

## 27009 - Ordinary Differential Equations

### Información del Plan Docente

Academic Year	2016/17
Academic center	100 - Facultad de Ciencias
Degree	453 - Degree in Mathematics
ECTS	9.0
Course	2
Period	Annual
Subject Type	Compulsory
Module	---

### 1. Basic info

#### 1.1. Recommendations to take this course

#### 1.2. Activities and key dates for the course

### 2. Initiation

#### 2.1. Learning outcomes that define the subject

#### 2.2. Introduction

### 3. Context and competences

#### 3.1. Goals

#### 3.2. Context and meaning of the subject in the degree

#### 3.3. Competences

#### 3.4. Importance of learning outcomes

### 4. Evaluation

### 5. Activities and resources

#### 5.1. General methodological presentation

The course contains theoretical classes, including examples, exercise sessions in small groups, as well as computer sessions in small groups. Interaction between the teacher and the student is encouraged. Exercises proposed to the students will be presented to the group. Students will be attended by the teacher at office hours.

#### 5.2. Learning activities

During the lectures the teacher will provide explanations about the theory and abundant examples. Exercises will be solved by the student and presented to the group. After every computer session the student will elaborate a report.

**5.3.Program****I.- Linear systems: constant coefficients****1. Linear differential equations with constant coefficients**

First-order homogeneous equation  
First-order nonhomogeneous equation  
Second order equations

**2. Homogeneous linear systems: obtaining solutions**

Eigenvectors and eigensolutions  
Generalized eigenvectors  
Generalized eigensolutions

**3. Exponential Matrix**

Convergence  
Exponential matrix definition and first properties  
Exponential matrix via generalized eigensolutions  
Differential of the exponential matrix

**4. Linear systems**

Solution of homogeneous system  
Solution of a nonhomogeneous system  
Higher-order differential equations

**5. Qualitative theory**

Notion of stability  
Stability and spectrum  
Phase portrait. Classification of 2-d systems.

**6. Laplace transform**

Laplace transform defined  
Calculus of Laplace transform  
Calculus of inverse Laplace transform  
Solution of initial value problems  
Stability

**II.- Linear systems: general case**

**7. Linear equations**

Homogeneous equations  
Nonhomogeneous equations  
Grönwall inequality

**8. Linear systems**

Existence and uniqueness of solutions (homogeneous system)  
Superposition principle. Resolvent matrix  
Nonhomogeneous equations  
Higher-order equations  
Stability\*

**9. Periodic systems\***

Periodic solutions  
Structure of the solution  
Stability and resonance

**III.- Nonlinear systems****10. Autonomous equations**

Some examples and properties  
Existence and uniqueness. Asymptotes  
Qualitative analysis

**11. Nonautonomous equations**

Exact equations  
Integrating factors  
Other methods (separable, homogeneous,...)

**12. Existence and uniqueness**

Lipchitz functions  
Existence and uniqueness: Picard theorem  
Maximal solution

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### 13. Numerical methods

Euler methods and Taylor method  
Convergence  
Runge-Kutta method  
Multistep methods\*

### 14. Regularity of the general solution

Continuous dependence  
Smooth dependence.  
The variational equation  
Trivialization\*

### 15. Qualitative theory

Autonomous systems  
Stability of equilibria: linearization method  
Stability of equilibria: Lyapunov functions  
Phase diagram

## 5.4.Planning and scheduling

Two weekly lectures plus a weekly exercise session. Four computer session (2 hours) during the course.

## 5.5.Bibliography and recommended resources

- Simmons, George F.. Ecuaciones diferenciales : con aplicaciones y notas históricas / George F. Simmons ; con un capítulo sobre métodos numéricos de John S. Robertson ; traducción Lorenzo Abellanas Rapun . - 2a ed. Madrid [etc.] : McGraw-Hill, D.L. 2000
- Boyce, William E.. Ecuaciones diferenciales y problemas con valores en la frontera / William E. Boyce, Richard C. DiPrima ; colaboración en la traducción Hugo Villagómez Velázquez . - 4a ed. México [etc.] : Limusa, cop.1998
- Braun, Martin. Ecuaciones diferenciales y sus aplicaciones / M. Braun ; Traductor Ignacio Barradas Bribiesca . - [1a ed.] México : Grupo Editorial Iberoamérica, 1990
- Hirsch, Morris W.. Ecuaciones diferenciales, sistemas dinámicos y álgebra lineal / Morris W. Hirsch, Stephen Smale ; versión española, Carlos Fernández Pérez Madrid : Alianza, 1983
- Guzmán, Miguel de. Ecuaciones diferenciales ordinarias : teoría de estabilidad y control / M. de Guzmán . - [1a. ed., reimp.] Madrid : Alhambra, 1987
- Calvo Pinilla, M.. Curso de ecuaciones diferenciales ordinarias / Manuel Calvo Pinilla y Jesús Carnicer Álvarez Zaragoza : Prensas Universitarias de Zaragoza, 2010
- Zill, Dennis G.. Ecuaciones diferenciales con aplicaciones de modelado / Dennis G. Zill . - 6a ed. México [etc.] : International Thomson Editores, cop. 1997
- Marcellan, Francisco. Ecuaciones diferenciales : problemas lineales y aplicaciones / Francisco Marcellan, Luis Casasus, Alejandro Zarzo . - 1ª ed. en español, [reimp.] Madrid [etc.] : McGraw-Hill, D. L. 1991

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