



## Syllabus

### Subject

<b>Subject / Group</b>	11298 - Introduction to Dynamic Systems / 1
<b>Degree</b>	Master's Degree in Advanced Physics and Applied Mathematics
<b>Credits</b>	3
<b>Period</b>	First semester
<b>Language of instruction</b>	English

### Professors

Lecturers	Office hours for students					
	Starting time	Finishing time	Day	Start date	End date	Office / Building
Bartomeu Coll Vicens <a href="mailto:tomeu.coll@uib.es">tomeu.coll@uib.es</a>						You need to book a date with the professor in order to attend a tutoring session.
Rafel Jaume Prohens Sastre <a href="mailto:rafel.prohens@uib.cat">rafel.prohens@uib.cat</a>						You need to book a date with the professor in order to attend a tutoring session.

### Context

This course, which is a part of the module Dynamical Systems, has the aim to introduce advanced concepts tools concerning Dynamical Systems.

A particular emphasis will be done in the local and global stability Theory and their relationship with structural stability of dynamical systems.

Applications and practical problems will also be of particular interest in this course. One of the main goals is to provide, through seminars and practical sessions, a good skill in these two aspects.

This course will be taught by two professors whose publications in journals on the subject ensure proper development of the topics.

### Requirements

#### Recommended

It is highly recommended to have attended a course in differential equations.

### Skills

#### Specific

- \* EMA1 Ability to understand the specific language of the treated application (neuroscience, images, dynamic systems) and ability to work in the field interdisciplinary .



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- \* EMA3 Ability to relate the theory of dynamical systems with applications in the different covered fields: mechanics, circuit theory, neuroscience .
- \* CE1 - Students must possess the learning skills that enable them to combine specialized knowledge in Astrophysics and Relativity, Geophysical Fluids, Materials Physics, Quantum Systems or Applied Mathematics, with the versatility that provides an open training curriculum .
- \* CE2 - Students must possess the ability to use and adapt mathematical models to describe physical phenomena of different nature .
- \* CE3 - To acquire edge-line knowledge in the international scientific research context and demonstrate a full comprehension of theoretical and practical aspects, together with the scientific methodology .

### Generic

- \* CG1. A systematic understanding of a field of study and mastery of skills and methods of research associated with that field .
- \* CB6 - Possess the knowledge and its understanding to provide the basis or opportunity to be original in developing and/or applying ideas, often within a research context .
- \* CB7 - Students can apply the broader (or multidisciplinary) acquired knowledge and ability to solve problems in new or unfamiliar environments within contexts related to their field of study .
- \* CB9 - Students can communicate their knowledge to specialized and non-specialized audiences in a clear way and without ambiguities. .
- \* CB10 - Students gain the learning skills that enable them to continue studying in a way that will be largely self-directed or autonomous. .

### 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

### Range of topics

1. Introduction to the Qualitative Theory of ODEs
  - \* Vectorial field, flow
  - \* Dynamical System
  - \* Phase portrait, equivalence, local structure of equilibrium points, Hartman-Grobman Theorem
2. Return map
  - \* Transversal section
  - \* Tubular flow box Theorem
  - \* Return map and periodic orbits
3. Poincaré-Bendixson Theorem
  - \* alpha- and omega-limit set
  - \* Poincaré-Bendixson Theorem
  - \* Applications
4. Stability Theory
  - \* Lyapunov functions
  - \* Stability Theory
  - \* Perturbation Theory
  - \* Limit cycles
  - \* Poincaré compactification, local charts, critical points at infinity

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\* Structural stability Theory

### Teaching methodology

In-class work activities (1 credits, 25 hours)

Modality	Name	Typ. Grp.	Description	Hours
Theory classes		Large group (G)	The basic theoretical concepts will be explained so that they could be applied to several concrete problems.	17
Seminars and workshops		Medium group (M)	These sessions will be devoted to evaluate the practical skills	2
Practical classes		Large group (G)	These sessions will be devoted to develop the practical skills	4
Assessment		Large group (G)	These sessions will be devoted to evaluate the theoretical and practical skills through an oral presentation of a memory.	2

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 Aula Digital platform.

Distance education tasks (2 credits, 50 hours)

Modality	Name	Description	Hours
Individual self-study		Students will devote part of their home study to study in depth the concepts explained in theory class. Students will devote part of their time to solving various problems that will be done throughout the course.	50

### 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

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### Frau en elements d'avaluació

In accordance with article 33 of Academic regulations, "regardless of the disciplinary procedure that may be followed against the offending student, the demonstrably fraudulent performance of any of the evaluation elements included in the teaching guides of the subjects will lead, at the discretion of the teacher, a undervaluation in the qualification that may involve the qualification of "suspense 0" in the annual evaluation of the subject".

### Seminars and workshops

Modality	Seminars and workshops
Technique	Oral tests ( <b>non-retrievable</b> )
Description	These sessions will be devoted to evaluate the practical skills
Assessment criteria	
Final grade percentage:	60%

### Assessment

Modality	Assessment
Technique	Papers and projects ( <b>non-retrievable</b> )
Description	These sessions will be devoted to evaluate the theoretical and practical skills through an oral presentation of a memory.
Assessment criteria	These sessions will be devoted to evaluate the theoretical and practical skills through an oral presentation of a memory.
Final grade percentage:	40%

## Resources, bibliography and additional documentation

### Basic bibliography

- \* "Qualitative Theory of Planar Differential Systems" Springer (Universitext); Freddy Dumortier, Jaume Llibre, Joan C. Artés. ISBN-10: 3540328939 | ISBN-13: 978-3540328933 | Edition: 2006
- \* "Practical Bifurcation and Stability Analysis, from equilibrium to chaos" Springer-Verlag (Interdisciplinary Applied Mathematics, Vol. 5); R. Seydel, December 10, 2009 | ISBN-10: 144191739X | ISBN-13: 978-1441917393 | Edition: 3rd
- \* "Differential Equations, Dynamical Systems and Linear Algebra", Academic Press 1974, M. W. Hirsch, S. Smale