COURSE OUTLINE

(1) GENERAL

SCHOOL	SCHOOL OF SCIENCES		
ACADEMIC UNIT	DEPARTMENT OF MATHEMATICS		
LEVEL OF STUDIES	POSTGRADUATE **Studies in Mathematics**		
COURSE CODE	**B2**	**SEMESTER**	**A**
COURSE TITLE	DYNAMICAL SYSTEMS		
INDEPENDENT TEACHING ACTIVITIES		**WEEKLY TEACHING HOURS**	**CREDITS**
		3	10
COURSE TYPE	SPECIALISED GENERAL KNOWLEDGE		
PREREQUISITE COURSES:	NO		
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	GREEK		
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES		
COURSE WEBSITE (URL)	http://www.math.aegean.gr/index.php/en/academics/undergraduate-programs		

(2) LEARNING OUTCOMES

Learning outcomes

The postgraduate course “Dynamical Systems”, serves to the postgraduate student an introduction to the fundamental notions, at a postgraduate level, of the qualitative theory of differential equations, and dynamical systems. It also offers the necessary background for advanced studies potentially leading to research activities in this field, or relevant interdisciplinary fields for which the study of emerged dynamical systems, may have a crucial role.

After completing this course, students should demonstrate competency in the following skills:

- To understand the dynamics, and the structure of the phase-plane of linear systems.
- To apply local techniques, for the analysis of the local phase portrait of non-linear systems.
- To apply Lyapunov and invariant manifold methodologies, in order to analyze the stability properties of nonlinear systems.
- To understand and recognize fundamental nonlinear phenomena such as the emergence of limit cycles, and bifurcations.
- To understand and apply global non-linear techniques, based on Poincaré-Bendixson theorem.
- To understand and analyze the global phase portrait of 2^{nd} order conservative systems, the notions of homoclinic and heteroclinic connections, and their importance as underlying structures, emerging complex behavior in nonlinear systems.

General Competences

Working independently
Team working
Working in an interdisciplinary environment
Decision-making
Production of free, creative and inductive thinking

(3) SYLLABUS

Scalar differential equations, and scalar flows. Stability of fixed points, and the phase portrait of scalar flows. Elementary bifurcations for scalar flows. Planar systems: fundamental notions for the autonomous planar systems. Linear systems: the phase plane of linear systems, the flow of a linear system. Nonlinear systems: linearization principle, invariant subspaces, Hartman-Grobman theory, local invariant manifolds, topological conjugate, and topological equivalent dynamical systems. Lyapunov's stability theorem. Chetaev's instability theorem. 2^{nd} order conservative systems and their phase-plane analysis. The notion of homoclinic end heteroclinic connections. Periodic solutions and limit cycles: Hopf's bifurcation. Limit sets. Poincaré-Bendixson theorem and applications. Center manifold theorem and applications.

(4) TEACHING and LEARNING METHODS - EVALUATION

DELIVERY	Face-to-face
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY	• Communication with students via e-mail. • Usage of (open source) software learning management system (Moodle). • Potential case studies with suitable symbolic and numerical computation scientific software.
TEACHING METHODS	see table below
STUDENT PERFORMANCE EVALUATION	Student's performance is evaluated in Greek, by a written examination paper which includes short-answer questions and problem solving. Disabled students are evaluated by suitably structured examinations (pending on the disability of the student, e.g., oral exams, etc.).

Activity	***Semester workload***
Lectures	39
Independent study	148.5
Assignments	62.5
Course total (25 per ECTS)	***250***

(5) ATTACHED BIBLIOGRAPHY

- Suggested bibliography:

1. Jack K. Hale and H. Koçak. Dynamics and Bifurcations. Springer-Verlag, 1991.
2. M. W. Hirsch, S. Smale and R. L. Devaney. Differential Equations, Dynamical Systems & an Introduction to Chaos. Elsevier- Academic Press, 2004.
3. S. H. Strogatz. Nonlinear Dynamics and Chaos-With Applications to Physics, Biology, Chemistry and Engineering. Perseus Books Publishing, L.L.C, Massachusetts, 1994.
4. S. Wiggins, Introduction to Applied Nonlinear Dynamical Systems and Chaos. Springer Verlag,2003.
5. D. W. Jordan and P. Smith. Nonlinear Ordinary Differential Equations. Oxford University Press, 2007.
6. Vougiatzis Georgios, Meletlidou Efthymia, Introduction to Non-Linear Dynamical Systems. Kallipos, Open Academic Editions(2015). https://repository.kallipos.gr/handle/11419/1789

- Related academic journals: Academic journals focused in the field of Dynamical Systems Differential equations and their applications, Nonlinear Science and Nonlinear Phenomena.