ESOGÜ Electrical-Electronics Engineering Department

COURSE CODE:151228421-151248421 **COURSE TITLE:**Nonlinear Control Systems

Semester	**Weekly Hours**		**COURSE**			
	Theoretical	**Practical**	**Credits**	**ECTS**	**Type**	**Language**
8	3	0	3	5	Compulsory ( ) Elective (x)	Turkish ( ) English (x)

Write the credit (for non-credit courses weekly hours) below (If necessary distribute the credits.).

Math and Basic Science	**Electrical Engineering** [mark (√) if there is high design content]	**General Education**	**Humanities**
	3 ( )		

Assessment	**THEORETICAL-PRACTICAL COURSES**			**LABORATORY COURSES**		
	Type	**Number**	**%**	**Activity Type**	**Number**	**%**
Midterm	Midterm	1	50	Quiz		
	Quiz			Lab performance		
	Homework	2	10	Report		
	Project			Oral exam		
	Other (……)			Other (……)		
Final		1	40			
Makeup exam (Oral/Written)	Written					

Prerequisites	Fundamentals of Control Systems
Brief content of the course	Differential equation representation of nonlinear systems. Simple plane pendulum. Simple double pendulum. Equilibrium points. Limit cycles. Bifurcations. Finite escape points. Multiple isolated equilibria. Chaos. Phase plane analysis. Lyapunov analysis. Stability. Linearization and local stability. Lyapunov's direct method. Positive definite functions. Equilibrium point theorems. Invariant set theorems. Feedback linearization. Input state linearization. Input output linearization. Sliding control. Sliding surfaces. Switching control laws.
Objectives of the course	Fundamental concepts of nonlinear control systems. Stability analysis of control systems. Introductory level nonlinear control system design.
Contribution of the course towards professional education	Aircrafts, land vehicles, ships, and robots form a significant part of the industry. These systems are effectively modelled and analyzed by nonlinear system tools.
Outcomes of the course	Students who successfully complete this course 3) Analyze a class nonlinear system models. 4) Design control laws for a class of nonlinear control systems. 5) Understand stability in the nonlinear systems context.
Textbook of the course	J.-J. E. Slotine and W. Li, Applied Nonlinear Control, Prentice Hall, 1991.
Other reference books	H. K. Khalil, Nonlinear Systems, Prentice Hall, 2002.
Required material for the course	Basic MATLAB software.

WEEKLY PLAN OF THE COURSE	
Week	**Topics**
1	Differential equation representation of nonlinear control systems, Numerical solutions of nonlinear differential equations by MATLAB
2	The simple plane pendulum, the double plane pendulum. Equilibrium points
3	Limit cyscles, Bifurcations, Finite escape time, Multiple isolated equilibria, Chaos
4	Phase plane analysis, Singular points, Symmetry, Constructing the phase portrait,
5	Phase plane analysis of linear systems, More on limit cycles
6	Lyapunov analysis, stability
7	Linearization and local stability, Lyapunov's direct method
8	Midterm
9	Midterm
10	Positive definite Functions, Lyapunov functions
11	Invariant set theorems
12	Feedback linearization,
13	Sliding mode control, sliding surfaces
14	Switching control laws
15,16	Final exam

NO	OUTCOMES OF THE PROGRAMME	4	3	2	1
1	Adequate knowledge of mathematics, science and Electrical and Electronic Engineering; ability to practice theoretical and practical knowledge of these areas into modeling and solving complex problems of Electrical and Electronic Engineering	√			
2	Ability to identify complex engineering problems in Electrical and Electronic Engineering and related fields, for this purpose having skills to formulate, select and apply appropriate methods.		√		
3	Having skills to apply modern design methods to design a complex system, process, equipment or product that should work under realistic conditions and constraints and satisfy specific requirements concerning the Electrical and Electronic Engineering.				
4	Having skills to develop, select and apply modern techniques and tools needed to analyze and solve complex applications in Electrical and Electronic Engineering, skills to use information technology effectively.				
5	Skills to design and conduct tests, collect data, analyze results, and interpret data for the experimental investigation of complex problems in Electrical and Electronic Engineering				
6	Ability to function effectively as an individual and as a member of teams within the discipline and in multidiscipline areas.				
7	Communicating effectively in oral and written form both in Turkish and English. Effective report writing and understanding written reports, preparing design and manufacturing reports, making effective presentations, skills to give and receive clear and concise instructions.				
8	Awareness of the necessity of lifelong learning, access to information, monitoring developments in science and technology and the ability to self-renewing				
9	Understanding of professional and ethical responsibility				
10	Information on project management, change management and risk management practices, awareness on entrepreneurship and innovation, knowledge on sustainable development.				
11	Information about universal and societal effects of engineering applications on health, safety and environment; awareness of the legal consequences of engineering solutions.				

Scale for assessing the contribution of the course to the program outcomes:

4: High 3: Medium 2: Low 1:None

Name of Instructor(s): Prof. Dr. Abdurrahman Karamancıoğlu

Signature(s):

Date: