C. Dorf, and Robert H. Bishop. *Modern Control Systems*, Pearson.
3. Franklin, Gene F., et al. *Feedback Control of Dynamic Systems*, Prentice Hall.

Assessment Criteria (may change!)

Quizzes	15%
Assignments	15%
Midterms	20%
Final Exam	30%

Course Plan

Week(s)	***Subject***
1	*Introduction and Basic Concepts:* Historical development of control systems. Basic concepts. Definition of control system basic elements. Control cycle types. Applications of automatic control systems.

2-4	*Laplace Transform and Matrix Algebra:* Basics of Laplace transform. Theorems of Laplace transform. Laplace transforms of certain functions. Inverse Laplace transform. Solution of linear differential equations with partial fraction separation method. Basic vector-matrix algebra
5	*Mathematical Modeling of Control Systems:* Mathematical model and definition of physical model. Simple system elements and similarity. Transfer function and impulse-response function. Modeling in state space. Linearization of nonlinear mathematical models.
6-7	*Mathematical Modeling of Physical Systems:* Mathematical modeling of mechanical, electrical, fluid and thermal systems
8	*Midterm Exam I*
9	*Transient and Steady-State Response Analysis:* Proportion element and its dynamic behavior. Capacity or integral elements. Time constant. First order systems, type of vibration element or second order systems.
10	*Steady State Response and Error Of Control Systems:* Steady state error and classification of systems. Static error coefficients. Disturbing entrance errors.
	Midterm Exam II
11-12	*Control Systems Analysis and Design by the Root-Locus Method:* Transient response analysis using transfer function poles and zeros. Improving stability by adjusting closed-loop poles.
13	*Methods Of Frequency Response And Bode Diagrams:* Frequency domain or response of sinusoidal entrance. Bode diagrams. Polar curves. Nypquist stability criteria.
14	*PID Controller Design:* Linear controller design. Parameter tuning. Controller performance assessment.