# Mathematics II

Code: 102096
ECTS Credits: 6

**2024/2025**

| Degree | Type | Year |
|---|---|---|
| 2501231 Accounting and Finances | FB | 1 |
| 2501232 Business and Information Technology | FB | 1 |

## Contact

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## Teaching groups languages

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

## Prerequisites

To follow properly this course, a correct understanding of basic mathematical concepts and tools is necessary, including the fundamental notions of continuity, differentiability, and graphical representation of real functions of one real variable, as studied in Mathematics I.

## Objectives and Contextualisation

This course introduces students to the study of linear algebra and functions of several variables, with emphasis on their applications in economics. Students should not only acquire and assimilate new mathematical knowledge, but also be able to apply them in quantitative analysis in economics and business.
Therefore, the purpose of the course is that students become familiar with basic mathematical concepts to be used in the study of economic theory and analysis.

Specifically the objectives are intended to achieve are:

1. To familiarize students with the n-dimensional Euclidean space.
2. Working with determinants and matrices.
3. Solving systems of linear equations.
4. Understanding the functions of several variables and their role in more complex economic models.
5. Geometric representation of functions of two variables using contour maps.
6. Understand the concepts of limit of a function at a point and of a continuous function.
7. Understanding the Weierstrass theorem.
8. To familiarize students with the partial derivatives of functions of several variables and the concept of differentiability.
9. Using partial derivatives to obtain the slope of the contour at one point and to perform comparative statics exercises.
10. Solving optimization problems without constraints and with equality constraints.

## Learning Outcomes

1. CM22 (Competence) Refer to the operation of the most common mathematical programming algorithms for solving optimisation problems.
2. CMU10 (Competence) Use mathematical language and basic demonstration methods for problems in the field of business and economics.
3. CMU11 (Competence) Analyse the properties and notions of limits, derivatives and integrals using the graph of a function that describes economic and business behaviours.
4. CMU12 (Competence) Describe basic differential calculus results in one and several real variables to determine optimal solution.
5. CMU13 (Competence) Solve linear equation systems that represent problems in the field of business and economics.
6. CMU14 (Competence) Analytically solve optimisation problems in the field of business and economics.
7. CMU17 (Competence) Use mathematical language and basic methods of proof to solve problems in the economic and business field.
8. CMU18 (Competence) Analyse the properties and notions of limit, derivative and integral from the graph of a function describing economic and business behaviour.
9. CMU19 (Competence) Describe basic results of differential calculus in one and several real variables to determine the optimal ones.
10. CMU20 (Competence) Solve systems of linear equations that represent problems in the field of economics and business.
11. CMU21 (Competence) Analytically solve optimisation problems in the field of economics and business.
12. KM19 (Knowledge) Define the mathematical and algorithmic principles applicable to solving business and technological problems.
13. KMU07 (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. KMU20 (Knowledge) Describe the necessary analysis tools, both at a qualitative and quantitative level, for problem solving and decision-making in the different functional levels of the company.
15. SMU06 (Skill) Use mathematical and algorithmic tools to solve problems in the business-economic sphere with deterministic components.
16. SMU07 (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. SMU13 (Skill) Use mathematical and algorithmic tools to solve problems in the economic-business field with deterministic components.
18. SMU14 (Skill) Apply the methods to convert data into relevant information for the control and taking of business decisions and their dissemination inside and outside the organisation.

## Content

PART I. LINEAR ALGEBRA

Topic 1. ALGEBRA OF VECTORS AND MATRICES

1.1. Systems of linear equations

1.2 Operations with arrays and vectors

1.2. Linear dependence and independence of vectors

1.3. Properties of basic operations and geometric interpretations

1.4. Euclidean norm and distance

1.5. Sets, lines and planes

Topic 2. MATRIX CALCULATIONS

2.1. Matrices, determinants, inverse matrices, and rank

2.2. Solving systems of equations using matrices

PART II. FUNCTIONS OF MANY VARIABLES

Topic 3. STUDY OF FUNCTIONS OF MANY VARIABLES

3.1. Characteristics of functions of several variables

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 of quadratic forms

4.7 First and second order Taylor series approximations

Topic 5. IMPLICIT FUNCTION THEOREM AND INVERSE FUNCTION THEOREM

5.1. Implicit function theorem

5.2. Inverse function theorem

5.3. Geometric applications and intuition

PART III. OPTIMIZATION WITH MULTIPLE VARIABLES

Topic 6. UNRESTRICTED 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. OPTIMIZATION WITH RESTRICTIONS

7.1. Maximization and minimization with equality constraints

7.2. Restrictedlocal optima. Lagrange theorem

7.3. Global constrained optima of concave and convex functions

7.4 Weierstrass Theorem

## Activities and Methodology

| Title | Hours | ECTS | Learning Outcomes |
|---|---|---|---|
| Type: Directed | | | |
| Practical classes | 17 | 0.68 | CMU10, CMU11, CMU13, CMU14, CMU17, CMU18, CMU20, CMU21, SMU06, SMU07, SMU13, SMU14 |
| Theory classes | 32.5 | 1.3 | CM22, CMU10, CMU11, CMU12, CMU13, CMU14, CMU17, CMU18, CMU19, CMU20, CMU21, KM19, KMU07, KMU20, SMU06, SMU07, SMU13, SMU14 |
| Type: Supervised | | | |
| Tutoring | 10 | 0.4 | CM22, CMU12, CMU19, KM19, KMU07, KMU20 |
| Type: Autonomous | | | |
| Preparation and solution of exercises | 42 | 1.68 | CMU10, CMU11, CMU13, CMU14, CMU17, CMU18, CMU21, SMU06, SMU07, SMU13, SMU14 |
| Study | 45 | 1.8 | CMU10, CMU11, CMU13, CMU14, CMU17, CMU18, CMU20, SMU06, SMU07, SMU13, SMU14 |

To achieve the objectives of the course, the following taxonomy of activities will be used:

1. Theory classes where teachers develop the main concepts.

The objective of this activity is to present the fundamental notions of course, and to facilitate their learning through the analysis of examples illustrating the intuitions and economic applications.

2. Exercises sessions devoted to the resolution of problems.

This activity aims to discuss and answer any questions that students may have in solving the problem sets, and at the same time to correct mistakes. These sessions will also stimulate the participation of students presenting the solutions of the problem sets either orally or in written form.

3. Organized supervised activities, to apply the concepts studied to economic situations

The objective of this activity is to encourage the student to establish links between the mathematical tools and their use in economics. When possible, these sessions will be organized in small groups of students.

4. Problem solving by students

Each topic will have a list of associated problems that must be solved independently by students.
The objective of this activity is two-fold: on the one hand it aims at the reinforcement of the theoretical concepts and tools exposed in the theory sessions; on the other hand it aims at the acquisition of the skills required to solve exercises and problems.
We promote the cooperative resolution of problems in stable working groups of 3 or 4 students throughout the semester, to stimulate team work to overcome the difficulties that may arise to their components.

5. Tutorial attendance

Students have several hours where the teachers of the course may help them to resolve any doubts that may arise in the study of the course and in the solution of the problem sets. These sessions cannot be on-line, but face-to-face between the teacher and the students.

The proposed teaching methodology may undergo some modifications according to the restrictions imposed by the health authorities on on-campus courses.

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 |
|---|---|---|---|---|
| Deliverable activities and continuous evaluation | 20% | 0 | 0 | CMU10, CMU11, CMU13, CMU14, CMU17, CMU18, CMU20, CMU21, SMU06, SMU07, SMU13, SMU14 |
| Final exam | 50% | 2 | 0.08 | CM22, CMU10, CMU11, CMU12, CMU13, CMU14, CMU17, CMU18, CMU19, CMU20, CMU21, KM19, KMU07, KMU20, SMU06, SMU07, SMU13, SMU14 |
| Partial Exam | 30% | 1.5 | 0.06 | CM22, CMU10, CMU11, CMU13, CMU14, CMU17, CMU18, CMU19, CMU20, KM19, KMU07, KMU20, SMU06, SMU07, SMU13, SMU14 |

This subject/module does not offer the option for comprehensive evaluation.

Evaluation criteria

The grade of the midterm exam will wieght a 30% of the average grade of the subject.

The grade of the final exam will weight a 50% of the average grade of the subject.

