System Dynamics and Control

Course Code:

ME 352

Course Period:

Spring

Course Type:

Core

Credits:

4

Theoric:

3

Practice:

1

Laboratory Hour:

1

ECTS:

7

Prerequisite Courses:

Differential Equations [1]
Dynamics [2]
Course Language:

English

Courses given by:

Koray K. Şafak [3]
Course Objectives:

This course aims at providing the junior mechanical engineering students with the following knowledge and abilities: -Feedback control concept. -Mathematical modeling of linear time-invariant systems, with examples from typical engineering systems. -Analysis and design of basic feedback control methods, use of mathematical tools for design of control systems. -Hands-on experience by means of physical and computational laboratory experiments.

Course Content:

Introduction to automatic control. Modeling of dynamic systems. Response analysis by Laplace transform method. Transfer functions and block diagrams. Feedback control systems. Typical actuators and sensors. Control laws. PID control setting methods. Root locus analysis. Frequency response analysis. Laboratory experiments parallel to theory.

Course Methodology:

1: Lecture, 3: Homework, 5: Laboratory experiments

Course Evaluation Methods:

A: Exam, C: Homework, D: Laboratory reports

Learning Outcomes	Program Outcomes	Teaching Methods	Assessment Methods
1. Elementary tools of modeling of mechanical, electrical, fluid, and thermo-fluid systems.	1, 2	1, 3	A, C
1. A basic understanding of behavior of first- and second-order linear time invariant differential equations.	1, 2	1, 3	A, C
1. Basic concepts of Laplace transforms, transfer functions, and frequency response analysis.	2, 3	1, 3	A, C
1. Concept of stability and the use of feedback control to actively control system behavior.	2, 3	1, 3	A, C
1. Use of computational (MATLAB) and experimental tools in modeling, analysis, and design of control systems.	5, 6	3, 5	C, D

COURSE CONTENT

Week	Topics	Study Materials
1	Introduction and Overview of Control Systems	Textbook Ch.1
2	Dynamics of Mechanical System	Textbook Ch. 2
3	Models of Electric Circuits / Models of Electromechanical Sys.	Textbook Ch. 2
4	Heat and Fluid Flow Models	Textbook Ch. 2
5	System Description in State Space / Nonlinear Sys. and Linearization	Textbook Ch. 7,9
6	Review of Laplace Transform	Textbook Ch. 3
7	Blockdiagram Representations	Textbook Ch. 3
8	Effect of Pole Locations / Time-Domain Specifications	Textbook Ch. 3
9	Stability	Textbook Ch. 3
10	Control of Dynamic Error: PID Control	Textbook Ch. 4
11	The Root-Locus Design Method	Textbook Ch. 5
12	The Root-Locus Design Method	Textbook Ch. 5
13	Frequency Response Design Method	Textbook Ch. 6
14	Frequency Response Design Method	Textbook Ch. 6

RECOMMENDED SOURCES	
Textbook	G.F. Franklin, J.D. Powell, A. Emami-Naeini, Feedback Control of Dynamic Systems, 6th ed., Prentice Hall, 2010.
Additional Resources	K. Ogata, Modern Control Engineering, 5th ed., Prentice Hall, 2009.

MATERIAL SHARING

Documents	Syllabus, Weekly course schedule, Laboratory manuals
Assignments	Homework assignments
Exams	None

ASSESSMENT		
IN-TERM STUDIES	**NUMBER**	**PERCENTAGE**
Midterms	2	20
Homeworks	8	15
Lab work	4	20
Total		**75**
CONTRIBUTION OF FINAL EXAMINATION TO OVERALL GRADE		25
CONTRIBUTION OF IN-TERM STUDIES TO OVERALL GRADE		75
Total		**100**

COURSE'S CONTRIBUTION TO PROGRAM

No	Program Learning Outcomes		Contribution					
		NA	1	2	3	4	5	
1	Adequate knowledge in mathematics, science and engineering subjects pertaining to the relevant discipline; ability to use theoretical and applied knowledge in these areas in complex engineering problems.	**X**						
2	Ability to identify, formulate, and solve complex engineering problems; ability to select and apply proper analysis and modeling methods for this purpose.	**X**						
3	Ability to design a complex system, process, device or product under realistic constraints and conditions, in such a way as to meet the desired result; ability to apply modern design methods for this purpose.	**X**						
4	Ability to devise, select, and use modern techniques and tools needed for analyzing and solving complex problems encountered in engineering practice; ability to employ information technologies effectively.	**X**						

5	Ability to design and conduct experiments, gather data, analyze and interpret results for investigating complex engineering problems or discipline specific research questions.	**X**						
6	Ability to work efficiently in intra-disciplinary and multi-disciplinary teams; ability to work individually.	**X**						
7	Ability to communicate effectively in Turkish, both orally and in writing; knowledge of a minimum of one foreign language; ability to write effective reports and comprehend written reports, prepare design and production reports, make effective presentations, and give and receive clear and intelligible instructions.	**X**						
8	Recognition of the need for lifelong learning; ability to access information, to follow developments in science and technology, and to continue to educate him/herself.	**X**						
9	Consciousness to behave according to ethical principles and professional and ethical responsibility; knowledge on standards used in engineering practice.	**X**						
10	Knowledge about business life practices such as project management, risk management, and change management; awareness in entrepreneurship, innovation; knowledge about sustainable development.	**X**						
11	Knowledge about the global and social effects of engineering practices on health, environment, and safety, and contemporary issues of the century reflected into the field of engineering; awareness of the legal consequences of engineering solutions.	**X**						
12	Ability to work professionally in both thermal and mechanical systems areas, including design and realization.	**X**						
13	Ability to verify and validate numerical solutions to engineering problems.	**X**						

ECTS ALLOCATED BASED ON STUDENT WORKLOAD BY THE COURSE DESCRIPTION

Activities	Quantity	Duration (Hour)	Total Workload (Hour)
Course Duration (Including the exam week: 16x Total course hours)	16	4	64

Hours for off-the-classroom study (Pre-study, practice)	16	5	80
Mid-terms	2	4	8
Lab work	6	1	6
Final examination	1	16	16
Total Work Load			182
Total Work Load / 25 (h)			7.28
ECTS Credit of the Course			7