Partial differential equations

Academic Year: (2023 / 2024) **Review date: 09/02/2024 13:13:46**

Department assigned to the subject: Mathematics Department

Coordinating teacher: PABLO MARTINEZ, ARTURO DE

Type: Compulsory ECTS Credits : 6.0

Year : 3 Semester : 2

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

Besides the Basic Core matters: Vector calculus (year 1, semester 2), Integration and measure (year 2, semester 1), Ordinary differential equations (year 3, semester 1).

LEARNING OUTCOMES

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.
CB3. Students have the ability to gather and interpret relevant data (usually within their field of study) in order to make judgements which include reflection on relevant social, scientific or ethical issues.
CB4. Students should be able to communicate information, ideas, problems and solutions to both specialist and non-specialist audiences.
CB5. Students will have developed the learning skills necessary to undertake further study with a high degree of autonomy.
CG1. Students are able to demonstrate knowledge and understanding of concepts in mathematics, statistics and computation and to apply them to solve problems in science and engineering with an ability for analysis and synthesis.
CG2. Students are able to formulate in mathematical language problems that arise in science, engineering, economy and other social sciences.
CG4. Students are able to show that they can analyze and interpret, with help of computer science, the solutions obtained from problems associated to real world mathematical models, discriminating the most relevant behaviours for each application.
CG5. Students can synthesize conclusions obtained from analysis of mathematical models coming from real world applications and they can communicate in verbal and written form in English language, in an clear and convincing way and with a language that is accessible to the general public.
CG6. Students can search and use bibliographic resources, in physical or digital support, as they are needed to state and solve mathematically and computationally applied problems arising in new or unknown environments or with insufficient information.
CE1. Students have shown that they know and understand the mathematical language and abstract-rigorous reasoning as well as to apply them to state and prove precise results in several areas in mathematics.
CE4. Students have shown that they understand the fundamental results from the theory of ordinary differential equations as well as the theory of partial derivative and stochastic equations.
CE7. Students are able to construct mathematical models of both discrete and continuous processes that appear in real world applications emphasizing the use of deterministic and stochastic difference and differential equations.

RA1. Students must have acquired advanced cutting-edge knowledge and demonstrated indepth understanding of the theoretical and practical aspects of working methodology in the area of applied mathematics and computing.
RA2. Through sustained and well prepared argument and procedures, students will be able to apply their knowledge, their understanding and the capabilities to resolve problems in complex specialized

professional and work areas requiring the use of creative and innovative ideas.
RA3. Students must have the capacity to gather and interpret data and information on which they base their conclusions, including where relevant and necessary, reflections on matters of a social, scientific, and ethical nature in their field of study.
RA4. Students must be able to perform in complex situations that require developing novel solutions in the academic as well as in the professional realm, within their field of study.
RA5. Students must know how to communication with all types of audiences (specialized or not) their knowledge, methodology, ideas, problems and solutions in the area of their field of study in a clear and precise way.
RA6. Students must be capable of identifying their own education and training needs in their field of study and the work or professional environment and organize their own learning with a high degree of autonomy in all types of contexts (structured or not).
RA7. Students must possess the professional maturity necessary to choose and evaluate their work objectives in a reflexive, creative, self-determined and responsible way, for the betterment of society.

DESCRIPTION OF CONTENTS: PROGRAMME

1. Introduction to PDEs. First concepts. Fundamental equations.
2. Fourier series. Motivation. Convergence and regularity of Fourier series. Sturm-Liouville problems. Generalized Fourier series. The Fourier transform.
3. Elliptic equations. Laplace equation. Properties of harmonic functions. Poisson equation . Green representation. Green function in different domains. Eigenvalue problem.
4. Parabolic equations. Heat equation in bounded domains. Green representation. Heat equation in the whole space. Gauss kernel. Selfsimilarity.
5. Hyperbolic equations. Wave equation in bounded domains. Resonance. Green representation. Wave equation in the line. D'Alembert formula. Wave propagation in dimensions 3 and 2, Green function. Huygens principle.

LEARNING ACTIVITIES AND METHODOLOGY

THEORETICAL-PRACTICAL CLASSES. [44 hours with 100% classroom instruction, 1.76 ECTS]
Knowledge and concepts students must acquire. Student receive course notes and will have basic reference texts to facilitate following the classes and carrying out follow up work. Students partake in exercises to resolve practical problems and participate in workshops and evaluation tests, all geared towards acquiring the necessary capabilities.
TUTORING SESSIONS. [4 hours of tutoring with 100% on-site attendance, 0.16 ECTS]
Individualized attendance (individual tutoring) or in-group (group tutoring) for students with a teacher.
STUDENT INDIVIDUAL WORK OR GROUP WORK [98 hours with 0 % on-site, 3.92 ECTS]
FINAL EXAM. [4 hours with 100% on site, 0.16 ECTS]
Global assessment of knowledge, skills and capacities acquired throughout the course.
METHODOLOGIES
THEORY CLASS. Classroom presentations by the teacher with IT and audiovisual support in which the subject`s main concepts are developed, while providing material and bibliography to complement student learning.
PRACTICAL CLASS. Resolution of practical cases and problems, posed by the teacher, and carried out individually or in a group.
TUTORING SESSIONS. Individualized attendance (individual tutoring sessions) or in-group (group tutoring sessions) for students with a teacher as tutor.

ASSESSMENT SYSTEM

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

SE1 - FINAL EXAM. [60 %]
Global assessment of knowledge, skills and capacities acquired throughout the course.
SE2 - CONTINUOUS EVALUATION. [40 %]
Assesses papers, projects, class presentations, debates, exercises, internships and workshops throughout the course.

BASIC BIBLIOGRAPHY

- Harry Dym, Henry P. MacKean Fourier series and integrals, Academic Press , 1972

- Richard Courant, David Hilbert Methods of mathematical physics, John Wiley & Sons, 1989

- Richard Haberman Elementary applied partial differential equations : with Fourier series and boundary value problems, Prentice Hall, 1998

ADDITIONAL BIBLIOGRAPHY

- A.N. Tijonov Ecuaciones de la física matemática, URSS, 1980

- E. Zauderer Partial differential equations of applied mathematics, Wiley, 2006

- F. John Partial differential equations, Springer Verlag, 1980

- F. Treves Basic linear partial differential equations, Academic Press, 1975

- G.F. Pearson, C.E. Carrier Partial differential equations : theory and technique, Academic Press, 1988

- I. Peral Primer curso de ecuaciones en derivadas parciales, Addison Wesley UAM, 1995

- J. Kevorkian Partial differential equations, Texts in applied math., 2000

- L.C. Evans Partial differential equations, AMS, 2010

- P. Garabedian Partial differential equations, AMS, 1998

- R.V. Churchil Series de Fourier y problemas de contorno, McGraww-Hill, 1966

- S.K. Godunov Ecuaciones de la física matemática, Mir, 1978