ABDULLAH GÜL UNIVERSITY
GRADUATE SCHOOL OF ENGINEERING & SCIENCE
ELECTRICAL AND COMPUTER ENGINEERING PROGRAM
COURSE DESCRIPTION AND SYLLABUS

Course Title	Code	Semester	T+L Hours	Credit	ECTS
LINEAR SYSTEMS	ECE-501	FALL-SPRING	3 + 0	3	10

Prerequisite Courses	none

Type	Elective
Language	English
Coordinator	Assoc. Prof. Dr. Günyaz Ablay
Instructor	Assoc. Prof. Dr. Günyaz Ablay
Adjunct	none
Aim	Learning, understanding and applying linear analysis and design tools that are needed in electrical engineering studies.
Learning Outcomes	To give an opportunity to students for • learning the fundamentals of linear systems • learning the stability theorems • learning linear control design with feedback • learning optimal design methods • learning discrete-time systems and related tools • learning software tools that can be used for analysis and design of nonlinear systems
Course Content	• Introduction to Linear Systems • State-space representation and analysis • Solution for state-space linear time-invariant (LTI) systems • Controllability and Observability • State Feedback Control • Optimal Control • Stability • Discrete-time systems • Design Considerations and Steady-state accuracy • MIMO systems • Passivity • Polynomial representations

WEEKLY TOPICS AND PRELIMINARY STUDY

Week	Topic	Preliminary Study
1	Introduction and course overview • System representation, Superposition principle • Analog vs. Digital signals and systems • Laplace solutions, Transfer functions, Block diagrams	The relevant lecture notes
2	System representation and analysis • State-space representations • Realizations • Linearization	The relevant lecture notes
3	Solution for state-space linear time-invariant (LTI) systems • Solution to homogeneous linear systems • State-transition matrix • Properties of the state transition matrix • Solution to nonhomogeneous linear systems	The relevant lecture notes
4	Controllability and Observability • Controllability and observability matrices • Canonical forms • Eigenvalues & Eigenvectors • Jordan Canonical form	The relevant lecture notes
5	State Feedback Control • Feedback control and estimations (observers) • Integral control • Observer-based control	The relevant lecture notes
6	Optimal Control • Performance index • Riccati solutions	The relevant lecture notes

	• Kalman filter	
7	Stability • Definitions • Complex plane and Eigenvalues condition • Lyapunov Stability Theorem • Stability of nonlinear systems from local linearization	The relevant lecture notes
8	Midterm	
9	Discrete-time systems • Discrete equations • Stability • Discretization	The relevant lecture notes
10	Design Considerations and Steady-state accuracy • Performance requirements • Steady-state accuracy • Disturbance rejection	The relevant lecture notes
11	MIMO systems • Diagonal realizations • Controllability and observability • Controlling MIMO systems	The relevant lecture notes
12	Polynomial representations • Polynomial matrix • Smith and McMillian forms • Polynomial Control Design	The relevant lecture notes
13	Review Summary of the course, questions and answers	The relevant lecture notes
14	Final Exam	

SOURCES	
Lecture Notes	Lecture notes and slides
Other Sources	**Course Textbook:** J. Hespanha, *Linear Systems Theory*, Princeton University Press, 2009. **Additional Materials:** 1. P. Antsaklis, A. Michel. Linear Systems. McGraw Hill, 1997.

COURSE MATERIALS SHARING	
Documents	Lecture notes, slides and papers
Homework	Students will be given one homework each week
Exams	1 Midterm and 1 Final Exam

EVALUATION SYSTEM		
SEMESTER STUDY	**NUMBER**	**CONTRIBUTION**
Midterm	1	20
Homework	14	25
Quiz	14	25
SUB-TOTAL		70
Contribution of Semester Study		70
Contribution of Final Exam	1	30
TOTAL		100

Course Category	
Sciences and Mathematics	30%
Engineering	70%
Social Sciences	0%

RELATIONSHIPS BETWEEN LEARNING OUTCOMES AND PROGRAM QUALIFICATIONS						
No	Program Qualifications	Contribution Level				
		1	2	3	4	5
1	The skills of using mathematics, science and engineering information in advanced research,					**X**

2	The skills of analyzing, designing and/or implementing an original system that will be able to solve an engineering problem,					x
3	The skills of using the required software, hardware and modern measurement equipment in their field of research,					x
4	The skills of planning independent research and implementing in detail,					x
5	The skills of following literature, listening to and making technical presentation, writing a paper in academic level,				x	
6	The skills of innovative and interrogative thinking and finding original solutions				x	

*Increasing from 1 to 5.

ECTS / WORK LOAD TABLE			
Activities	Number	Duration (Hours)	Total Work Load
Course Length (includes exam weeks: 16x total course hours)	14	3	42
Out-of-class Study Time (Pre-study, practice)	14	4	56
Internet search, library work, literature search	14	5	70
Presentation	1	5	5
Homework	14	5	70
Midterm	1	27	27
Final Exam	1	30	30
Total Work Load			300
Total Work Load / 30			300/30
Course ECTS Credit			10