Mathematics II

Code: 102096
ECTS Credits: 6

2025/2026

Degree	Type	Year
Accounting and Finances	FB	1
Business and Information Technology	FB	1

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Teaching groups languages

You can view this information at the end of this document.

Prerequisites

To successfully follow this course, students must be able to handle basic mathematical concepts and tools, as well as have previously acquired fundamental notions of continuity, derivatives, and the analysis and graphical representation of real functions of a single real variable, as presented and studied in the Mathematics I course.

Objectives and Contextualisation

In this course, students are introduced to the study of linear algebra and multivariable functions, with an emphasis on their applications in the field of economics.

Therefore, the objective of the course is for students to become familiar with the basic mathematical concepts that they will later use in the study of economic theory and analysis.

Specifically, the intended learning objectives are:

- To familiarize students with *n*-dimensional Euclidean space
- To work with determinants and matrices
- To solve systems of linear equations
- To understand multivariable functions and their role in more complex economic models
- To represent functions of two variables geometrically using contour plots
- To understand the notion of the limit of a function at a point and the concept of continuity
- To understand Weierstrass's Theorem
- To familiarize students with partial derivatives of multivariable functions and with the concept of differentiability
- To use partial derivatives to obtain the slope of the contour line at a point and to carry out comparative statics exercises

- To solve optimization problems both without constraints and with equality constraints

Learning Outcomes

1. CM09 (Competence) Analyse the properties and notions of limits, derivatives and integrals using the graph of a function that describes economic and business behaviours.
2. CM10 (Competence) Refer to the operation of the most common mathematical programming algorithms for the resolution of optimization problems.
3. CM10 (Competence) Use mathematical language and basic demonstration methods for problems in the field of business and economics.
4. CM11 (Competence) Solve linear equation systems that represent problems in the field of business and economics.
5. CM11 (Competence) Analyse the properties and notions of limits, derivatives and integrals using the graph of a function that describes economic and business behaviours.
6. CM12 (Competence) Describe basic differential calculus results in one and several real variables to determine optimal solution.
7. CM12 (Competence) Analytically solve optimisation problems in the field of business and economics.
8. CM13 (Competence) Solve linear equation systems that represent problems in the field of business and economics.
9. CM14 (Competence) Analytically solve optimisation problems in the field of business and economics.
10. CM18 (Competence) Use mathematical language and basic demonstration methods for problems in the field of business and economics.
11. CM21 (Competence) Describe basic differential calculus results in one and several real variables to determine optimal solution.
12. KM07 (Knowledge) Describe the analytical tools required, both qualitative and quantitative, for problem-solving and decision-making at the different functional levels of the company.
13. KM12 (Knowledge) Describe the analytical tools required, both qualitative and quantitative, for problem-solving and decision-making at the different functional levels of the company.
14. KM19 (Knowledge) Define the mathematical and algorithmic principles applicable to solving business and technological problems.
15. SM05 (Skill) Use mathematical and algorithmic tools to solve problems in the business-economic sphere with deterministic components.
16. SM06 (Skill) Apply methods to convert data into relevant information for business control and decision making and to share these decisions within and outside the organisation.
17. SM06 (Skill) Use mathematical and algorithmic tools to solve problems in the business-economic sphere with deterministic components.
18. SM07 (Skill) Apply methods to convert data into relevant information for business control and decision making and to share these decisions within and outside the organisation.

Content

PART I. LINEAR ALGEBRA

Topic 1. VECTOR AND MATRIX ALGEBRA

1.1. Systems of linear equations
1.2. Operations with matrices and vectors
1.3. Linear dependence and independence of vectors
1.4. Properties of basic operations and geometric interpretations
1.5. Norm and Euclidean distance
1.6. Sets, lines, and planes

Topic 2. MATRIX CALCULUS

2.1. Matrices, determinants, inverse matrices, and rank
2.2. Solving systems of equations using matrices

PART II. MULTIVARIABLE FUNCTIONS

Topic 3. STUDY OF MULTIVARIABLE FUNCTIONS

3.1. Characteristics of multivariable functions
3.2. Geometric representation
3.3. Surfaces and distances
3.4. Level curves

Topic 4. PARTIAL DERIVATIVES AND DIFFERENTIABLE FUNCTIONS

4.1. Derivative of a function at a point in the direction of a unit vector
4.2. Partial derivatives
4.3. Gradient of a function at a point. Geometric interpretation and directional derivatives
4.4. Differentiable functions. Continuity of partial derivatives
4.5. Chain rule
4.6. Partial derivatives of linear combinations and quadratic forms
4.7. First- and second-order Taylor approximations

