UNIVERSIDADE DA CORUÑA

Teaching Guide			
Identifying Data			2023/24
Subject (*)	Mathematics II	Code	611G02010
Study programme	Grao en Administración e Dirección de Empresas		

Descriptors				
Cycle	Period	Year	Type	Credits
Graduate	2nd four-month period	First	Basic training	6

Language	SpanishGalician		
Teaching method	Face-to-face		
Prerequisites			
Department	Economía		
Coordinador	Lema Fernández, Carmen Socorro	E-mail	carmen.lemaf@udc.es
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Web	campusvirtual.udc.gal		
General description	The objective of this course is to introduce students to the basics of differential calculus of several variables and mathematical programming, which will be necessary for learning other subjects of the grade and for their future career. The student will understand the basic concepts presented and the results that relate them, and will be able to properly and rigorously apply this knowledge to solving practical problems. An special emphasis will be made on the application of the course contents to economic problems, and on the interpretation of the results. Another aim is to help students develop generic skills such as analysis and synthesis, logical reasoning, problem solving, critical thinking, independent learning, or retrieving and using information from various sources.		

Study programme competences	
Code	Study programme competences
A3	Evaluate and foreseeing, from relevant data, the development of a company.
A4	Elaborate advisory reports on specific situations of companies and markets
A6	Identify the relevant sources of economic information and to interpret the content.
A8	Derive, based on from basic information, relevant data unrecognizable by non-professionals.
A9	Use frequently the information and communication technology (ICT) throughout their professional activity.
A10	Read and communicate in a professional environment at a basic level in more than one language, particularly in English
A11	To analyze the problems of the firm based on management technical tools and professional criteria
A12	Communicate fluently in their environment and work by teams
B1	CB1-The students must demonstrate knowledge and understanding in a field of study that part of the basis of general secondary education, although it is supported by advanced textbooks, and also includes some aspects that imply knowledge of the forefront of their field of study
B2	CB2 - The students can apply their knowledge to their work or vocation in a professional way and have competences typically demostrated by means of the elaboration and defense of arguments and solving problems within their area of work
B3	CB3- The students have the ability to gather and interpret relevant data (usually within their field of study) to issue evaluations that include reflection on relevant social, scientific or ethical
B4	CB4-Communicate information, ideas, problems and solutions to an audience both skilled and unskilled
B5	CB5-Develop skills needed to undertake further studies learning with a high degree of autonomy
B10	CG5-Respect the fundamental and equal rights for men and women, promoting respect of human rights and the principles of equal opportunities, non-discrimination and universal accessibility for people with disabilities.
C1	Express correctly, both orally and in writing, in the official languages of the autonomous region
C4	To be trained for the exercise of citizenship open, educated, critical, committed, democratic, capable of analyzing reality and diagnose problems, formulate and implement knowledge-based solutions oriented to the common good

C5	Understand the importance of entrepreneurial culture and know the means and resources available to entrepreneurs
C6	Assess critically the knowledge, technology and information available to solve the problems and take valuable decisions
C7	Assume as professionals and citizens the importance of learning throughout life.
C8	Assess the importance of research, innovation and technological development in the economic and cultural progress of society.

Learning outcomes			
Learning outcomes	Study programme competences		
Understand the basic concepts of the euclidean space IRn.	A8 A11		
Determine if a set is open, closed, bounded, compact and convex.	A8 A11		
Understand the concept of function of several variables.	A8 A11		
Draw the level set of a function of two variables.	A8 A11		
Understand the concept of continuous function.	A8 A11		
Determine if a function is continuous or not.	A8 A11		
Recognize a linear function.	A8 A11		
Recognize a quadratic form.	A8 A11		
Classify a quadratic form by examining the signs of the principal minors and by eigenvalues.	A8 A11		
Classify a constrained quadratic form.	A8 A11		
Calculate and interpret partial derivatives and elasticities.	A4 A8 A11	B1 B2 B5 B10	C1 C7
Find the Taylor polynomial of a function.	A8 A11		
Calculate the partial derivatives of a compounded function.	A8 A11		
Use the existence theorem to analyze if a equation defines an implicit real function.	A8 A11		
Find the partial derivatives and elasticities of an implicit function, and interpret them.	A8 A11		
Analyze the concavity/convexity of a function.	A8 A11		
Formulate mathematical programming problems.	A3 A4 A6 A8 A9 A10 A11	B1 B2 B3 B4 B5 B10	C1 C4 C5 C6 C7 C8

