COURSE INFORMATION

Course Code	BMUH 533	Course Name	Nonlinear Dynamics And Chaos					
Type of Course	**Level of Course**	**Semester**	**Language**	**Theory**	**Application (Practice)**	**Laboratory**	**Local Credits**	**ECTS**
Elective	Graduate	Fall & Spring	English	3	0	0	3	6

Department	: Electrical and Electronics Engineering
Prerequisites/Requirements for Admission	: None
Mode of Delivery	: Face to face
Course Coordinator	: Dr. Esra Karaoglu
Course Lecturer(s)	: Dr. Esra Karaoglu
Course Assistant(s)	:
Course Description/Aim	Students will obtain familiarity with methods for analyzing dynamical systems, will be familiar with the theoretical foundations of popular computational tools used for bifurcation analysis, and will learn how to interpret and critically evaluate the application of these methods.
Course Contents	Introduction to nonlinear dynamics with applications to physics, engineering, biology, and chemistry, one dimensional systems; bifurcations, phase plane, two dimensional flows; linear system analysis and bifurcations, one dimensional maps.
Recommended Optional Program Components	: None
Compulsory Attendance	: %70 attendance is mandatory.

Course Learning Outcomes

#	Learning outcome	Teaching Methods/ Techniques	Assessment method(s)
At the end of this course; students will be able to:			
1	analyze the behavior of dynamical systems (e.g. find periodic orbits and assess their stability, draw phase portraits, etc.) expressed as either a discrete-time mapping or a continuous-time flow,	Lecture, Case Study, Discussion, On-line Activity	Written Exam, Project, Homework
2	apply the techniques of nonlinear dynamics to physical processes drawn from a variety of scientific and engineering disciplines	Lecture, Case Study, Discussion, On-line Activity	Written Exam, Project, Homework

3	analyze changes (i.e. bifurcations) to dynamical systems as system parameters are varied,	Lecture, Case Study, Discussion, On-line Activity	Written Exam, Project, Homework
4	analyse various applications in real-life systems, say engineering and biomedical applications, control and synchronise them as per requirement and carry out simulation as well as hardware realisation of these systems.	Lecture, Case Study, Discussion, On-line Activity	Written Exam, Project, Homework

Weekly Detailed Course Content

Week	Content	Recommended Resource(s)	Time (Hours)
1	One-Dimensional Flows: Fixed Points and Stability	Textbook/ Lecture Notes	3
2	One-Dimensional Flows : Linear Stability Analysis	Textbook/ Lecture Notes	3
3	Bifurcations: Saddle-Node Bifurcation, Transcritical Bifurcation	Textbook/ Lecture Notes	3
4	Bifurcations: Pitchfork Bifurcation	Textbook/ Lecture Notes	3
5	Flows on the Circle	Textbook/ Lecture Notes	3
6	Two-Dimensional Flows: Classification of Linear Systems	Textbook/ Lecture Notes	3
7	Two-Dimensional Flows: Phase Plane, Phase Portraits	Textbook/ Lecture Notes	3
8	Two-Dimensional Flows: Fixed Points and Linearization	Textbook/ Lecture Notes	3
9	Limit cycles: Poincaré−Bendixson Theorem	Textbook/ Lecture Notes	3
10	Bifurcations Revisited: Saddle-Node, Transcritical, and Pitchfork Bifurcations	Textbook/ Lecture Notes	3
11	Bifurcations Revisited: Hopf Bifurcations	Textbook/ Lecture Notes	3
12	One-Dimensional Maps: Fixed Points and Cobwebs	Textbook/ Lecture Notes	3
13	One-Dimensional Maps: Liapunov Exponent	Textbook/ Lecture Notes	3
14	Projects	Textbook/ Lecture Notes	3

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Sources

Course Notes / Textbooks	Strogatz S. H., Nonlinear Dynamics and Chaos, CRC Press, 2nd Ed., 2015, ISBN 13: 978-0-8133- 4910-7.
Supplemental Readings	Wiggins S., Introduction to Applied Nonlinear Dynamical Systems and Chaos, Springer, 2nd Ed., 2003, ISBN: 0-387-00177-8. Guckenheimer J. and Holmes P., Nonlinear Oscillations, Dynamical Systems and Bifurcations of Vector Fields, New York, NY: Springer-Verlag, 2002, ISBN: 9780387908199. Hale J. and Koçak H., Dynamics and Bifurcations, Springer-Verlag, 1991, ISBN: 0-387-97141-6.

Evaluation System

Work Placement	Number	Percentage of Grade
Attendance		
Quizzes		
Homework		
Presentation		
Laboratory/Practice		
Report(s)		
Graduate Thesis/Project		
Seminar		
Projects	2	40
Midterm exam(s)	1	30
Others		
Final exam	1	30
	Total	100
	Percentage of semester work	70
	Percentage of final exam	30
	Total	100

Workload Calculation

Activity	Number	Time (hours)	Total work load (hours)
Course hours	14	3	42
Individual study for course	14	8	112
Midterm exam(s)	1	3	3
Final exam	1	3	3
Individual study for homeworks	2	5	10
Individual study for final exam	1	20	20
		Total	190
		ECTS Credit(Total/30)	6