SUBJECT TEACHING GUIDE

G2007 - Calculus

First Degree in Civil Engineering
Degree in Civil Engineering
BILINGUAL UC-CU CIVIL ENGINEERING PROGRAM
Academic year 2023-2024

1. IDENTIFYING DATA				
Degree	First Degree in Civil Engineering Degree in Civil Engineering		Type and Year	Core. Year 1 Core. Year 1
Faculty	School of civil Engineering			
Discipline	BASIC MATHEMATICS FOR ENGINEERING			
Course unit title and code	G2007 - Calculus			
Number of ECTS credits allocated	6	Term	Semester based (1)	
Web				
Language of instruction	English		Mode of delivery	Face-to-face

Department	DPTO. MATEMATICA APLICADA Y CIENCIAS DE LA COMPUTACION
Name of lecturer	JOAQUIN BEDIA JIMENEZ
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Other lecturers	

3.1 LEARNING OUTCOMES

- Acquire knowledge and proficiency in elementary univariate functions.
  Understand and apply the concepts of limit and continuity at a point of a function.
  Calculate derivatives of real functions and utilize them to solve optimization problems.
  Determine the derivative of an implicitly defined function.
  Analyze the derivability of functions at a specific point and within an interval.
  Demonstrate competence in working with numerical sequences, numerical series, and power series.
  Utilize Taylor expansions to approximate real functions.
  Implement numerical local approximations of a function using Taylor polynomials, including error estimation.
- Acquire knowledge and proficiency in real multivariate functions and vector fields.
  Calculate partial derivatives, directional derivatives, and gradients of functions.
  Determine the plane that is tangent to a surface at a specific point.
  Compute higher-order partial derivatives and Hessian matrices.
  Formulate and solve maximum and minimum problems using differential calculus.
- Apply common techniques of analytical integration for univariate functions.
  Calculate arc lengths, planar areas, and volumes of revolution using integral calculus.
  Apply formulas for changing variables to polar coordinates.
  Parameterize common curves.
  Compute line integrals over scalar and vector fields.
- Gain proficiency in using a symbolic calculation program.
  Apply the program to reinforce understanding of theoretical concepts.
  Solve exercises using the software.
  Recognize the importance of software as a tool for efficiently solving complex problems.

4. OBJECTIVES

In the Civil Engineering syllabus, the Calculus course serves as an introduction to essential mathematical tools that students will utilize throughout their studies. The objectives include developing proficiency in mathematical language and reasoning, cultivating intellectual work habits, understanding the modeling potential of calculus, gaining operational skills in manipulating mathematical functions and their properties, comprehending and applying differential and integral calculus in single and multiple variables to physics and engineering problems, familiarizing with relevant software and programming tools for problem-solving, and instilling a commitment to independent and collaborative study.