Distinguish between local and global optima.	A8 A11		
Graphically solving an optimization problem	A8 A11	B3	
Analyze the existence of global optima using the Weierstrass theorem.	A8 A11		
Find the critical points of a function of several variables.	A8 A11		
Classify the critical points using the second-order conditions.	A8 A11		
Determine the local or global character of the optima of an unconstrained problem.	A8 A11		
Formulate economic problems as mathematical programs with equality constraints.	A8 A11		
Find the critical points of a mathematical program with equality constraints.	A8 A11		
Classify the critical points and interpret the Lagrange multipliers.	A8 A11		
Determine the local or global character of the optima of an equality-constrained problem.	A8 A11		
Know the structure and basic properties of a linear program.	A8 A11		
Formulate simple economic problems as linear programs.	A3 A4 A8 A11 A12	B1 B2 B3 B4 B5 B10	C1 C4 C6 C7 C8
Solve linear programs by the simplex algorithm.	A3 A4 A6 A8 A9 A11	B1 B2 B3 B4 B5 B10	C1 C4 C5 C6 C7 C8

Contents	
Topic	**Sub-topic**
1. The euclidean space IRn.	The vector space IRn. Inner product. Norm. Distance. Open and closed sets. Compact sets.
2. Functions of several variables.	Basic concepts. Graphical representation of real functions. Level sets. Limit of a function at a point. Continuity. Linear functions. Quadratic forms. Classification. Constrained quadratic forms.

3. Derivatives of functions of several variables.	Partial derivatives. Partial derivatives of higher order. Class one function Chain's Rule. Taylor's theorem. Implicit function theorem.
4. Convexity of sets and functions.	Convex sets. Properties. Convex functions. Properties. Characterization of twice continuously differentiable convex functions.
5. Introduction to mathematical programming.	Formulation of a mathematical program. Local and global optima. Graphic solving. Basic Theorems in optimization.
6. Unconstrained optimization.	First-order necessary conditions. Second-order conditions. The convex case. Sensitivity analysis.
7. Equality-constrained optimization	Formulation. First-order necessary conditions: the Lagrange theorem. Second-order conditions. The convex case. Sensitivity analysis.
8. Linear programming.	Formulation of linear programs. Basic feasible solutions. Fundamental theorems. The simplex algorithm.

Planning				
Methodologies / tests	Competencies	Ordinary class hours	Student?s personal work hours	Total hours
Introductory activities	A6 A9 A12 C1	1	0	1
Multiple-choice questions	A10 B2 B3 B4	2	7	9
Mixed objective/subjective test	A10 B2 B3 B4	3	15	18
Guest lecture / keynote speech	A3 A4 A8 A9 A11 A12 B1 B5 C6 C7	15	15	30
Seminar	B10 C4 C5 C8	2	4	6
Practical test:	A8 A11 B1 B2 B3 B4 B5 C1	2	8	10
Problem solving	A6 B1	25	50	75
Personalized attention		1	0	1
(*)The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.				

Methodologies	
Methodologies	Description
Introductory activities	It will be the presentation of the course (one hour).
Multiple-choice questions	There will be several multiple-choice exams. These exams will have questions with several given answers --only one will be correct-- related to theoretical and practical concepts covered in the course.
Mixed objective/subjective test	At the end of the course, there will be a mixed (theoretical/practical) exam. This exam will take place at the official date determined by the Faculty.

Guest lecture / keynote speech	There will be 15 hours of keynote speech, that will be focused on the exposition of the theoretical contents.
Seminar	They will be several seminars with personalized attention of character essentially practical. These seminars will preferably be face-to-face. Sufficiently in advance, the dates, times and classrooms will be published for ecah group.
Practical test:	There will be several practical tests along the term. These tests will consist of one or several questions to which will have to answer by writing and justifying properly the answers.
Problem solving	There will be 25 hours of problem solving classes, which will be focused on the formulation and solving of problems related to the practical contents of the subject.

Personalized attention	
Methodologies	**Description**
Problem solving Seminar	The students will have of the following roads of communication: - Asynchronous Communication: -Virtual Campus UDC (by means of the use of the forums or direct messages). -Email of the teachers. For asynchronous queries. - Synchronous communication: -Personal Tutoring using the periods of time fixed by the teachers of the subject. -Seminars (Group tutoring). Also it will be possible tutoring in other dates and different hours to the established, previous application by part of the students.