The grade of the submission of exercises, essays and/or quizzes in the lab will weight a 20% of the average grade of the subject.

Therefore, the average grade of the subject is computed as:

average grade of the subject = 30% (grade of the midterm exam) +
+ 50% (grade of the final exam) +
+ 20% (grade exercises/essays/lab quizzes)

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

1. the average grade of the subject is equal to or greater than 5 and
2. the grade of the final exam is equal to or greater than 3.

- A student that meets the first requirement above but does not meet the second will recevie an average grade of the subject equal to 4.5, and will qualify for the re-evaluation test according to what is established in the section "Retake Process" below.
- A student that meets the second requirement above but does not meet the first, or any of them, will qualify for the re-evaluation test according to what is established in the section "Retake Process" below.

A student who has not participated in any of the assessment activities will be considered "Not evaluable"

Calendar of evaluation activities

The dates of the evaluation activities (exercises in the classroom, assignments, ...) will be announced well in advance during the semester.

The dates of the mid-term and final exams are scheduled in the assessment calendar of the Faculty.

"The dates of evaluation activities cannot be modified, unless there is an exceptional and duly justified reason why an evaluation activity cannot be carried out. In this case, the degree coordinator will contact both the teaching staff and the affected student, and a new date will be scheduled within the same academic period to make up for the missed evaluation activity."***Section 1 of Article 115. Calendar of evaluation activities (Academic Regulations UAB)***. Students of the Faculty of Economics and Business, who in accordance with the previous paragraph need to change an evaluation activity date must process the request by filling out an Application for exams' reschedule https://eformularis.uab.cat/group/deganat_feie/nou-reprogramacio-de-proves

Grade revision process

After all grading activities have ended, students will be informed of the date and way in which the course grades will be published. Students will be also be informed of the procedure, place, date and time of grade revision following University regulations.

Retake Process

"To be eligible to participate in the retake process, it is required for students to have been previously been evaluated for at least two thirds of the total evaluation activities of the subject."Section 3 of Article 112 ter. The recovery (UAB Academic Regulations). Additionally, it is required that the student to have achieved an average grade of the subject between 3.5 and 4.9.

The date of the retake exam will be posted in the calendar of evaluation activities of the Faculty. Students who take this exam and pass, will get a grade of 5 for the subject. If the student does not pass the retake, the grade will remain unchanged, and hence, student will fail the course.

Irregularities in evaluation activities

In spite of other disciplinary measures deemed appropriate, and in accordance with current academic regulations, *"in the case that the student makes any irregularity that could lead to a significant variation in the grade of an evaluation activity, it will be graded with a 0, regardless of the disciplinary process that can be instructed. In case of various irregularities occur in the evaluation of the same subject, the final grade of this subject will be 0"*. ***Section 10 of Article 116. Results of the evaluation. (UAB Academic Regulations).***

***The proposed evaluation activities may undergo some changes according to the restrictions imposed by the health authorities on on-campus courses.***

## Bibliography

Recommended textbook:

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

This textbook has contents and level appropriate for the course. Problems from this book will be presented in class. You must have access to this book.

Complementary textbook:

Sydsaeter, K. and P.J. Hammond, 1995, Mathematics for Economic Analysis. London, Prentice Hall.

This is a slightly more advanced textbook, of great tradition and acceptance. It is recommended to students who feel well prepared and who wish to study at a deeper level.

Other textbooks:

The textbooks listed below can be helpful to complement the explanations contained in the main textbook and also to students wishing to enlarge their knowledge.

Alegre, P., L. Jorba, F.J. Orti, G. Rodriguez, J.B. Saez, T. Sancho and A. Terceño, 2000, Ejercicios Resueltos de Matemáticas Empresariales II, Madrid, Alfacentauro.

Besada, M., F.J. García, M.A. Mirás and M.C. Vázquez, 2001, Cálculo de varias variables. Cuestiones y ejercicios resueltos, Madrid, Ed. Prentice Hall.

Chiang, A.C., 2005, Fundamental Methods of Mathematical Economics, McGraw-Hill. Larson, R., R. Hostetler, and B. Edwards, 1994, Calculus with Analytic Geometry, Lexington, D.C. Heath.

Other complementary material will be uploaded in the webpage of the course.

## Software

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## Language list

| 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 |