Differential Equations

Academic Year: (2023 / 2024) **Review date: 19-12-2023**

Department assigned to the subject: Mathematics Department

Coordinating teacher: ROMERA COLMENAREJO, ELENA

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, Calculus II and Linear Algebra

SKILLS AND LEARNING OUTCOMES

RA1: Acquire knowledge and understanding of the basic general fundamentals of engineering and biomedical sciences.
RA2: Be able to solve basic engineering and biomedical science problems through a process of analysis, identifying the problem, establishing different methods of resolution, selecting the most appropriate one and its correct implementation.
CB1: Students have demonstrated possession and understanding of knowledge in an area of study that builds on the foundation of general secondary education, and is usually at a level that, while relying on advanced textbooks, also includes some aspects that involve knowledge from the cutting edge of their field of study.
CB2: Students are able to apply their knowledge to their work or vocation in a professional manner and possess the competences usually demonstrated through the development and defence of arguments and problem solving within their field of study.
CG1: Adequate knowledge and skills to analyse and synthesise basic problems related to engineering and biomedical sciences, solve them and communicate them efficiently.
CG3: Knowledge of basic scientific and technical subjects that enables them to learn new methods and technologies, as well as providing them with great versatility to adapt to new situations.
CG4: Ability to solve problems with initiative, decision-making, creativity, and to communicate and transmit knowledge, skills and abilities, understanding the ethical, social and professional responsibility of the biomedical engineer's activity. Capacity for leadership, innovation and entrepreneurial spirit.
CG8: Ability to solve mathematical, physical, chemical and biochemical problems that may arise in biomedical engineering.
CG12: Ability to solve mathematically formulated problems applied to biology, physics and chemistry, using numerical algorithms and computational techniques.
ECRT1: Ability to solve mathematical problems that may arise in engineering and biomedicine. Ability to apply knowledge of: linear algebra; geometry; differential and integral calculus; differential and partial derivative equations; numerical methods; numerical algorithms; statistics and optimisation.
CT1: Ability to communicate knowledge orally and in writing to both specialised and non-specialised audiences.

OBJECTIVES

SPECIFIC LEARNING GOALS (PO a):
- To understand the fundamental theorems of existence and uniqueness in differential equations, paying particular attention to the concept of well-posed model.
- To understand the importance of differential equations in the field of biomedical engineering.
- To understand the concept of linear operators and their relation with the superposition principle for solving differential equations.
- To solve elementary differential equations by standard methods.
- To know the basic differential equations of mathematical engineering and physics as well as the initial and contour problems they lead to.
- To solve partial differential equations by separation of variables and Fourier analysis.

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.

DESCRIPTION OF CONTENTS: PROGRAMME

I) DIFFERENTIAL EQUATIONS OF FIRST ORDER

1.1 Introduction
1.2 Elementary methods of resolution
1.3 Other kinds of equations
1.4 Applications

II) HIGHER ORDER DIFFERENTIAL EQUATIONS

2.1 Introduction
2.2 Equations with constant coefficients
2.3 Equations with variable coefficients
2.4 Systems
2.5 Applications

III) LAPLACE TRANSFORM

3.1 Definition and Basic Properties
3.2 Resolution of equations and linear systems
3.3 Advanced properties

IV) METHOD OF SEPARATION OF VARIABLES

4.1 Introduction to Partial Differential Equations
4.2 Method of separation of variables
4.3 Fourier series
4.4 More examples of separation of variables
5.5 Advanced properties of partial differential equations

V) STURM-LIOUVILLE EIGENVALUE PROBLEMS

5.1 Introduction
5.2 Generalized Fourier series
5.3 Rayleigh Quotient and Minimization Principle
6.5 Bessel equation

LEARNING ACTIVITIES AND METHODOLOGY

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

ASSESSMENT SYSTEM

Two mid-term tests, 2 x 20%
Final exam, 60%

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

BASIC BIBLIOGRAPHY

- HABERMAN, R. Elementary Applied Partial Differential Equations, with Fourier Series and Boundary Problems 3rd. Ed., Prentice Hall, 1998
- SIMMONS, G. F. ; KRANTZ, S. G. Differential Equations, Theory, Technique and Practice, 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. Differential Equations and Boundary Value Problems, Pearson Education, 2014

- NAGLE, R. K., SAFF, E. B., SNIDER, A. D. Fundamentals of Differential Equations , Pearson Addison-Wesley, 2008, 7th ed.
- SIMMONS, G. F. Differential Equations with Applications and Historical Notes 2017, 3rd edition, CRC Press Textbooks in mathematics,, 2017, 3rd edition