COMILLAS
UNIVERSIDAD PONTIFICIA
ICAI
DEPARTAMENTO DE MATEMÁTICA APLICADA

DMA-GITI-212, DMA-GITT-212 Differential Equations

SEMESTER: Fall

CREDITS: 6 ECTS (4 hrs. per week)

LANGUAGE: Spanish

DEGREES: GITI, GITT

Course overview

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

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.

P1. Numerical solutions to initial value problems: Euler Method and Runge-Kutta Method.

P2. 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.

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.

Grading

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 exam of 4 over 10.

The overall grade is obtained as follows:

- Final exam 60%.
- Mid-term exam (1.5-hour long) 25%.
- Additional short-term exams (included a Lab term exam) 15%.