UNIVERSIDAD DE GRANADA | **Guías Docentes**

COURSE GUIDE

Mathematics for Economics I (226111A)

Grado (Bachelor's Degree)	Grado en Economía (Bilingüe)	Branch	Social and Legal Sciences

Module	Métodos Cuantitativos	Subject	Matemáticas para la Economía I

Year of study	1º	Semester	2º	ECTS Credits	6	Course type	Compulsory course

PREREQUISITES AND RECOMMENDATIONS

Completion of the Mathematics course given in the first semester.

BRIEF DESCRIPTION OF COURSE CONTENT (According to the programme's verification report)

- Real quadratic forms.
- Introduction to mathematical programming. The graphical method.
- Differential calculus for functions of several variables. Economic applications.
- Classic optimization without restrictions. Convex optimization.
- Integral calculus of functions of several variables.
- Introduction to differential equations.

SKILLS

GENERAL SKILLS

- CG02 - Cognitive comprehension skills.
- CG03 - Ability to analyse and summarise.
- CG04 - Ability to organise and plan.
- CG08 - Problem-solving skills.
- CG09 - Ability to make decisions.
- CG16 - Ability to engage in critical and self-critical reasoning.
- CG17 - Ability to learn and work autonomously.

SUBJECT-SPECIFIC SKILLS

- CE21 - Use basic quantitative tools for diagnosis and analysis.
- CE22 - Bring rationality to the analysis and description of any aspect of economic reality.
- CE23 - Evaluate the consequences of alternative courses of action and select the best

ones given the objectives.
- CE32 – Communicate fluently in an environment and work in a team.
- CE37 – Mathematical optimisation.
- CE50 – Acquire skills in solving optimization problems in the economic field.
- CE51 – Understand the techniques of differential and integral calculus in several variables and their application to economic analysis.
- CE52 – Know and understand how to apply the different methods of Mathematical Optimisation and some of the main dynamic models in Economics.
- CE53 – Learn to classify quadratic forms and to use graphical techniques to solve mathematical programmes and their application in Economics.
- CE54 – Understand the methods for solving first order differential equations, as well as the techniques of differential and integral calculus in several variables and their application to economic analysis.

TRANSFERABLE SKILLS

- CT01 – Through the knowledge and application of concepts learnt in the Bachelor's Degree (Grado), be able to identify and anticipate economic problems relevant to the allocation of resources, both in the public and private sectors.

LEARNING OUTCOMES

- Understand the concepts of partial derivatives, gradient vector and Hessian matrix of real functions of several variables.
- Learn the use of Taylor's theorem for approximating functions.
- Calculate the partial derivatives of a function implicitly defined.
- Understand the importance of the homogeneity of a function for economic applications.
- Calculate the local extreme of real functions of several variables.
- Mathematically formulate economic optimization problems.
- Graphically solve math programs in two variables.
- Study the convexity of a program and apply it to the calculation of global extremes.
- Calculate double integrals on simple regions.
- Calculate solutions of simple differential equations by the method of separation of variables.

PLANNED LEARNING ACTIVITIES

THEORY SYLLABUS

1. **BASIC NOTIONS ON FUNCTIONS OF SEVERAL VARIABLES.**
   - Notation for subsets of R^n. Graphic representation of subsets of R^2.
   - Euclidean distance. Basic topology in R^n: balls, relative position between points and sets (interior, exterior and boundary points), bounded, open, closed and compact sets.
   - Basic notions on functions of several variables: domain, maximal domain and range. Operations with functions.
   - Types of functions: separate variables, polynomial and rational functions.
   - Quadratic forms: definition and classification.
   - Level and sub-level sets.

- Some functions of several variables outstanding in economics: utility function, cost quadratic function, production function.

2. **OPTIMIZATION WITH INEQUALITY RESTRICTIONS: THE GRAPHICAL METHOD.**
   - Definition of local and global extrema. The Weierstrass Theorem.
   - Optimization with inequality restrictions: the graphical method in two variables.
   - Problems of linear programming in two variables applied to the economic field.

3. **DIFFERENTIAL CALCULUS FOR FUNCTIONS OF SEVERAL VARIABLES.**
   - First order partial derivatives. Gradient vector.
   - Chain rule. Implicit derivation.
   - Second order partial derivatives. Schwartz property. Hessian matrix.
   - Taylor formula: lineal and quadratic approximation of functions.

4. **OPTIMIZATION WITHOUT RESTRICTIONS.**
   - Critical points. Necessary and sufficient condition for local extrema. Saddle points.
   - Convex and concave functions: properties. Coercive and anti-coercive functions.
   - Sufficient conditions for existence of global extrema.
   - Applications to maximization of benefit functions and minimization of cost functions.

5. **INTEGRAL CALCULUS FOR FUNCTIONS OF SEVERAL VARIABLES.**
   - Different types of definite integrals. Double integrals over rectangular regions. The Fubini's Theorem.

6. **ORDINARY DIFFERENTIAL EQUATIONS.**
   - Basic methods for resolution of first order differential equations.
   - Separation of variables method.
   - Economic models: classic models, investment and public spending models.

PRACTICAL SYLLABUS

- **Seminars/Workshops**
  - Workshop for contents reinforcement.
- **Practice with computer**
  - Functions of several variables: definition and graphical representation.
  - Differential calculus for functions of several variables. Optimization without restrictions.
  - Resolution of double integrals over rectangular regions. Introduction to Ordinary Differential Equations.

Note: the teaching staff responsible for the class will integrate the practical content into the theoretical programme of the course.

