AYDIN ADNAN MENDERES UNIVERSITY
COURSE INFORMATION FORM

Course Title	Nonlinear System Theory								
Course Code	EEE504		Couse Level	Second Cycle (Master's Degree)					
ECTS Credit	8	Workload	200 *(Hours)*	Theory	3	Practice	0	Laboratory	0
Objectives of the Course	To describe the dynamics of nonlinear systems encountered in science and engineering, to understand the nature of nonlinear systems, to explain how some nonlinear systems go into chaos, and to understand the characteristics of chaos.								
Course Content	Nonlinear systems, system dynamics, phase space, bifurcation, stabiility, attractors, Lyapunov stability , ergodicity equation, logistic mapping, chaos.								
Work Placement	N/A								
Planned Learning Activities and Teaching Methods	Explanation (Presentation), Demonstration, Discussion, Case Study, Project Based Study, Individual Study, Problem Solving								
Name of Lecturer(s)									

Assessment Methods and Criteria		
Method	Quantity	Percentage (%)
Midterm Examination	1	30
Final Examination	1	30
Assignment	4	20
Project	1	20

Recommended or Required Reading	
1	S. H. Strogatz, Nonlinear Dynamics and Chaos, Perseus Books 1994, Massachusetts
2	R. H. Rand, Lecture Notes on Nonlinear Vibrations ,Cornell University Press, NewYork, 2001Erwin Kreyszig, Advanced Engineering Mathematics Seventh Edition, Wiley (2006)
3	L. N. Virgin, Introduction to Experimental Nonlinear Dynamics, Cambridge University Press, 2000, Cambridge

Week	Weekly Detailed Course Contents	
1	Theoretical	Review of linear vibration systems, concepts of system dynamics, phase space and stability concepts
2	Theoretical	One dimensional nonlinear systems-I: stability
3	Theoretical	One dimensional nonlinear systems-II: bifurcations
4	Theoretical	One dimensional nonlinear systems-III: Flows on the circle (uniform and non-uniform oscillator, overdamped pendulum, Science & engineering applications)
5	Theoretical	Two dimensional nonlinear systems-I: Definitions, examples and classifications of linear systems
6	Theoretical	Two dimensional nonlinear systems-II: Phase plane (Phase portraits, existence and uniqueness, fixed points and linearization, conservative systems, reversible systems, pendulum, index theory, Science & engineering applications)
7	Theoretical	Two dimensional nonlinear systems-III: Limit cycles (Ruling out closed orbits, Lienard systems, relaxation oscillator, weakly nonlinear oscillations)
8	Intermediate Exam	Midterm Exam
9	Theoretical	Bifurcation revisited-I: Saddle-node, Trans-critical, and Pitchfork bifurcations, Hopf Bifurcations and cycles
10	Theoretical	Bifurcation revisited-II: Oscillating chemical reactions, Global bifurcations of cycles, hysteresis in the driven pendulum and Josephson junction, Coupled oscillators and quasi-periodicity, Poincare maps
11	Theoretical	Lorentz equations, chaos on a strange attractor, Lorenz map, using chaos to send secret messages
12	Theoretical	One dimensional maps-I: Fixed point and cobwebs, logistic map: Numerics
13	Theoretical	One dimensional maps-II: logistic map: analysis, periodic windows, Lyapunov exponent, universality and experiments, renormalization
14	Theoretical	Stability of nonlinear systems, Lyapunov stability
15	Theoretical	Review and Science & Engineering applications
16	Final Exam	Final Exam

Workload Calculation				
Activity	Quantity	Preparation	Duration	Total Workload
Lecture - Theory	14	4	3	98
Assignment	4	10	3	52
Project	1	11	3	14
Midterm Examination	1	15	3	18
Final Examination	1	15	3	18
			Total Workload (Hours)	200
			[Total Workload (Hours) / 25*] = **ECTS**	8
25 hour workload is accepted as 1 ECTS				

Learning Outcomes	
1	To be able to understand system dynamics and phase space
2	To be able to understand the bifurcation theory
3	To be able to determine stability of systems and to understand the Lyapunov stability
4	To understand the logistic equation and its mapping
5	To understand chaos and its conditions

Programme Outcomes *(Electrical and Electronics Engineering Master)*	
1	Developing and intensifying knowledge that requires expertise in the area of Electrical-Electronics Engineering, and gaining the skills necessary to analyze and solve problems using this knowledge
2	Grasping the inter-disciplinary interaction related to Electrical-Electronics Engineering, interpreting and forming new types of knowledge by combining the knowledge from Electrical-Electronics Engineering and the knowledge from various other disciplines
3	Developing new approaches to solve the complex problems arising in Electrical-Electronics Engineering, coming up with solutions while taking responsibility and carrying out a specific study independently
4	Assessing the knowledge and skill gained in the area of Electrical-Electronics Engineering with a critical view
5	Transferring the current developments and one’s own work in Electrical-Electronics Engineering, to other groups in written, oral and visual forms
6	The ability to control the collecting, interpreting, practicing and announcing processes of the Electrical-Electronics Engineering related to data taking into consideration scientific, cultural and ethical values and the ability to teach these values to others
7	Developing application plans concerning the subjects related to Electrical-Electronics Engineering and the ability to evaluate the end results of these plans within the frame of quality processes

Contribution of Learning Outcomes to Programme Outcomes *1:Very Low, 2:Low, 3:Medium, 4:High, 5:Very High*

	L1	L2	L3	L4	L5
P1	4	3	4	4	4
P2	3	3	4	4	5
P3	4	3	3	4	4
P4	3	4	5	3	5
P5	4	3	4	4	4
P6	4	3	5	3	4
P7	4	4	4	4	4