MATHEMATICS FOR MANAGEMENT

Grado en Administración de Empresas / Bachelor in Business Administration BBA SEP-2023 MAT-NBA.1.M.F

Area Operations and Business Analytics

Number of sessions: 25

Academic year: 23-24

Degree course: FIRST

Number of credits: 5.0

Semester: 2º

Category: COMPULSORY

Language: English

Professor: **ANA MARIA GLAVAN**

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Ana Maria holds a Ph.D. in Mathematical Engineering from Carlos III University of Madrid. She taught different topics of Mathematics at Carlos III University and University of Navarra. Her actual research interest is on fintech and the application of mathematical modelling into finance, in particular in risk management and valuation of complex financial instruments, as an important cause of contagion during the recent global financial crisis.

Academic Qualifications

- Ph.D. in Mathematical Engineering, Carlos III University, 2016.
- Master in Biosensors for Environmental Monitoring, Perpignan University and Bucharest University, 2003.
- B.Sc. in Chemistry, Bucharest University, 2001.

Academic Experience

- Professor, IE Business School, 2016-present.
- Professor, Carlos III University, Ph.D. Programme in Mathematical Engineering, 2016-2017.
- Professor, University of Navarra, 2010-2012.
- Teaching Assistant, Carlos III University, 2004-2009.
- Research Assistant, BIOMEM, Centre de Phytopharmacie, 2002-2003.

Fields of Interest

- Computational methods in finance.
- Applied and computational mathematics.
- Numerical modelling algorithms.

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SUBJECT DESCRIPTION

This subject is the second course of a one-year sequence designed to give you the intuition to think about economic ideas in mathematical terms and interpret mathematical concepts in the context of economics. Your understanding of both economics and mathematics will have improved after this sequence.

Mathematics is increasingly vital regarding the expression and communication of ideas in Economics. Good knowledge of mathematics helps to understand economic laws and their application to business management. Especially some elements of calculus and linear algebra are crucial to the study of economics.

Economic concepts and models can often be easily and precisely described regarding mathematical notation when words and graphs would fail or mislead us. Mathematics for Management aims to teach you how to use mathematics to understand economics and business management. Therefore, as applications of the mathematical concepts covered in class, examples, and motivation will be drawn from important topics in economics and business. Topics covered include linear algebra, matrices, and systems of linear equations, derivatives of functions of several variables, interpretations of the derivative, convexity, constrained and unconstrained optimization, financial applications of Mathematics. The course includes an introduction to Linear Programming by using the program Solver in EXCEL® which is crucial for modern business management.

LEARNING OBJECTIVES

The main goal of this course is to provide a mathematical foundation for analysing data and drawing inferences from that analysis. Moreover, the course aims to increase the student's mastery of the deductive nature of reasoning and understanding the nature of critical thinking. To increase the student's ability in problem solving and abstract reasoning.

We classify the skills in two groups: specific and generic. Regarding the specific skills, the student will be able to:

- Define a matrix and carry out arithmetic operations involving matrices
- Solve a system of linear equations by Gaussian elimination.
- Define a determinant and evaluate 2 × 2 and 3 × 3 determinants
- Solve a system of linear equations using Cramer’s rule
- Calculate the inverse of a 2 × 2 and 3 × 3 matrix
- Solve a system of linear equations by the inverse matrix method
- Use Excel to carry out elementary row operations, to find determinants, to solve a system of linear equations, and to calculate the inverse of a matrix.
- Calculate first- and second-order partial derivatives.
- Calculate differentials and incremental changes.
- Calculate and interpret marginal functions and the law of diminishing returns.
- Show that a Cobb–Douglas function is homogeneous degree r and determine whether the function exhibits constant, decreasing or increasing returns to scale.
- Use partial derivatives to analyse the properties of production functions and utility functions.
- Calculate and interpret partial elasticities.
- Locate and determine the nature of stationary points for functions of several variables.
- Use Lagrange multipliers to determine maximum and minimum values for functions of two variables subject to a constraint.

- Calculate and interpret the Lagrange multiplier.
- Solve linear programming problems and illustrate the results graphically.
- Use Solver in EXCEL® to find constrained maxima and minima, and to carry out what-if analysis.