Assessment			
Methodologies	**Competencies**	**Description**	**Qualification**
Practical test:	A8 A11 B1 B2 B3 B4 B5 C1	There will be two presential exams, their weighting in the final evaluation is 20% (2 points). In this exams, the reasoning capacity of the students will be especially valued.	20
Mixed objective/subjective test	A10 B2 B3 B4	The final (presential) exam will represent a 60% of the final mark (6 points). It will be valued a good understanding of the concepts, the use of appropriate reasoning, the proper use of mathematical language, and the skills in formulating and solving problems.	60
Multiple-choice questions	A10 B2 B3 B4	Throughout the course there will be two multiple choice tests (multiple choice), their weighting in the final evaluation is 20% (2 points).	20

Assessment comments

A) EVALUATION REGULATIONS

1. Conditions for making of the examinations and test, and identification of students

During the realisation of the examinations will not be able to have access to any device that allow the communication with the outside and/or the storage of information. It will be able to deny the entrance to the classroom with this type of devices. They will not admit the examinations written with pencil. The students will have to identify by means of DNI or equivalent for making the tests of evaluation.

2. Use of calculator

The calculator that can be used must not have ANY of the following characteristics: Possibility of transmitting data, being programmable, graphic display, solving equations, operations with matrix, calculation of determinants, derivatives and/or integrals, storage of alphanumeric data. When it has any of these characteristics, it will be withdrawn. If during the development of the exam a calulator is used that is not allowed, the same measures will be adopted as when the students are copying.

3. Academic fraud

Fraudulent performance of test or evaluation activities, once verified, will directly imply a failing grade in the call in which it is committed: the student will be graded with "fail" (numerical grade 0) in the corresponding call of the academic year, whether the commission of the offense occurs on the first opportunity or on the second. For this, their qualification will be modified in the minutes of the first opportunity if neccessary.

B) QUALIFICATION TYPES

1. Not taken qualification

It will award the qualification of NOT TAKEN to the student that only participate in activities of evaluation that have a weight less than 20% of the final qualification, with independence of the qualification obtained.

2. Students part time (or with dispenses of attendence):

it will be evaluated according to the same norms that the rest of students

C) EVALUATION OPPORTUNITIES

1. First opportunity

Continuous evaluation

Continuous evaluation will consist of two multiple choice tests (multiple choice questions) and two presential exams (practical test) in the classroom. Their weighting in the final evaluation is 40% (4 points)

Final exam

Mixed objective/subjective test. The final exam will represent a 60% of the final mark (6 points)

In addition, students can obtain up to one point for active participation in classes, seminars and personal tutoring, which will be added to the mark obtained in the continuous evaluation and in the final exam.

2. Second opportunity

In the second opportunity there will be a mixed objective/subjective test and the qualification will be the highest of the following two options:

- Sum of the marks obtained in the continuous evaluation of the first opportunity (maximum four points of the multiple choice questions and practical test carried out) and in the mixed objective/subjective test of the second opportunity (maximum six points)
- Qualification obtained in the mixed objective/subjective test of the second opportunity valued on ten points.

3. Opportunity in Advance: The final qualification of the student that request this opportunity will be the obtained in the face-to-face examination valued on ten points.

Sources of information	
Basic	- Knut Sydsæter, Peter J. Hammond y Andrés Carvajal (2012). Matemáticas para el análisis económico . Madrid, Pearson

Complementary	- Esperanza Minguillón, Isabel Pérez Grasa y Gloria Jarne (2004). Matemáticas para la economía. Libro de ejercicios. Álgebra lineal y cálculo diferencial. Madrid, McGraw-Hill - Isabel Pérez Grasa, Gloria Jarne y Esperanza Minguillón (1997). Matemáticas para la economía: álgebra lineal y cálculo diferencial . Madrid, McGraw-Hill - Alpha Chiang y Kevin Wainwright (2006). Métodos fundamentales de economía matemática . Madrid, McGraw-Hill - Isabel Pérez Grasa, Gloria Jarne y Esperanza Minguillón (2001). Matemáticas para la economía: programación matemática y sistemas dinámicos . Madrid, McGraw-Hill - Michael Hoy, John Livernois, Chris McKenna, Ray Rees y Thanasis Stengos (2001). Mathematics for economics. Cambridge, MA, The MIT Press - Rosa Barbolla, Emilio Cerdá y Paloma Sanz (2001). Optimización. Cuestiones, ejercicios y aplicaciones a la economía . Madrid, Prentice Hall - Rafael Caballero, Susana Calderón, Teofilo Galache, Alfonso González, Lourdes Rey y Francisco Ruiz (2000). Matemáticas aplicadas a la economía y la empresa. 434 ejercicios resueltos y comentados . Madrid, Pirámide

Recommendations
Subjects that it is recommended to have taken before
Mathematics I/611G02009
Subjects that are recommended to be taken simultaneously
Subjects that continue the syllabus
Other comments
It is advisable to have passed Mathematics I. Students must be familiar with the concepts and fundamental results of linear algebra (matrices, determinants and systems of linear equations), and differential calculus in one variable (limit, continuity, derivative, elasticity, optima, convexity).