COMILLAS
UNIVERSIDAD PONTIFICIA
ICAI ICADE CIHS

Syllabus
2024 - 2025

GENERAL INFORMATION

Data of the subject	
Subject name	Differential Equations
Subject code	DMA-GITT-212
Mainprogram	Bachelor's Degree in Engineering in Telecommunication Technologies
Involved programs	Grado en Ingeniería en Tecnologías de Telecomunicación [Second year] Grado en Ingeniería en Tecnologías de Telecom. y Grado en Análisis de Negocios/Business Analytics [Second year]
Level	Reglada Grado Europeo
Quarter	Semestral
Credits	6,0 ECTS
Type	Básico
Department	Department of Applied Mathematics
Coordinator	Ángela Jiménez Casas

Teacher Information	
Teacher	
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Teacher	
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DESCRIPTION OF THE SUBJECT

Contextualization of the subject

Prerequisites

This course is an introduction to ordinary differential equations (ODEs) and partial differential equations (PDEs). It has two main goals. On the one hand, the course focuses on modelling in terms of ordinary or partial differential equations, a wide variety of problems and phenomena in the fields of physics and engineering. On the other hand, the course focuses on providing the main technical tools and skills for the exact or approximate resolution of such equations. Besides, the stability concept for stationary solutions of nonlinear planar autonomous systems will be studied, in order to obtain qualitative information about the solutions of such kind of systems.

Prerequisites:

Basic knowledge of linear algebra, geometry and calculus:

- Vector space concept. Coordinates of a vector in a basis. Euclidean vector space concept. Inner products. Orthogonal basis. Eigenvalues and eigenvectors. The Jordan Canonical Form. Affine space concept.
- Explicit, implicit and parametric form of a curve in the plane.
- Geometric interpretation of the derivative and of the partial derivatives. The Chain Rule for derivatives.
- Tangent line and orthogonal line equations to a function in a point of its graph.
- Jacobian Matrix of a vector field.
- Integration: elementary techniques.

Course contents

Contents

Theory

1. First Order Differential Equations.
2. Higher Order Linear Differential Equations.
3. The Laplace Transform. Operational properties and application to solve initial value problems.
4. Linear and Nonlinear Systems of First Order Differential Equations. Stability of critical points of planar autonomous systems.
5. Introduction to Fourier expansions. Eigenvalues and eigenfunctions of one-dimensional boundary value problems.
6. Introduction to Partial Differential Equations. Evolution PDEs. The Heat Equation and the Wave Equation. The Separation of Variables Method for solving the Heat and the Wave equations in the one-dimensional case. Stationary PDEs. The Laplace/Poisson equations. The Separation of Variables Method for solving the Laplace/Poisson equations in planar domains.
7. Numerical solutions to initial and boundary value problems (This part will be developed in two 2-hour laboratory sessions (P1 and P2)).

Laboratory

There will be two 2-hour sessions during the semester, between the third and the last lecture week.

1. Numerical solutions to initial value problems: Euler Method and Runge-Kutta Method.
2. Numerical solutions to one-dimensional boundary value problems: Finite Difference Method.

The laboratory work will be assessed by one 1-hour Lab term exam with Matlab. This lab term exam will consist in obtaining the numerical solutions to some initial and boundary value problems through the implementation with the *Matlab* software of the numerical methods studied in P1 and P2.

EVALUATION AND CRITERIA

Evaluation activities	Evaluation criteria	Weight
Theoretical-practical exams: • Mid term exam (1.5-hour long) (25%) • Final term exam (60%)	• Understanding of concepts • Application of concepts, techniques and procedures to problem solving • Analysis and interpretation of the results obtained in the resolution of problems • Presentation and written communication	85

Continuous performance evaluation: • Short continuous assessment tests	• Understanding of concepts • Application of concepts, techniques and procedures to problem solving • Analysis and interpretation of the results obtained in the resolution of problems • Presentation and written communication	10
Evaluation of the experimental wok: • Practice exam with MATLAB	• Understanding of concepts • Application of concepts, techniques and procedures to practice problem solving • Mastery in solving problems with the help of the computer and specific software • Analysis and interpretation of the results obtained in the problems solved with a computer	5

Grading

- The grade obtained in the final exam must be at least 4 over 10 to take into account the previous ponderations of the overall assessment criteria. In other case, the overall grade will be the grade obtained in the exam.
- The following conditions must be accomplished to pass the course:
  - A minimum overall grade of at least 5 over 10.
  - A minimum grade in the final term exam of 4 over 10.

BIBLIOGRAPHY AND RESOURCES

Basic References

Textbooks:

- Dennis G. Zill and Warren S. Wright. Differential Equations with Boundary-Value Problems. International Editions. 8th Edt. Brooks/Cole
- William E. Boyce and Richard C. DiPrima. Elementary Differential Equations and Boundary Value Problems. International Student Version. 10th Edt. Wiley.