Regarding the general skills, the student will develop the abilities:

- To address economic and financial problems by means of abstract models.
- To solve the above formal models.
- To use the basic tools which are needed in the modern analysis of economic problems.

Throughout the course, the student should maintain:

- An inquisitive attitude when developing logical reasoning, being able to tell apart a proof from an example.
- An entrepreneurial and imaginative attitude towards the examples studied.
- A critical attitude towards the formal results.

TEACHING METHODOLOGY

Students must work before each class. The Syllabus indicates what "Worked Examples" and "Progress Exercises" from the textbook should be read before each session. A good approach should be to read the suggested worked examples to make sure you understand the method; then try to solve the problem by yourself. The course lectures will be based on a combination of theoretical explanations and several practical exercises. Each mathematical concept will be followed immediately by one or more examples. Student participation is considered very important to acquire the skills needed to pose and solve exercises.

We encourage students to work in groups when solving homework problems. However, we highly recommend that each student tries, at the same time, to solve problems by himself.

IE University teaching method is defined by its collaborative, active, and applied nature. Students actively participate in the whole process to build their knowledge and sharpen their skills. Professor's main role is to lead and guide students to achieve the learning objectives of the course. This is done by engaging in a diverse range of teaching techniques and different types of learning activities such as the following:

Learning Activity	**Weighting**	**Estimated time a student should dedicate to prepare for and participate in**
Lectures	8.0 %	10.0 hours
Discussions	4.0 %	5.0 hours
Exercises in class, Asynchronous sessions, Field Work	36.0 %	45.0 hours
Group work	8.0 %	10.0 hours
Individual studying	44.0 %	55.0 hours
TOTAL	100.0 %	125.0 hours

PROGRAM

TOPIC 1: LINEAR ALGEBRA AND BUSINESS APPLICATIONS [SESSIONS 1-8]

T. Bradley: Chapter 9.

EXCEL exercises: Chapter 9.

SESSION 1 (LIVE IN-PERSON)

- ***Course presentation.***

- Matrices. Basic operations with matrices. Excel for linear algebra

Readings: T. Bradley: 9.2.1 and 9.2.2

- Worked examples: 9.3 and 9.4.
- Progress exercises 9.2.

SESSION 2 (LIVE IN-PERSON)

. Matrix multiplication and Applications of matrix arithmetic. Excel for linear algebra

Readings: T. Bradley: 9.2.3 and 9.2.4

- Worked examples: 9.5 and 9.6.
- Progress exercises 9.2.
- EXCEL Exercises Chapter 9: 1 (Read 9.6. Excel for linear Algebra)

SESSION 3 (LIVE IN-PERSON)

. Systems of Linear Equations. Elimination methods (Gaussian Method). Excel for linear algebra

Readings: T. Bradley: 9.3.

- Worked examples: 9.7 and 9.8.
- Progress exercises 9.3.
- EXCEL Exercises Chapter 9: 2.

SESSION 4 (LIVE IN-PERSON)

. Determinants. Cramer's rule. Excel for linear algebra

Readings: T. Bradley: 9.4.

- Worked examples: 9.10, 9.11, 9.12, 9.14, and 9.15.
- Progress exercises 9.4 and 9.5.

SESSION 5 (LIVE IN-PERSON)

. The inverse of a matrix. Some applications of the inverse matrix. Excel for linear algebra.

Readings: T. Bradley: 9.5.

- Worked examples: 9.19, and 9.21.
- Progress exercises 9.6.

EXCEL Exercises Chapter 9.3.

SESSION 6 (ASYNCHRONOUS)

. ***Asynchronous activities/exercises on Blackboard***

SESSION 7 (LIVE IN-PERSON)

Review Session

SESSION 8 (LIVE IN-PERSON)

Exam 1

TOPIC 2: FUNCTIONS OF SEVERAL VARIABLES [SESSIONS 9-20]

T. Bradley: Chapter 7.

SESSION 9 (LIVE IN-PERSON)

. **Functions of two or more variables. Partial differentiation. First order partial derivatives. Online calculator for derivatives.**

Readings: T. Bradley: 7.1.1, and 7.1.2.

· Worked examples: 7.1, 7.2, and 7.3.

· Progress exercises: 7.1.

