Applied differential calculus

Academic Year: (2021 / 2022) **Review date: 26-06-2021**

Department assigned to the subject: Department of Mathematics

Coordinating teacher: CARRETERO CERRAJERO, MANUEL

Type: Basic Core ECTS Credits : 6.0

Year : 2 Semester :

Branch of knowledge: Engineering and Architecture

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

Calculus (Course 1 - Semester 1)
Linear Algebra (Course 1 - Semester 1)

OBJECTIVES

The specific competences of the subject have been divided into three sections:

KNOWLEDGE:
- Know how to solve linear and nonlinear ordinary differential equations of first order and interpret results.
- Know how to solve linear ordinary differential equations of second order.
- Know how to calculate the Laplace transform and how to use it to solve differential equations.
- Know how to solve systems of linear differential equations of first order.
- Understand the concept of Fourier series and using it to solve differential equations.
- Know how to use numerical methods to compute approximate solutions of non-linear differential equations.

SPECIFIC ABILITIES:
- Increase the level of abstraction.
- To be able to solve practical problems using differential equations.

GENERAL ABILITIES:
- Ability to communicate orally and in writing correctly using signs and the language of Mathematics.
- Ability to model a real situation described in words by differential equations.
- Ability to interpret the mathematical solution of a problem, their reliability and limitations.

DESCRIPTION OF CONTENTS: PROGRAMME

1.- First order differential equations:
  a. Introduction.
  b. Linear equations.
  c. Separable equations.
  d. Exact equations.
  e. Homogeneous equations.

2.- Second order differential equations.
  a. Linear and nonlinear equations.
  b. Homogeneous and non-homogeneous linear Equations.
  c. Reduction of order.
  d. Euler-Cauchy equations.

3.- The Laplace Transform:
  a. Definition. Properties.
  b. Application to differential equations.

4.- Systems of differential equations:
  a. Linear and nonlinear systems.
  b. Vectorial representation.
  c. Eigenvalues and linearization.

5. Fourier series and separation of variables:
   a. Basic results.
   b. Fourier Sine and Cosine Series.
   c. Applications of Fourier series to partial differential equations.

6.- Numerical methods:
   a. Euler method.
   b. Runge-Kutta method.
   c. Boundary value problems.

LEARNING ACTIVITIES AND METHODOLOGY

1.- Teaching in big or aggregate groups. Lectures sessions (3 ECTS).
2.- Face-to-face teaching in small groups. Problem sessions with individual and group work (3 ECTS).

Office hours: Each teacher offers a number of office hours according to the regulations of the Carlos III University. In particular, a minimum of one hour per group with the time schedule compatible with the students.

ASSESSMENT SYSTEM

We follow a continuous-assessment system (40%) plus a final exam (60%) :

- The continuous-assessment part consists in two mid-term exams that will be held in regular class hours, according to the current regulations and will contribute a weight of 40% to the final mark. These mid-term tests allow the students to modify their own learning strategies, if necessary.

- The final exam (contributing with weight 60% to the final mark) will be held at the end of the semester, and allows to assess
globally the knowledge of the course topics, skills, and capabilities adquired by the students.

- In both the mid-term and final exams, competence CBG1 will be evaluated.

- There is an extraordinary final exam in June for those students who did not obtain the required end-of-semester mark.
This extrarodinay final exam has a maximum mark of 10, and the June final mark is given by max (EE, 0.6 EE + 0.4 CA), where EE (resp. CA) is the extrarodinary final-exam (resp. continuous-assessment) mark.

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

BASIC BIBLIOGRAPHY

- Boyce, William E. Elementary differential equations and boundary value problems , John Wiley & Sons,.

- Simmons, George Finlay Differential equations with applications and historical notes., McGraw-Hill.

- Zill, Dennis G. Ecuaciones diferenciales con aplicaciones de modelado , International Thomson.

ADDITIONAL BIBLIOGRAPHY

- Haberman, Richard Elementary applied partial differential equations with Fourier series and boundary value problems 3rd ed, Prentice Hall.

- Gockenbach, Mark S. Partial differential equations : analytical and numerical methods, SIAM.

- Kiseliov, Aleksandr I. Problemas de ecuaciones diferenciales ordinarias , Mir.

- Weinberger, Hans F. A first course in partial differential equations with complex variables and transform methods, Dover.

BASIC ELECTRONIC RESOURCES

- Manuel Carretero, Luis L. Bonilla, Filippo Terragni, Segei Iakunin, Rocío Vega . Curse OCW-UC3M Applied Differential Calculus: http://ocw.uc3m.es/matematicas/applied-differential-calculus