# Partial differential equations

**Academic Year: ( 2020 / 2021 )** **Review date: 24-07-2020**

**Department assigned to the subject:**

**Coordinating teacher: PABLO MARTINEZ, ARTURO DE**

**Type: Electives ECTS Credits : 6.0**

**Year : 1 Semester : 2**

## REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

ODEs and PDEs (basic level)

## OBJECTIVES

- Understanding of different type of PDEs
- Understanding of different sense for the solutions of PDEs
- Introduction to non-linear PDEs

## DESCRIPTION OF CONTENTS: PROGRAMME

1. Introduction
   1.a. Partial differential equations
   1.b. Strategies and difficulties
1. Introduction
   1.a. Partial differential equations
   1.b. Strategies and difficulties
   1.c. Different concepts of solution
   1.d. Sobolev spaces
2. Elliptic equations
   2.a. Laplace equation. Properties of harmonic functions
   2.b. Green' function
   2.c. Dirichlet principle
   2.d. General elliptic equations. Regularity
3. Parabolic equations
   3.a. Heat equation in bounded domains
   3.b. Maximum principle
   3.c. Het equation in the whole space
   3.d. Gauss kernel. Self-similarity
   3.e. Asymptotic behaviour
4. Hyperbolic equations
   4.a. Wave equation in bounded domains
   4.b. d'Alembert formula in the line
   4.c. Wave equation in the space. Spherical means
   4.d. Huygens principle
5. Semigroup theory
   5.a. Heat equation
   5.b. Wave equation
6. Advanced problems
   4.a. Nonlineasr elliptic equations
   4.b. Semilinear parabolic equations. Blow-up problems
   4.c. Quasilinear parabolic equations. Porous medium equation.

## LEARNING ACTIVITIES AND METHODOLOGY

The docent methodology will include:

* Master classes, where the knowledge that the students must acquire will be presented. To make easier the development of the class, the students will have written notes and also will have the basic texts of reference that will facilitate their subsequent work.

* Resolution of exercises by the students, in which proposed problems are discussed and developed (by

the professor and by the students). These classes allow to the students to acquire the necessary skills.

* Additionally, 1.4 ECTS will be used for tutorial learning activities. These tutorial activities will be supervised and they will have theoretical and practical content.
3.2 ECTS will be used for the personal study of the students, which will have access to computer rooms.

## ASSESSMENT SYSTEM

Oral presentations and written problem solving throughout the course in addition to the preparation of a work and oral presentation. Final Exam.

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|---|---|
| **% end-of-term-examination:** | 60 |
| **% of continuous assessment (assigments, laboratory, practicals…):** | 40 |

## BASIC BIBLIOGRAPHY


- Brezis, H. Functional analysis, Sobolev spaces and partial differential equations, Universitext. Springer, 2011

- Evans, L.C. Partial Differential Equations, American Mathematical Society, 1998

- Gilbarg, D.; Trudinger, N.S. Elliptic partial differential equations of second order , Springer-Verlag, 2001


## ADDITIONAL BIBLIOGRAPHY


- Brezis, H.. Functional analysis, Sobolev spaces and partial differential equations, Universitext. Springer, 2011

- DiBenedetto, E. Partial differential equations, Birkhäuser, 1995

- Vázquez, J.L. The Porous Medium equation: mathematical theory, Oxford Mathematical Monographs, 2007

- de Pablo, A. An introduction to the problem of blow-up for semilinear and quasilinear parabolic equations, MAT. Serie A, 12, 2006