



Academic year	2014-15
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 de presencials (30 hours) 3.8 de no presencials (95 hours) 5 de totals (125 hours).
Group	Group 1, 1S
Teaching period	1st semester
Teaching language	English

## Professors

Lecturers	Horari d'atenció als alumnes					
	Starting time	Finishing time	Day	Start date	Finish date	Office
Pere Colet Rafecas	09:30h	10:30h	Thursday	25/09/2014	18/12/2014	IFISC-210
Emili Hernandez Garcia <a href="mailto:ehg899@uib.es">ehg899@uib.es</a>	09:00h	10:00h	Thursday	01/10/2014	31/07/2015	IFISC, 214
Oreste Piro Perusin <a href="mailto:oreste.piro@uib.es">oreste.piro@uib.es</a>	12:00h	15:00h	Wednesday	01/07/2014	31/07/2015	Mateu Orfila F-320

## 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 course 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 extended systems.

### Essential requirements

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

### Recommendable

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

## Skills

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





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### Specific

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

### Generic

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

### Basic

- \* You may consult the basic competencies students will have to achieve by the end of the Master's degree at the following address: [http://estudis.uib.cat/master/comp\\_basiques/](http://estudis.uib.cat/master/comp_basiques/)

## 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



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\* 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	Hours
Theory classes	Theory class	Large group (G)	It aims to explain to the student the basic concepts of each topic as well as to illustrate how to perform prototypical calculations	22
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 specific cases.	5
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.	3

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.

### Distance education work activities

Modality	Name	Description	Hours
Individual self-study	Final project	The student has to carry out a project involving several of the concepts and contents of the course. The project has to be hand in writing and has to give a talk about it to the professor and the other students. The aim is to consolidate the knowledge, particularly the application of several concepts to a specific system. It also aims to promote and improve the student's oral and writing skills to explain the results appropriately.	25
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 assign to the student several problems that the student has to solve and hand in writing.	40
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.	30





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## 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.

## Student learning assessment

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

### Final project

Modality	Individual self-study
Technique	Papers and projects ( <b>non-retrievable</b> )
Description	The student has to carry out a project involving several of the concepts and contents of the course. The project has to be hand in writing and has to give a talk about it to the professor and the other students. The aim is to consolidate the knowledge, particularly the application of several concepts to a specific system. It also aims to promote and improve the student's oral and writing 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.

Final grade percentage: 50%

### Homework

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

Final grade percentage: 50%

## Resources, bibliography and additional documentation

Some basic as well as some additional references for this course 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).



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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).

