COURSE OUTLINE

(1) GENERAL

SCHOOL	School of Science		
ACADEMIC UNIT	Physics		
LEVEL OF STUDIES	Undergraduate		
COURSE CODE	**10ΕΛΕ06**	**SEMESTER**	**8**
COURSE TITLE	**Non linear dynamical systems**		

INDEPENDENT TEACHING ACTIVITIES *if credits are awarded for separate components of the course, e.g. lectures, laboratory exercises, etc. If the credits are awarded for the whole of the course, give the weekly teaching hours and the total credits*	**WEEKLY TEACHING HOURS**	**CREDITS**
Lectures (theory and exercises)	4	6

COURSE TYPE *general background, special background, specialised general knowledge, skills development*	General Knowledge
PREREQUISITE COURSES:	No
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek
IS THE COURSE OFFERED TO ERASMUS STUDENTS	No
COURSE WEBSITE (URL)	*https://eclass.uoa.gr/courses/PHYS289/*

(2) LEARNING OUTCOMES

Learning outcomes

The course learning outcomes, specific knowledge, skills and competences of an appropriate level, which the students will acquire with the successful completion of the course are described.

Consult Appendix A

- *Description of the level of learning outcomes for each qualifications cycle, according to the Qualifications Framework of the European Higher Education Area*
- *Descriptors for Levels 6, 7 & 8 of the European Qualifications Framework for Lifelong Learning and Appendix B*
- *Guidelines for writing Learning Outcomes*

The course provides a rigorous, systematic and an in-depth study of the theory of dynamical systems with applications from the fields of physics, biology, chemistry, climatology and economics.

With the completion of the course the student is able to:

- Determine the qualitative behavior of one dimensional and two-dimensional systems and determine the stability of their equilibria or of their periodic orbits.
- Determine the evolution of linear dynamical systems. Provide numerical solutions of the dynamical systems.
- Provide approximate solutions with the use of perturbation techniques.
- Characterize the nature of the attractor that emerges at bifurcation points.
- Determine the sensitivity of a chaotic system by calculating the Lyapunov exponent of its trajectories.
- Use the method of characteristics in order to solve kinematic wave equations and analyze shock waves.
- Be able to study non-linear waves. Recognize/construct solitonic solutions. Understands the role of non-linearity, dispersion and dissipation in wave solutions.

General Competences

Taking into consideration the general competences that the degree-holder must acquire (as these appear in the Diploma Supplement and appear below), at which of the following does the course aim?

Search for, analysis and synthesis of data and information, with the use of the necessary technology
Adapting to new situations
Decision-making
Working independently
Team work
Working in an international environment
Working in an interdisciplinary environment
Production of new research ideas
Project planning and management
Respect for difference and multiculturalism
Respect for the natural environment
Showing social, professional and ethical responsibility and sensitivity to gender issues
Criticism and self-criticism
Production of free, creative and inductive thinking
……
Others…
…….

The course aims at the following general competences

Team Work
Production of free, creative and inductive thinking
Analytical and synthetic thinking
Critical thinking
Problem solving

(3) SYLLABUS

- Dynamical systems as flows in phase space and as maps. Equilibria and their stability. Bifurcations in one-dimensional dynamical systems.
- Two dimensional dynamical systems. Linear dynamics in two dimensions. Poincare-Bendixson theorem. Limit cycles. Hopf bifurcations. Stability of limit cycles. Parametric instability.
- Non linear oscillations. Perturbation methods. Method of multiple time scales.
- Introduction to chaotic systems. Lorenz system. Lyapunov exponents.
- Quasi-linear 1st order partial differential equations. Characteristics and formation of shock waves and applications. Burgers equation.
- Non linear waves. Boussinesq equations. Korteweg-de Vries and non-linear Schrödinger equations. Introduction to soliton theory.

(4) TEACHING and LEARNING METHODS - EVALUATION

<table>
<tr><td>DELIVERY
Face-to-face, Distance learning, etc.</td><td>Face-to-face</td></tr>
<tr><td>USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY
Use of ICT in teaching, laboratory education, communication with students</td><td>Yes

Computer-aided lectures through Overhead Projector, Electronic communication with the students using ICT, eclass platform</td></tr>
<tr><td>TEACHING METHODS
The manner and methods of teaching are described in detail.
Lectures, seminars, laboratory practice, fieldwork, study and analysis of bibliography, tutorials, placements, clinical practice, art workshop, interactive teaching, educational visits, project, essay writing, artistic creativity, etc.

The student's study hours for each learning activity are given as well as the hours of non-directed study according to the principles of the ECTS</td><td>
<table>
<tr><th>Activity</th><th>Semester workload</th></tr>
<tr><td>Lectures</td><td>26</td></tr>
<tr><td>Exercises</td><td>26</td></tr>
<tr><td>Individual Study/Study and Analysis of bibliography / Preparation</td><td>98</td></tr>
<tr><td></td><td></td></tr>
<tr><td>Course Total</td><td>150</td></tr>
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<tr><td>STUDENT PERFORMANCE EVALUATION
Description of the evaluation procedure

Language of evaluation, methods of evaluation, summative or conclusive, multiple choice questionnaires, short-answer questions, open-ended questions, problem solving, written work, essay/report, oral examination, public presentation, laboratory work, clinical examination of patient, art interpretation, other

Specifically-defined evaluation criteria are given, and if and where they are accessible to students.</td><td>Final written exams in Greek

Intermediate tests.</td></tr>
</table>

(5) ATTACHED BIBLIOGRAPHY

- Suggested bibliography:

- Strogatz, S. - Nonlinear Dynamics and Chaos,CRC Press, 2018, Boca Raton, FL, U.S.A.
- Ablowitz, M.- Nonlinear Dispersive Waves, Cambridge University Press, 2012, Cambridge, U.K.
- Arnold, V. Ordinary Differential Equations, MIT Press, 1978, Cambridge, MA, U.S.A.

- Related academic journals:-

Selected research articles