Topic 5. IMPLICIT FUNCTION THEOREM AND INVERSE FUNCTION THEOREM

5.1. Implicit function theorem
5.2. Inverse function theorem
5.3. Applications and geometric intuition

PART III. OPTIMIZATION WITH MULTIVARIABLE FUNCTIONS

Topic 6. UNCONSTRAINED OPTIMIZATION

6.1. Local and global optima
6.2. First- and second-order conditions for local optima
6.3. Global optima of concave and convex functions

Topic 7. CONSTRAINED OPTIMIZATION

7.1. Maximization and minimization problems with equality constraints
7.2. Constrained local optima. Lagrange's Theorem
7.3. Global constrained optima of concave and convex functions
7.4. Weierstrass Theorem
7.5. Introduction to inequality constraints

Activities and Methodology

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Preparation and solution of exercises	17	0.68	CM09, CM10, CM11, CM12, CM13, CM14, CM18, CM21, KM07, KM12, KM19, SM05, SM06, SM07, CM09
Theory classes	32.5	1.3	CM09, CM10, CM11, CM12, CM13, CM14, CM18, CM21, KM07, KM12, KM19, SM05, SM06, SM07, CM09

Type: Supervised			
Progress monitoring	3	0.12	CM09, CM10, CM11, CM12, CM13, CM14, CM18, CM21, KM07, KM12, KM19, SM05, SM06, SM07, CM09
Tutorials	7	0.28	CM09, CM10, CM11, CM12, CM13, CM14, CM18, CM21, KM07, KM12, KM19, SM05, SM06, SM07, CM09
Type: Autonomous			
Preparation and solution of exercises	40	1.6	CM09, CM10, CM11, CM12, CM13, CM14, CM18, CM21, KM07, KM12, KM19, SM05, SM06, SM07, CM09
Study	45	1.8	CM10, CM11, CM12, CM13, CM14, CM18, CM21, KM07, KM12, KM19, SM05, SM06, SM07, CM10

Lecture-based classes in which professors will develop the main concepts.

The aim of this activity is to introduce fundamental notions and facilitate student learning, with an emphasis on the economic applications of the mathematical concepts studied.

Guided instruction, where professors will apply the concepts studied to specific families of multivariable functions.

The goal of this activity is to foster student independence in the learning process by applying theoretical concepts to families of multivariable functions.

Problem sets to be solved by students.

Each topic will be accompanied by a list of problems that students must solve independently. This activity has a dual purpose: on one hand, to help students assimilate the theoretical concepts presented in class; on the other hand, to develop the necessary problem-solving skills.

Collaborative problem solving will be encouraged, through stable work groups of 3 or 4 students throughout the semester, who will collaborate to overcome difficulties encountered by any of the group members.

Problem-solving classes in which students will discuss the resolution of problems.

This activity aims to address and clarify doubts that students may have had while working on the problem sets, allowing them to better understand the material and correct any mistakes made.

In-person tutorials

Students will have access to a number of scheduled hours during which professors will be available to answer questions in person.

The proposed teaching methodology may be subject to change depending on any restrictions on in-person attendance imposed by health authorities.

Annotation: Within the schedule set by the centre or degree programme, 15 minutes of one class will be reserved for students to evaluate their lecturers and their courses or modules through questionnaires.

Assessment

Continous Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Final exam	50%	2	0.08	CM09, CM10, CM11, CM12, CM13, CM14, CM18, CM21, KM07, KM12, KM19, SM05, SM06, SM07
Parcial exam	30%	1.5	0.06	CM09, CM10, CM11, CM12, CM13, CM14, CM18, CM21, KM07, KM12, KM19, SM05, SM06, SM07
Progress monitoring	20%	2	0.08	CM09, CM10, CM11, CM12, CM13, CM14, CM18, CM21, KM07, KM12, KM19, SM05, SM06, SM07

This course/module does not include a single-assessment system.

Assessment Criteria

The midterm exam will account for 30% of the final average grade of the course.
The final exam will account for 50% of the final average grade of the course.

Thus, the final average grade is calculated as follows:

> Final average grade =
> 30% (midterm exam grade) +
> 50% (final exam grade) +
> 20% (grade from exercises/assignments/laboratory tests)

The course will be considered passed if the following two requirements are met:

- The final average grade is equal to or greater than 5, and
- The final exam grade is equal to or greater than 3.