6. COURSE ORGANIZATION	
	CONTENTS
1	BLOCK I: REAL AND COMPLEX NUMBERS, SEQUENCES, AND NUMERICAL SERIES. REAL UNIVARIATE FUNCTIONS. UNIT 1: REAL AND COMPLEX NUMBERS, NUMERICAL SEQUENCES, SERIES, AND POWER SERIES. 1.1. Real numbers: Axiomatics of real numbers. 1.2. Geometric representation and key concepts of the real line. 1.3. Complex numbers: Definition. 1.4. Geometric representation of complex numbers. 1.5. Operations with complex numbers. 1.6. Numerical sequences and series: Definitions. 1.7. Convergence criteria for numerical series. UNIT 2: REAL UNIVARIATE FUNCTIONS. 2.1. Concept and definitions of functions. Operations with functions. 2.2. Elementary functions. 2.3. Properties of even and odd functions, periodicity, symmetry, and dimension. 2.4. Limit of a function at a point: Definition and properties. 2.5. Indeterminate forms. 2.6. Continuous function at a point and within an interval: Types of discontinuities. 2.7. Theorems about continuous functions. 2.8. Properties of differentiable functions at a point and within an interval. 2.9. Rolle's and Mean Value Theorems. 2.10. Application of the derivative to the calculation of limits: L'Hôpital's rule. 2.11. Representation of functions as power series: Taylor and Mac-Laurin formulas. Local approximation of functions.
2	BLOCK II: INTEGRAL CALCULUS OF FUNCTIONS OF ONE VARIABLE UNIT 3. INTEGRAL CALCULUS 3.1. Calculation of primitives. Definitions and properties 3.2. Integration Methods 3.3. Riemann integral. Interpretation and Properties 3.4. Mean value theorem. Fundamental Theorem of Calculus. Barrow's rule 3.5. Improper integrals 3.6. Parameterization of curves. Polar coordinates. 3.7. Applications of integrals to the calculation of planar areas, volumes of revolution, surfaces of revolution and lengths of curves, in Cartesian, parametric and polar coordinates.
3	BLOCK III. MULTIVARIATE REAL FUNCTIONS UNIT 4. MULTIVARIATE SCALAR AND VECTOR-VALUED FUNCTIONS 4.1. First notions about multivariate functions 4.2. Limits of scalar functions 4.3. Limits of vector-valued functions 4.4. Continuity of multivariate functions 4.5. Partial derivatives. Introduction. Definition. geometric interpretation. 4.6. Continuity and partial derivatives. Partial derivatives of higher orders 4.7. Differential. Differentiability and continuity. Sufficient condition for differentiability. 4.8. Gradient. Definition. Gradient vector and directional derivative. Gradient and contour lines. 4.9. Extremes. Optimization. Lagrange multipliers.

7. ASSESSMENT METHODS AND CRITERIA

Description	Type	Final Eval.	Reassessn	%
Lab practice reports	Laboratory evaluation	No	No	12,00
Continuous asessment	Others	No	No	28,00
Partial examination of Block I	Written exam	No	Yes	15,00
Partial examination of Block II	Written exam	No	Yes	15,00
Partial Examination of Block III	Written exam	Yes	Yes	30,00
TOTAL				100,00

Observations

The final grade for the extraordinary assessment will be determined by the weighted average of various evaluation components outlined in the course's teaching guide. Students attending the extraordinary assessment will take a comprehensive exam, accounting for 60% of the final grade, covering the entire course syllabus, irrespective of prior approval of individual parts during regular evaluation.

Failure to adhere to prescribed test formats (e.g., report templates, designated answer spaces in written exams) will result in penalties. Additionally, the following actions will be penalized:

- Unjustified answers.
- Inappropriate use of terminology and mathematical notation.
- Untidy work, excessive corrections, etc.
- Frequent spelling/grammar errors.
- Demonstrating a lack of fundamental mathematical skills in procedures.

In exceptional cases supported by valid justifications (e.g., health restrictions), remote completion of assessment tests may be permitted with prior authorization from the Academic Authority.

Observations for part-time students

The course is accessible through the University of Cantabria Moodle platform. Part-time students are required to meet the same evaluation criteria as full-time students. However, in their case, the continuous assessment tasks assigned throughout the course may be completed individually and submitted in electronic format. Additionally, part-time students have the option, exclusive to them, to take a single written exam covering the material from all three thematic blocks. This exam carries a weight of 60% towards the final grade and will be administered on the scheduled final exam date.

8. BIBLIOGRAPHY AND TEACHING MATERIALS

BASIC

Larson, L. y Edwards, B. H. Cálculo I y II. 9ª ed. Mc Graw Hill. ISBN: 978-970-10-5710-0.
http://catalogo.unican.es/cgi-bin/abnetopac/?TITN=263113.
See also electronic book version: https://catalogo.unican.es/cgi-bin/abnetopac/O7448/IDd1bea231/NT1

Electronic material available in Moodle (exercises, slides, videos, software scripts etc.)