University of the Balearic Islands

Teaching guide

Academic year	2012-13
Subject	10103 - Nonlinear Dynamical Systems and Time-Space Complexity
Group	Group 1, 1S
Teaching guide	A
Language	English

Subject identification

Subject	10103 - Nonlinear Dynamical Systems and Time-Space Complexity
Credits	1.2 in-class (30 hours) 3.8 distance (95 hours) 5 totals (125 hours).
Group	Group 1, 1S
Teaching period	1st semester
Teaching language	English

Lecturers

Lecturers	Timetable for student attention					
	Starting time	Finishing time	Day	Start date	Finish date	Office
Pere Colet Rafecas	There are no defined sessions					
Emili Hernandez Garcia ehg899@uib.es	There are no defined sessions					
Oreste Piro Perusin oreste.piro@uib.es	There are no defined sessions					

Degrees where the subject is taught

Degree	Character	Course	Studies
Master's Degree in Physics	Optional		Postgraduate degree
Master's Degree in Electronic Engineering	Optional		Postgraduate degree

Contextualisation

Course of the Master's Degree in Physics within the Module "Statistical and Non-Linear Physics". This course will be taught in English if any student request that.

Requirements

This curse is intended to provide a solid background in dynamical systems to students of the Master Degree in Physics as well as to introduce some aspects of dynamics in extendend systems.

Essential requirements

The course is open to any student of the Master Degree in Physics. It is required that the student understands English.

Date of publication: 18/07/2012

Recommendable

Prior knowledge, at a Batchelor level, in basic ordinary differential equations is assumed.

Skills

This curse includes some general competences as well as some specific ones.

Specific

1. Knowledge of the basic terminology used in dynamic systems.
2. Determination of fix points in dynamic systems. Stability analysis.
3. Capability to identify the most common bifurcations in a variety of systems.
4. Capability to apply the techniques of dynamic systems to a variety of physical, chemical or biological systems.
5. Understanding the appearance of chaotic attractors. Routes to chaos.

Generic

1. Understand and express meanings in physical, mathematical and programming language.
2. Apply theoretical and practical knowledge to problem solving.
3. Begin research in field.
4. Apply information and computing technology.
5. Development of writing and presentation skills for personal and research work.

Content

The contents of the course are given below.

Theme content

1. Discrete one-dimensional applications

    * Unidimensional maps
    * Fix points
    * Periodic solutions
    * Chaos. Universality
    * Fractal dimension

2. Dissipative differential systems

    * Fix points. Linear stability analysis
    * Codimension 1 bifurcations
    * Limit cycles
    * Chaotic attractors. Routes to chaos.

3. Applications to several fields

    * Laser dynamics
    * Population dynamics
    * Excitability in physical and biological systems

4. Spatially extended systems

* Examples of spatio-temporal patterns in fluids, chemical reactions and optical systems
* Introduction to amplitude equations

Teaching methodology

The methodology combines theoretical classes, practical classes, lab demonstrations, individual study, homework and a final project.

In-class work activities

Modality	Name	Typ. Grp.	Description
Theory classes	Theory class	Large group (G)	It aims to exlain to the student the basic concepts of each topic as well as to illustrate how to perform prototypical calculations
Practical classes	practical class	Medium group (M)	The professor solves typical problems and examples so that the student learns the application of the theoretical concepts to some specifical cases.
Laboratory classes	Non linear phenomena demonstrations in the lab	Medium group (M)	The professor performs experiments in the lab to show non linear phenomena in several physical and chemical systems. The objective is that the student understands the relevance of the theoretical concepts in real systems.

Distance education work activities

Modality	Name	Description
Individual self-study	Final project	The student has to carry out a project involving several of the concepts and contents of the curse. The project has to be hand in writting and has to give a talk about it to the professor and the other students. The aim is to consolidate the knoweledge, particularly the application of several concepts to a specific system. It also aims to promote and improve the student's oral and writting skills to explain the results appropriately.
Individual self-study	Homework	It aims that the student consolidates the knowledge applying the theoretical concepts to specific problems and exercises. The methodology is to asign to the student several problems that the student has to solve and hand in writting.
Individual self-study	Understanding of theoretical concepts	In order to learn the concepts explained in class, the student should study these concepts and reproduce by himself the solution to problems and examples given in class.

Specific risks and protective measures

The learning activities of this course do not entail specific health or safety risks for the students and therefore no special protective measures are needed.

Workload estimate

Modality	Name	Hours	ECTS	%
In-class work activities		**30**	**1.2**	**24**
Theory classes	Theory class	22	0.88	17.6
Practical classes	practical class	5	0.2	4
Laboratory classes	Non linear phenomena demonstrations in the lab	3	0.12	2.4
Distance education work activities		**95**	**3.8**	**76**
Individual self-study	Final project	25	1	20
Individual self-study	Homework	40	1.6	32
Individual self-study	Understanding of theoretical concepts	30	1.2	24
	Total	**125**	**5**	**100**

At the beginning of the semester a schedule of the subject will be made available to students through the UIBdigital platform. The schedule shall at least include the dates when the continuing assessment tests will be conducted and the hand-in dates for the assignments. In addition, the lecturer shall inform students as to whether the subject work plan will be carried out through the schedule or through another way included in the Campus Extens platform.

Student learning assessment

Evaluation will be performed on the basis of the exercises the student presents in a writen form as well as on a project that he has to develop.

Final project

Modality	Individual self-study
Technique	Papers and projects **(Non-retrievable)**
Description	The student has to carry out a project involving several of the concepts and contents of the curse. The project has to be hand in writting and has to give a talk about it to the professor and the other students. The aim is to consolidate the knoweledge, particularly the application of several concepts to a specific system. It also aims to promote and improve the student's oral and writting skills to explain the results appropriately.
Assessment criteria	Accuracy and quality of the results.Quality of the presentation of the results.Quality of the written report.

Percentage of final qualification: 50% following path A

Homework

Modality	Individual self-study
Technique	Papers and projects **(Non-retrievable)**
Description	It aims that the student consolidates the knowledge applying the theoretical concepts to specific problems and exercises. The methodology is to asign to the student several problems that the student has to solve and hand in writting.
Assessment criteria	Accuracy of the results.Quality of the explanations and of the interpretation of the results.Quality of the presentation.

Percentage of final qualification: 50% following path A

Resources, bibliography and additional documentation

Some basic as well as some additional references for this curse are included below.

Basic bibliography

S.H. Strogatz, "Nonlinear Dynamics and chaos", Addison Wesley 1994 / Westview Press 2000.
E. Ott, "Chaos in Dynamical Systems", Cambridge (1993).
H.G. Schuster, "Deterministic Chaos, an Introduction", VCH (1988).

Complementary bibliography

P. Manneville, "Dissipative structures and weak turbulence", Academic (1990).
C. O. Weiss, R. Vilaseca, "Dynamics of Lasers", John Wiley & Sons, (1991).
D. Walgraef, "Spatio-Temporal Pattern Formation: With Examples from Physics, Chemistry, and Materials Science", Springer-Verlag (1996).

Other resources