COURSE GUIDE

Mathematics for Economics I (226111A)

Approval date: 27/06/2025

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

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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 vectors, and Hessian matrices for real functions of several variables.
- Learn how to use Taylor's theorem to approximate functions.
- Calculate the partial derivatives of an implicitly defined function.
- Understand the importance of function homogeneity in economic applications.
- Calculate the local extrema of real functions with several variables.
- Mathematically formulate economic optimization problems.
- Graphically solve mathematical programs with two variables.
- Study the convexity of a program and apply it to the calculation of global extrema.
- Calculate double integrals over simple regions.
- Solve simple differential equations using 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,

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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.
   - 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** for contents reinforcement.
- **Reinforcement software will be presented to students as an additional tool to allow them to verify the results of the problems proposed in class**.

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

RECOMMENDED READING

ESSENTIAL READING

- Álvarez de Morales Mercado, M., & Fortes Escalona, M. Á. (2019). Cálculo en varias variables para Economía y Administración y Dirección de Empresas. Avicam.
- Álvarez de Morales Mercado, M., & Fortes Escalona, M. Á. (2008). Matemáticas empresariales (2a ed. rev.). Copicentro.
- **García Cabello, Julia (2019). Matemáticas II Para Economía Y Empresa. LLeno de problemas resueltos paso a paso.** Monografías Matemáticas, Editorial Avicam Fleming.
- Haeussler, E., S. Paul, R., Wood J.Richard, S. Paul, R., Wood J.Richard, Haeussler, E., S. Paul, R., & Wood J.Richard. (2021). Introductory mathematical analysis : For Business, Economics, and The life and Social sciences / (14th edition). Pearson Global Editions.
- Carvajal, A., Hammond, P. J., Strøm, A., Sydsaeter, K., Strøm, A., Sydsaeter, K., Strøm, A., & Sydsaeter, K. (2021). Essential mathematics for economic analysis / (6th edition). Pearson Global Editions.
- Sydsaeter, K., Hammond, P. J., & Stom, A. (2012). Essential mathematics for economic analysis (5th ed.). Pearson Education Limited.

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- Sydsaeter, K. (2008). Further mathematics for economic analysis (2nd ed.). Prentice Hall.

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.
- 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.
- 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 supporting software
  - ⊠⊠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 Granada (⊠⊠ https://www.ugr.es/universidad/normativa/texto-consolidado-normativa-evaluacion-calificacion-estudiantes-universidad-granada), 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.

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- **In the event that AI tools are used in the development of the course, students are expected to make ethical and responsible use of such tools.**
  They must adhere to the guidelines set forth in the document "Recommendations for the Use of Artificial Intelligence at the University of Granada", available at the following link: https://ceprud.ugr.es/formacion-tic/inteligencia-artificial/recomendaciones-ia#contenidoo
- In the **continuous assessment option**, the total score will be the sum of all scores corresponding to assessment activities. These are the following:
  - Two mid-term exams: two eliminatory mid-term exams will be held. Each of them will represent 50% of the final grade.
  - **If necessary (borderline cases) the instructor may include additional activities to validate the overall grade obtained in the two midterm exams.** These activities may include solving problems on the board, take-home exercises (individually or in groups), valuable in-class contributions such as thoughtful responses to questions posed by the instructor, or other academic tasks deemed appropriate to confirm the final mark.
- 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).
- 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.

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 will have the final mark "Not Having Been Submitted" ("No Presentado").

SINGLE FINAL ASSESSMENT (evaluación única final)

- Following the regulations, a single final evaluation is established for those students who have completed the required requirements and have applied for the single final assessment in a timely and proper manner, 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/procs/Gestion-Academica-Solicitud-de-evaluacion-unica-final/, 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).
- 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.

ADDITIONAL INFORMATION

Información de interés para estudiantado con discapacidad y/o Necesidades Específicas de Apoyo

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Educativo (NEAE): Gestión de servicios y apoyos (https://ve.ugr.es/servicios/atencion-social/estudiantes-con-discapacidad).

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