

SUBJECT TEACHING GUIDE

G41 - Differential Calculus

Double Degree in Physics and Mathematics Degree in Mathematics

Academic year 2022-2023

1. IDENTIFYING DATA					
Degree	Double Degree in Physics and Mathematics Degree in Mathematics			Type and Year	Core. Year 1 Core. Year 1
Faculty	Faculty of Sciences				
Discipline	Subject Area: Basic Mathematics Basic Module				
Course unit title and code	G41 - Differential Calculus				
Number of ECTS credits allocated	6	Term	Semester based (1)		
Web	http://personales.unican.es/lafernandez/				
Language of instruction	Spanish	English Friendly	Yes	Mode of delivery	Face-to-face

Department	DPTO. MATEMATICAS, ESTADISTICA Y COMPUTACION				
Name of lecturer	LUIS ALBERTO FERNANDEZ FERNANDEZ				
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Other lecturers					

3.1 LEARNING OUTCOMES
- Use real numbers to solve equations and inequalities with absolute values
- Use the mathematical language involved in: concepts of sequence and series, in particular for power series and therefore for Taylor series in his region of convergence; concepts of limits and criteria for their existence, for functions of one and several variables; concept of continuity and derivability, and criteria related to such functions.
- Calculate partial derivatives, gradients, Jacobians and Hessians in specific contexts.
- Use Taylor polynomials to study and approximate functions of one or several variables.
- Solve simple problems about relative and absolute maximum and minimum, and about conditioned extremes.

4. OBJECTIVES

Know, understand and handle various basic concepts and results concerning a real variable:

- Sequences and Series in \mathbb{R} ; study of their convergence.
- Real functions of real variable; limits, continuity and differentiability. Applications: roots separation, functions approximation.

Know, understand and manage the versions for several real variables of the previously mentioned issues.

6. COURSE ORGANIZATION

CONTENTS

1	<p>REAL NUMBERS: SEQUENCES AND SERIES OF REAL NUMBERS</p> <ol style="list-style-type: none"> 1. Real numbers, absolute values and inequalities. 2. Sequences in \mathbb{R} and limits (finite and infinite) of such sequences. 3. Common criteria to study the convergence of a sequence in \mathbb{R} and to calculate its limit if it exists: Sandwich rule, monotonous sequences (the number e), Stolz criterion, equivalences. 4. Series in \mathbb{R} and convergence of such series. Examples: geometric series and harmonic series. 5. Series of positive terms and of any terms. Common criteria for the study of their convergence: Gauss, the ratio, Leibniz, absolute convergence. 6. Power Series.
2	<p>LIMITS AND CONTINUITY OF REAL FUNCTIONS OF ONE REAL VARIABLE.</p> <ol style="list-style-type: none"> 1. Brief introduction to the real functions of real variable. 2. Limit at a point of a real function of real variable. Limits at infinity. Infinitesimals and infinities. 3. Continuity of a real function of real variable. 4. Common methods to study the existence of the limit at a point of a real function of real variable, and for calculating this limit if it exists: lateral limits, sandwich rule, equivalences. 5. Bolzano Theorem for locating roots.
3	<p>DERIVABILITY OF REAL FUNCTIONS OF REAL VARIABLE</p> <ol style="list-style-type: none"> 1. Derivability. Relationship between continuity and derivability of a real function of real variable. 2. L'Hopital rule. Applications. 3. Chain rule. Inverse function. 4. Rolle Theorem. Separation of roots. 5. Function approximation. Taylor formula. Estimation of the rest. 6. Taylor series.
4	<p>LIMITS AND CONTINUITY OF FUNCTIONS OF SEVERAL REAL VARIABLES.</p> <ol style="list-style-type: none"> 1. Introduction to functions of several real variables with values in \mathbb{R}^n. 2. Extension to those functions of the concepts of limit and continuity, and of their manipulation and properties. 3. Directional and iterated limits. Limits in polar coordinates.
5	<p>DERIVATION OF FUNCTIONS OF SEVERAL REAL VARIABLES.</p> <ol style="list-style-type: none"> 1. Differentiable functions of several real variables. Partial derivative. Gradient. Jacobian matrix. 2. Properties of differentiable functions. Chain rule. Change of variables. 3. Partial derivatives of higher order. Hessian matrix. 4. Taylor formula for real functions of several real variables. 5. Extremes of real functions of several real variables. Conditioned extremes. Lagrange multipliers. 6. Derivation of implicit functions.

7. ASSESSMENT METHODS AND CRITERIA

Description	Type	Final Eval.	Reassessn	%
Concerning chapters 1 and 2 of the subject.	Written exam	Yes	Yes	50,00
Concerning the chapters 3, 4 and 5 of the subject. Those students who have failed the first partial exam will can overcome it after the examination of the second part.	Written exam	Yes	Yes	50,00
TOTAL				100,00
Observations				
The final mark of the subject will be the average of the marks obtained in the two partial exams. To pass the subject it will be needed to obtain a final mark greater than or equal to 5.				
In September, the exam will have a value of 100%.				
Observations for part-time students				
Evaluation of part-time students will be the same as that of the rest.				

8. BIBLIOGRAPHY AND TEACHING MATERIALS

BASIC

T. M. Apostol. Calculus. Ed. Reverté, 1987.

J.E. Marsden, A.J. Tromba. Cálculo Vectorial. Pearson, Addison-Wesley, 2004.

M. Spivak. Cálculo Infinitesimal. Ed. Reverté, 1991.