If a student meets the first requirement but not the second, they will receive a final average grade of 4.5 and may take the reassessment exam, according to the conditions outlined in the "Reassessment Process" section below.

If a student meets the second requirement but not the first, or neither of the two, they may still take the reassessment exam, under the same conditions.

A student who has not participated in any assessment activity will be considered "Not assessable."

Assessment Schedule

The dates of the various assessment activities (midterm exams, in-class exercises, assignment submissions, etc.) will be announced well in advance during the semester.

The date of the final exam is scheduled in the Faculty's official exam calendar.

> "Assessment activities may not be rescheduled, except in cases of exceptional and duly justified reasons that prevent the student from attending an evaluation activity.
> In such cases, the academic program coordinators, after consultation with the teaching staff and affected students, will propose a new schedule within the corresponding academic period."
> *(Section 1, Article 264 - Assessment Activities Calendar, UAB Academic Regulations)*

Students from the Faculty of Economics and Business who, according to the above, need to reschedule an assessment must submit a request by filling out the form:
Assessment Rescheduling Request: e-Form for Rescheduling Assessments.

Grade Review Procedure

Coinciding with the final exam, the date and method of publication of the final grades will be announced. Details regarding the procedure, location, date, and time of the exam review session will also be provided, in accordance with university regulations.

Reassessment Process

> "To participate in the reassessment process, students must have been previously assessed in activities representing at least two-thirds of the total grade for the course or module."
> *(Section 2, Article 261 - Reassessment, UAB Academic Regulations)*

Students must have obtained a final average grade between 3.5 and 4.9.

The date of the reassessment exam will be scheduled in the Faculty's exam calendar.
If the student passes this exam, they will pass the course with a grade of 5. Otherwise, their original grade will remain unchanged.

Irregularities in Assessment

Without prejudice to other disciplinary measures deemed appropriate and in accordance with current academic regulations:

> "If a student commits any irregularity that could lead to a significant alteration of the grade of an assessment activity, that activity will be graded with a 0, regardless of any disciplinary proceedings that may be initiated.
> If multiple irregularities occur across different assessment activities in the same course, the final grade for that course will be 0."
> *(Section 11, Article 266 - Assessment Results, UAB Academic Regulations)*

Bibliography

Basic Bibliography

Sydsaeter, K., P.J. Hammond, and A. Carvajal, 2012, ***Matemáticas para el Análisis Económico***. Prentice Hall, Madrid.
(*Available online through the UAB library*)

This is a widely accepted reference manual with a long-standing reputation. Thanks to its updated editions, it has become a standard reference work. It also covers the syllabus of the course *Mathematics for Economists I*. It is a comprehensive and accessible textbook focused on economic applications.

The same authors have another book at a slightly more basic level, available only in English, which is also a good option as a main textbook:

Sydsaeter, K. and P.J. Hammond, 2012, ***Essential Mathematics for Economic Analysis***. Fourth edition. Pearson Education.

Complementary Bibliography

The following manuals can be very useful for students, whether to complement the content of the main textbook or to expand their knowledge:

- Alegre, P., L. Jorba, F.J. Orti, G. Rodríguez, J.B. Sáez, T. Sancho, and A. Terceño, 2000, *Solved Exercises in Business Mathematics II*. Editorial Alfacentauro, Madrid.

- Besada, M., F.J. García, M.A. Mirás, and M.C. Vázquez, 2001, *Multivariable Calculus: Questions and Solved Exercises*. Prentice Hall, Madrid.
- Chiang, A.C., 2006, *Fundamental Methods of Mathematical Economics*. McGraw-Hill, Madrid.
- Larson, R., R. Hostetler, and B. Edwards, 2006, *Calculus II of Several Variables*. McGraw-Hill, Mexico.

Additional material will be uploaded to the course webpage on the Virtual Campus, at the discretion of the teaching staff.

Software

NA

Groups and Languages

Please note that this information is provisional until 30 November 2025. You can check it through this link. To consult the language you will need to enter the CODE of the subject.

Name	Group	Language	Semester	Turn
(PAUL) Classroom practices	101	Catalan	second semester	morning-mixed
(PAUL) Classroom practices	201	Catalan	second semester	morning-mixed
(PAUL) Classroom practices	501	Catalan	second semester	afternoon
(TE) Theory	10	Catalan	second semester	morning-mixed
(TE) Theory	20	Catalan	second semester	morning-mixed
(TE) Theory	50	Catalan	second semester	afternoon