Calculus I

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

Department assigned to the subject: Mathematics Department

Coordinating teacher: LAMPO , ANIELLO

Type: Basic Core ECTS Credits : 6.0

Year : 1 Semester : 1

Branch of knowledge: Engineering and Architecture

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

a. To understand the concept of real number and its implications, mainly the concept of limit.

b. To understand and manipulate series of real numbers.

c. To identify functions, their dependence on variables and their basic properties (monotony, parity, continuity, differentiability).

d. To master the basic operations of Calculus: limits, derivatives, integrals and Taylor expansions.

e. To interpret the derivative as rate of variation of a function, and the integral as an area.

f. To understand the Taylor polynomial as the best polynomial local approximation for a sufficiently smooth function, and to apply that approximation to simple cases.

g. To be able to graph simple functions.

h. To be able to solve simple optimization problems.

DESCRIPTION OF CONTENTS: PROGRAMME

Part I: Real Numbers and Functions

Chapter 1: The Real Line
- 1.1 Ordered Fields
- 1.2 Number Systems
- 1.3 Absolute value, bounds, and intervals

Chapter 4: Real Functions
- 2.1 Definition and basic concepts
- 2.2 Elementary functions
- 2.3 Operations with functions

Part II: Sequences and Series

Chapter 3: Sequences
- 3.1 Sequences of real numbers
- 3.2 Limit of a sequence
- 3.3 Number e
- 3.4 Indeterminacies
- 3.5 Asymptotic comparison of sequences

Chapter 4: Series
- 4.1 Series of real numbers
- 4.2 Series of nonnegative terms
- 4.3 Alternating series
- 4.4 Telescopic series

Part III: Differential Calculus

Chapter 5: Limit of a Function
- 5.1 Concept and definition
- 5.2 Algebraic properties
- 5.3 Asymptotic comparison of functions

Chapter 6: Continuity
- 6.1 Definition, properties, and continuity of elementary functions
- 6.2 Discontinuities
- 6.3 Continuous functions in closed intervals

Chapter 7: Derivatives
- 7.1 Concept and definition
- 7.2 Algebraic properties
- 7.3 Derivatives and local behaviour

Chapter 8: Taylor expansions
- 8.1 Asymptotic comparison of functions
- 8.2 Taylor¿s polynomial
- 8.3 Calculating limits
- 8.4 Remainder and Taylor¿s theorem
- 8.5 Taylor series
- 8.6 Numerical approximations
- 8.7 Local behaviour of functions
- 8.8 Function graphing

Part IV: Integral Calculus

Chapter 9: Primitives
9.1 Integration by parts
9.2 Primitives of rational functions
9.3 Change of variable

Chapter 10: Fundamental Theorem of Calculus
10.1 Riemann¿s integral
10.2 Properties of the integral
10.3 Riemann¿s sums
10.4 Fundamental theorem of calculus

Chapter 11: Geometric Applications of Integrals
11.1 Area of flat figures
11.2 Area of flat figures in polar coordinates
11.3 Volumes
11.4 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

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

The final grade will be assigned through the students' performance in two kinds of tests: two in-class tests, with a weight of 40% in the final grade, together with a final exam, amounting to 60% of the final grade. Failing to attend any of the in-class tests implies obtaining 0 points in that test. The weights above, as well as the points obtained in the in-class tests, will be kept for those students who have to take the extraordinary exam.

BASIC BIBLIOGRAPHY

- J. Stewart Single variable calculus: early transcendentals, Brooks-Cole , 1999

- R. Larson, R.P. Hostetler & B.H. Edwards Calculus, Brooks-Cole, 2005

- S.L. Salas, G.J. Etgen & E. Hille Calculus: One and Several Variables, Wiley, 2006

ADDITIONAL BIBLIOGRAPHY

- H. Anton, I.R.L. Bivens and S. Davis Calculus: Early Transcendentals , Wiley, 2012

- J. Stewart and T. Day Biocalculus. Calculus for Life Sciences, Cengage Learning, 2015

- T.M. Apostol Calculus vol. 1, Wiley, 1991