SESSION 10 (LIVE IN-PERSON)

. ***Second order partial derivatives. Online calculator for derivatives. Differentials and small changes.***

Readings: T. Bradley: 7.1.3 and 7.1.4.

· Worked examples: 7.4, 7.5, 7.6.a and 7.6.b.

· Progress exercises: 7.2 and 7.3.

SESSION 11 (LIVE IN-PERSON)

. ***Business and Economic applications of Partial Differentiation (I). Production Functions and Returns to Scale.***

Readings: T. Bradley: 7.2.

· Worked examples: 7.7, 7.8, 7.9, 7.10, 7.11, and 7.12.

· Progress exercises: 7.5 (page 393), and 7.6 (page 399).

SESSION 12 (LIVE IN-PERSON)

. ***Business and Economic applications of Partial Differentiation (II). Utility Functions, Partial Elasticities.***

Readings: T. Bradley: 7.2.

. Worked examples: 7.7, 7.8, 7.9, 7.10, 7.11, and 7.12.

. Progress exercises: 7.4, 7.5, and 7.6.

SESSION 13 (LIVE IN-PERSON)

. Unconstrained Optimization.

Readings: T. Bradley: 7.3.1

· Worked examples: 7.14.

· Progress exercises 7.7

SESSION 14 (LIVE IN-PERSON)

. Revenue and Profit maximization. Price discrimination.

Readings: T. Bradley: 7.3.2.

· Worked examples: 7.15, 7.16, and 7.17.

· Progress exercises 7.8.

SESSION 15 (LIVE IN-PERSON)

. Constrained optimization. The Lagrange Method. Maximizing TR subject to a budget constraint.

Readings: T. Bradley: 7.4.1, and 7.4.2.

· Worked examples: 7.18

SESSION 16 (LIVE IN-PERSON)

. Constrained optimization. Utility functions.

Readings: T. Bradley: 7.4.3.

· Worked examples: 7.19, 7.20 and 7.21.

· Progress exercises 7.9.

SESSION 17 (LIVE IN-PERSON)

. Constrained optimization. Production functions.

Readings: T. Bradley: 7.4.4, 7.4.5.

· Worked examples: 7.22, and 7.23.

· Progress exercises 7.9.

SESSION 18 (ASYNCHRONOUS)

Asynchronous activities/exercises on Blackboard.

SESSION 19 (LIVE IN-PERSON)

Review session

SESSION 20 (LIVE IN-PERSON)

Exam 2

TOPIC 3. LINEAR PROGRAMMING [SESSION 21-24]

T Bradley: Chapter 9.1 and W. L. Winston: Chapters 66 and 67

SESSION 21 (LIVE IN-PERSON)

. **Introduction to Formulation of Linear Programming Models. The graphical method.**

Readings: T. Bradley: 9.1.

- Worked examples: 9.1, and 9.2.
- Progress exercises: 9.1.

SESSION 22 (LIVE IN-PERSON)

An introduction to optimization with Excel Solver

Readings: W. L. Winston: Chapter 29.

- EXCEL exercises (W.L. Winston) Chapters 66.

SESSION 23 (LIVE IN-PERSON)

. **Using Solver to determine the optimal product mix.**

Readings: W. L. Winston: Chapter 30.

- EXCEL exercises (W.L. Winston) Chapter 67.

SESSION 24 (LIVE IN-PERSON)

Review session

SESSION 25 (LIVE IN-PERSON)

FINAL EXAM

See details in section 6.

EVALUATION CRITERIA

A. CLASS PARTICIPATION-CP-

It will be worth 10% of the overall grade - students are expected to come prepared and participate actively (and voluntarily) during lectures. Your class grade will be based also on attendance, punctuality, participation, and class conduct – there may be a penalty if you create a disruption, talk excessively, or use electronic devices in the wrong way. Your overall class participation grade will be obtained by adding the class grades across all the sessions.

B. INTERMEDIATE TESTS (EXAMS)-E-

It will be worth 25% of the overall grade.

There will be 2 intermediate exams (12.5% each).

Important. Only if you miss an exam due to force majeure, you will be offered an alternative option

C. ASYNCHRONOUS ACTIVITIES and OTHERS (A)

It will be worth 25% of the overall grade.

