

# Linear Algebra and Dynamical Systems

## 21892

**Degree/study:** Grau en Economia  
**Course:** 3<sup>rd</sup> or 4<sup>th</sup> (MQA program)  
**Term:** first  
**Number of ECTS credits:** 5 credits  
**Hours of student's dedication:** 125 hours  
**Language or languages of instruction:** English  
**Professor:** Eulàlia Nualart and Mireia Besalú

### 1. Presentation of the subject

This course is dedicated to the principles of dynamical systems. The material includes examples of growth models and their analysis via systems of differential equations. Basic notions such as equilibrium, stability, bifurcations, sources, sinks, etc. are discussed. Linear systems of differential equations are thoroughly analysed and some aspects of nonlinear systems are discussed as well. The course also covers basic mathematical tools including principles of linear algebra, eigenvalues and eigenvectors of matrices, and complex numbers.

### 2. Competences to be attained

After following this course, the students should be able to read and understand a rigorous mathematic exposition in the field of linear algebra and dynamical systems. Understand the elements that form a dynamical system, the methods in order to solve it exactly or numerically and the basic properties that characterize it. The students should also be able to identify the characteristics of the models in dynamical systems that have applications to economy and administration.

### 3. Contents

1. Examples of simple differential equations, logistic growth model, equilibrium, stability.
2. Planar systems: linear systems of two differential equilibrium and their classification. Sources, sinks, saddle points.
3. Complex numbers. Complex eigenvalues and eigenvectors.
4. Higher-dimensional linear algebra: linear independence, quadratic matrices, determinants, eigenvalues, eigenvectors.
5. Higher-dimensional linear systems. Canonical forms.
6. The exponential function of a matrix. Autonomous and non-autonomous linear systems.
7. Non-linear systems. The variational equation and stability.

## **4. Assessment**

15%: Weekly exercises, 85%: Final exam.

For that student whose final global grade is less strictly than 5, and took the final exam, there will be a recuperation exam during the second term that will count as 85% as well. The grade of the weekly exercises cannot be modified.

## **5. Bibliography and teaching resources**

### **5.1. Basic bibliography**

Large part of the material of the course is based on the book Hirsch, Smale, and Devaney: "Differential equations, dynamical systems, & an introduction to chaos"

### **5.2. Teaching resources**

Aula global

## **6. Methodology**

In class there will be 20 lectures and 6 seminars. The lectures will essentially follow the first chapters of the book mentioned in the bibliography. Before each seminar a list of exercises will be distributed. The students do the exercises at home individually or in groups of 2 and they are graded. These exercises will be corrected and commented during the seminars.

## **7. Activities Planning**

20 lectures and 6 seminars. Individually work and study at home for each student to do the list of exercises and study the lectures.