Calculus I

Academic Year: (2023 / 2024) **Review date: 12-02-2024**

Department assigned to the subject: Mathematics Department

Coordinating teacher: PEREZ PARDO, JUAN MANUEL

Type: Basic Core ECTS Credits : 6.0

Year : 1 Semester : 1

Branch of knowledge: Engineering and Architecture

SKILLS AND 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.
CG2. Learn new methods and technologies from basic scientific and technical knowledge, and being able to adapt to new situations.
CG3. Solve problems with initiative, decision making, creativity, and communicate and transmit knowledge, skills and abilities, understanding the ethical, social and professional responsibility of the engineering activity. Capacity for leadership, innovation and entrepreneurial spirit.
CG4. Solve mathematical, physical, chemical, biological and technological problems that may arise within the framework of the applications of quantum technologies, nanotechnology, biology, micro- and nano-electronics and photonics in various fields of engineering.
CG5. Use the theoretical and practical knowledge acquired in the definition, approach and resolution of problems in the framework of the exercise of their profession.
CE1. Solve mathematical problems that may arise in engineering and apply knowledge of linear algebra, differential and integral calculus, numerical methods, numerical algorithms, statistics, differential equations and in partial derivatives, complex and transformed variables.
CE22. Design, plan and estimate the costs of an engineering project.
CT1. Work in multidisciplinary and international teams as well as organize and plan work making the right decisions based on available information, gathering and interpreting relevant data to make judgments and critical thinking within the area of study.

RA1. To have acquired sufficient knowledge and proved a sufficiently deep comprehension of the basic principles, both theoretical and practical, and methodology of the more important fields in science and technology as to be able to work successfully in them.
RA2. To be able, using arguments, strategies and procedures developed by themselves, to apply their knowledge and abilities to the successful solution of complex technological problems that require creating and innovative thinking.
RA3. To be able to search for, collect and interpret relevant information and data to back up their conclusions including, whenever needed, the consideration of any social, scientific and ethical aspects relevant in their field of study.
RA6. To be aware of their own shortcomings and formative needs in their field of specialty, and to be able to plan and organize their own training with a high degree of independence.

OBJECTIVES

At the end of the course successful students will have the following habilities:
1. Knowledge and understanding of the mathematical principles underlying their branch of engineering.
2. The ability to apply their knowledge and understanding to identify, formulate and solve mathematical problems using established methods.

3. The ability to select and use appropriate tools and methods to solve mathematical problems.
4. The ability to combine theory and practice to solve mathematical problems.
5. The ability to understanding of mathematical methods and procedures, their area of application and their limitations.

DESCRIPTION OF CONTENTS: PROGRAMME

1. Real Numbers and Completeness

   - Ordered Fields, inequalities, cardinality, Absolute value
   - Sequences and convergence of sequences
   - Completeness of R
   - Bounds and intervals. Existence of the supremum and the infimum

2. Sequences of real numbers

   - Sequences defined by formulae and by recursion
   - Convergence, not convergence and divergence
   - Monotonically increasing and bounded sequences
   - Induction principle
   - Criteria to determine convergence
   - Properties of limits

3. Series

   - Series of real numbers
   - Series of nonnegative terms
   - Criteria to determine convergence
   - Alternating series
   - Telescopic series

4. Functions of one real variable

   - Limit of a Function
   - Continuity
   - Derivatives and calculus of derivatives

5. Intermediate value Theorem, Extreme Value Theorem and Mean Value Theorem

6. Power series

   - Radius of convergence
   - Elemental functions
   - Properties and identities

7. Taylor Expansion and Taylor series

   - Definition
   - Lagrange's Reminder Theorem

8. Analysis of functions
   - Growth, convexity, asymptotes
   - Local extrema of a function
   - Global extrema of a function (Extreme value theorem)

9. Integration of functions of one variable

   - Riemann's integral
   - Properties of the integral
   - Fundamental theorem of calculus
   - Primitives
   - Integration by parts
   - Primitives of rational functions
   - Change of variable

10. Geometric Applications of Integrals

- Area of flat figures
- Volumes
- Length of curves

LEARNING ACTIVITIES AND METHODOLOGY

The methodology will be the usual one for classes in the classroom, writing on the blackboard, with the occasional help of some resources on-line to illustrate some graphic or computational aspects of the course. Also, the classroom notes will be uploaded in Aula Global at the end of each chapter, along with the problem sheets that will be solved and discussed in the small groups.

ASSESSMENT SYSTEM

The final grade will be assigned through the students' performance in two kinds of tests: (a) partial tests along the term, with a weight of 40% in the final grade, and (b) a final exam, amounting to 60% of the final grade.

The weights above, as well as the marks obtained in the midterm tests, will be kept for those students who have to take the extraordinary exam---provided it is beneficial for the student's final grade.

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

BASIC BIBLIOGRAPHY

- Bressoud A radical approach to real analysis, Mathematical Association of Ame- rica, 1994
- S.L. Salas, G.J. Etgen & E. Hille Calculus: One and Several Variables, Wiley, 2006

ADDITIONAL BIBLIOGRAPHY

- Spivak Calculus, Cambridge University Press, 1994
- Thomas & Finney Calculus, Addison-Wesley Publishing Company, 1998

BASIC ELECTRONIC RESOURCES

- Gilbert Strang & Edwin Herman . Calculus: https://math.libretexts.org/Bookshelves/Calculus/Book%3A_Calculus_(OpenStax)