Differential Equations

Academic Year: (2021 / 2022) **Review date: 29-06-2021**

Department assigned to the subject: Mathematics Department

Coordinating teacher: CUESTA RUIZ, JOSE ANTONIO

Type: Basic Core ECTS Credits : 6.0

Year : 2 Semester : 1

Branch of knowledge: Engineering and Architecture

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

Calculus I, Cálculus II and Linear Algebra

OBJECTIVES

SPECIFIC LEARNING OBJECTIVES (PO a):
- To understand the Linear operators and the principle of superposition for solving differential equations.
- To solve elementary differential equations by separation of variables and other methods.
- To understand the different application scopes of the differential equation to engineering and physics.
- To distinguish between elliptic, hyperbolic and parabolic partial differential equations and which initial or boundary conditions are appropriate for them.
- To understand how to apply separation of variables and the Fourier method to solve initial-boundary value problems for the equations of Mathematical Physics.
- To understand the separation of variables technique, the role of the resulting eigenvalue problems and the principle of superposition to solve initial-boundary value problems for the equations of Mathematical Physics.
- To understand when and how to use the method of characteristics to solve different cases of partial differential equations.

GENERAL ABILITIES (PO a, g, k):
- To understand the necessity of abstract thinking and formal mathematical proofs.
- To acquire communicative skills in mathematics.
- To acquire the ability to model real-world situations mathematically, with the aim of solving practical problems.
- To improve problem-solving skills.

(PO: a)

DESCRIPTION OF CONTENTS: PROGRAMME

1. Introduction
   1.1 Basic models; direction fields
   1.2 Classification of differential equations

2. First Order Differential Equations
   2.1 Linear equations; integrating factors
   2.2 Separable equations
   2.3 Exact equations

3. Second Order Linear Equations
   3.1 Definitions and examples
   3.2 Linear homogeneous equations
   3.3 Homogeneous equations with constant coefficients
   3.4 Inhomogeneous equations: undetermined coefficients
   3.5 Variation of constants

4. Systems of First Order Linear Equations
   4.1 Basic theory; higher-order equations
   4.2 Explicit solutions of non-homogeneous linear systems
   4.3 Planar linear systems

5. Nonlinear Systems and Stability
   5.1 Planar nonlinear systems
   5.2 Stability
   5.3 Periodic solutions
   5.4 Higher-dimensional systems

6. Partial Differential Equations: Introduction
   6.1 Examples and physical derivation
   6.2 Types of equations and data; well- vs ill-posed problems

7. Separation of Variables
   7.1 Problem resolution by separation of variables
   7.2 Fourier trigonometric series: basic properties

8. Boundary-value Problems
   8.1 Sturm-Liouville problems
   8.2 Self-adjoint operators and spectrum
   8.3 Rayleigh¿s quotient
   8.4 Generalized Fourier series
   8.5 Multivariable Sturm-Liouville problems

9. Non-Homogeneous Problems
   9.1 Shifting the data
   9.2 Fredholm¿s alternative
   9.3 Eigenfunction expansions

LEARNING ACTIVITIES AND METHODOLOGY

1.- Master classes.
2.- Problem classes.
3.- Partial controls.
4.- Final exam.
5.- Tutorials.

ASSESSMENT SYSTEM

Two mid-term tests, 2x20%
Final exam, 60%

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

BASIC BIBLIOGRAPHY

- Haberman, R. Ecuaciones en derivadas parciales con series de Fourier y problemas de contorno, Prentice Hall, 2003
- Robinson, J. C. An Introduction to Ordinary Differential Equations, Cambridge University Press, 2004
- Simmons, G. F. ; Krantz, S. G. Ecuaciones diferenciales. Teoría, técnica y práctica, McGraw-Hill, 2007

ADDITIONAL BIBLIOGRAPHY

- Brannan, J. R., Boyce, W. E. Differential Equations with Boundary Value Problems: An Introduction to Modern Methods & Applications, Wiley., 2010
- Edwards, C. H., Penney, D. E., Calvis, D. Differential Equations and Boundary Value Problems: Computing and Modeling, Pearson Education, 2016
- Nagle, R. K., Saff, E. B., Snider, A. D. Fundamentals of differential equations , Pearson Addison-Wesley, 2008, 7th ed.
- Tikhonov, A. N., Samarskii, A. A. Equations of Mathematical Physics, Dover, 1990