RECOMMENDED READING

ESSENTIAL READING

- M. Álvarez de Morales Mercado y M.A. Fortes Escalona. Matemáticas Empresariales. Ed. Copicentro.
- J. García Cabello. El Cálculo Diferencial de las Ciencias Económicas. Ed. Delta Publicaciones.
- E.F. Haeussler y R. Paul. Matemáticas para Administración, Economía, Ciencias Sociales y de la Vida. Ed. Prentice Hall.
- E.F. Haeussler and R. Paul. Introductory mathematical analysis : for business, economics and the life and social sciences (9th ed.). Upper Saddle River, N.J: Prentice Hall.

- K. Sydsaeter, P. Hammond y A. Stom, Matemáticas para el Análisis Económico. Ed. Prentice Hall.
- K. Sydsaeter, P. Hammond, and A. Stom. Essential mathematics for economic analysis. Harlow: Pearson Education Limited.

COMPLEMENTARY READING

- P. Alegre. Matemáticas Empresariales. Ed. AC.
- M. Álvarez de Morales Mercado y M.A. Fortes Escalona. Matemáticas para Economía y Administración y Dirección de Empresas. Ed. Godel Godel Impresiones Digitales S.L.
- A. Balbás. Análisis Matemático para la Economía (I y II). Ed. AC.
- A. Balbás. Programación Matemática. Ed. AC.
- R. Caballero. Matemáticas Aplicadas a la Economía y la Empresa. Ed. Pirámide.
- E. Costa. Matemáticas para Economistas. Ed. AC.
- G. Gandolfo. Economic Dynamics. Ed. Springer.
- J. García Hernández, C. Martínez Álvarez, M. L. Rodríguez González, Optimización Matemática aplicada a la Economía, Ed. Godel Impresiones Digitales S.L.
- H. Lomelí. Métodos Dinámicos en Economía. Ed. Thomsom.
- V. Ramírez González. Matemáticas con Mathematica para Empresariales y Económicas. Ed. Proyecto Sur.
- O. Samamed. Matemáticas I. Economía y empresa. Ed. Centro de Estudios Ramón Areces.
- O. Samamed. Problemas Resueltos de Matemáticas I. Economía y Empresa. Ed. Centro de Estudios Ramón Areces.
- D.G. Zill. Ecuaciones Diferenciales con Aplicaciones. Grupo Editorial Iberoamericano.

RECOMMENDED LEARNING RESOURCES/TOOLS

- Web sites for computer practice
  - https://www.wolframalpha.com/
  - https://www.geogebra.org/

TEACHING METHODS

- MD01 - Face-to-face teaching in the classroom
- MD02 - Individual work by the student; retrieval, consultation and processing of information; problem solving and practical case studies; and completion of assignments and presentations
- MD03 - Individual and/or group tutoring and evaluation

ASSESSMENT METHODS (Instruments, criteria and percentages)

ORDINARY EXAMINATION DIET

- According to the Rules for Assessment and grading of the students of the University of the assessment of students' academic performance will reflect public, objective and impartial criteria, and will preferably be continuous. Nevertheless, the students may apply for a **single final assessment** (article 8 of the current Rules for Assessment , which provides for the taking of a single final assessment). On one hand, lack of application for

single final assessment option will be understood as a waiver of the right of such assessment. On the other hand, those students who are granted with single final assessment are not eligible for continuous assessment.

- In the **continuous assessment option**, the total score will be the sum of all scores corresponding to assessment activities. These are the following:
  - Diverse activities: computer based activities, online tests, face-to-face problem solving, or any other activity proposed by the professor. The total of these activities will represent 10% of the final grade.
  - Two mid-term exams: two eliminatory mid-term exams will be held. Each of them will represent 45% of the final grade.
- Students who wish to obtain a higher grade in any of the two mid-term exams, or in both of them, may perform a final exam. Previously, they must waive in writing the grade obtained in the corresponding mid-term exam(s).

EXTRAORDINARY EXAMINATION DIET

- It will consist of a single written exam which will be graded on a 0-10 scale (scoring a maximum of 10 points). In order to pass the course under this option, a final mark equal or bigger than 5 is required. Otherwise, the course is considered to be failed. Date and place for the final written exam will be made public by the Faculty of Economic and Business Sciences.
- Students with no attendance to such final written exam (that scores a maximum of 10 points) will have the final mark "Not Having Been Submitted" ("No Presentado").

SINGLE FINAL ASSESSMENT (evaluación única final)

- Following the regulations, a final evaluation is established for those students who have completed the required requirements and have applied for the single final assessment (https://sede.ugr.es/sede/catalogo-de-procedimientos/solicitud-evaluacion-unica-final.html).
- It will consist of a single written exam which will be graded on a 0-10 scale (scoring a maximum of 10 points). In order to pass the course under this option, a final mark equal or bigger than 5 is required. Otherwise, the course is considered to be failed. Date and place for the final written exam will be made public by the Faculty of Economic and Business Sciences.
- Students with no attendance to such final written exam (that scores a maximum of 10 points) will have the final mark "Not Having Been Submitted" ("No Presentado").
- Students may apply for single final assessment option, either within the first two weeks of teaching of the subject or within two weeks following change of matriculation. Application is to be made through the electronic system (https://sede.ugr.es/sede/catalogo-deprocedimientos/solicitud-evaluacion-unica-final.html), citing and accrediting the reasons for not being able to undergo the system of continuous assessment (reasons of employment, health, disability or any other correctly justified cause).