

## SUBJECT TEACHING GUIDE

### G41 - Differential Calculus

#### Double Degree in Physics and Mathematics Degree in Mathematics

Academic year 2017-2018

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	First Year Subjects 1 YEAR DT-FISIMATE 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	<a href="http://personales.unican.es/lafernandez/">http://personales.unican.es/lafernandez/</a>				
Language of instruction	Spanish	English Friendly	No	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	MARIA DE UJUE ETAYO RODRIGUEZ				

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

### 7. ASSESSMENT METHODS AND CRITERIA

Description	Type	Final Eval.	Reassessn	%
Concerning chapters 1 and 2 of the subject.	Written exam	Yes	Yes	40,00
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	60,00
<b>TOTAL</b>				<b>100,00</b>
<b>Observations</b>				
The final mark of the subject will be the average of the marks obtained in the two exams. To pass the subject it will be needed to obtain a final mark greater than or equal to 5. In September, the exam has a value of 100%.				
<b>Observations for part-time students</b>				
Evaluation will be exactly the same.				

### 8. BIBLIOGRAPHY AND TEACHING MATERIALS

#### BASIC

D. Brannan. A First Course in Mathematical Analysis. Cambridge University Press, 2006

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

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