Asynchronous activities will consist of several exercises/activities on Blackboard throughout the asynchronous sessions (2) and they will be worth 15%. Another 10% will be obtained from a different activity announced in advance by the professor.

D. FINAL EXAM

It is worth 40% of the overall grade. You need to score at least 3.5 on the final exam to pass the overall course, even if you have already passed the course through the other course assessments.

The final exam will cover the whole subject.

FINAL GRADE: The final grade will be computed according to the following formula

FINAL GRADE = 0.10x(CP) + 0.15x(A) + 0.25x(E1) +0.15x(E2) + 0.35x(FE)

Your final grade in the course will be based on both individual and group work of different characteristics that will be weighted in the following way:

criteria	**percentage**	**Learning Objectives**	**Comments**
Final Exam	40 %		Session 25
Intermediate Tests	25 %		
Asynchronous activities	25 %		
Class Participation	10 %		

RE-SIT / RE-TAKE POLICY

Each student has four (4) chances to pass any given course distributed over two (2) consecutive academic years. Each academic year consists of two calls: one (1) ordinary call (during the semester when the course is taking place); and one (1) extraordinary call (or “re-sit”) in June/July.

Students who do not comply with the 80% attendance requirement in each subject during the semester will automatically fail both calls (ordinary and extraordinary) for that Academic Year and have to re-take the course (i.e., re-enroll) during the next Academic Year.

The Extraordinary Call Evaluation criteria will be subject to the following rules:

· Students failing the course in the ordinary call (during the semester) will have to re-sit evaluation for the course in June / July (except those students who do not comply with the attendance rule, and therefore will not have that opportunity, since they will fail both calls and must directly re-enroll in the course during the next Academic Year).

· It is not permitted to change the format nor the date of the extraordinary call exams or deadlines under any circumstance. All extraordinary call evaluation dates will be announced in advance and must be taken into consideration before planning the summer (e. g. internships, trips, holidays, etc.)

· The June/July re-sit will consist of a comprehensive evaluation of the course. Your final grade for the course will depend on the performance in this exam or evaluation only. I.e., continuous evaluation over the semester (e. g. participation, quizzes, projects and/or other grade components over the semester) will not be taken into consideration on the extraordinary call. Students will have to achieve the minimum passing grade of 5 and the maximum grade will be capped at 8.0 (out of 10.0) – i.e., “notable” in the extraordinary call.

· Re-takers: Students who failed the subject on a previous Academic Year and are now re-enrolled as re-takers in a course will need to check the syllabus of the assigned professor, as well as contact the professor individually, regarding the specific evaluation criteria for them as re-takers in the course during that semester (ordinary call of that Academic Year). The maximum grade that may be obtained as a retaker during the ordinary call (i.e., the 3rd call) is 10.0 (out of 10.0).

After exams and other assessments are graded by the professor (on either the ordinary or extraordinary call), students will have a possibility to attend a review session (whether it be a final exam, a final project, or the final overall grade in a given course). Please be available to attend the session in order to clarify any concerns you might have regarding your grade. Your professor will inform you about the time and place of the review session.

· Students failing more than 18 ECTS credits after the June/July re-sits will be asked to leave the Program. Please, make sure to prepare yourself well for the exams in order to pass your failed subjects.

· In case you decide to skip the opportunity to re-sit for an exam or evaluation during the June/July extraordinary call, you will need to enroll in that course again for the next Academic Year as a re-taker, and pay the corresponding tuition fees. As you know, students have a total of four (4) allowed calls to pass a given subject or course, in order to remain in the program.

The students in their third attempt must do:

- o Asynchronous sessions (15%)
- o Intermediate exams (40 %)
- o Final exam (45%)

To pass the subject in this attempt, you need a minimum grade of 5 points in the retake. Be aware that you need to score at least 3.5 on the final exam to pass the overall course, even if you have already passed the course through the other course assessments.

BIBLIOGRAPHY

Compulsory

- Bradley, Teresa. (2013). *Essential Mathematics for Economics and Business.* 4th. John Wiley & Sons/. ISBN 9781118358290 (Digital)

Recommended

- Winston, Wayne L.. (2021). *Microsoft Excel Data Analysis and Business Modeling (Office 2021 and Microsoft 365).* 7th edition. Microsoft Press. ISBN 9780137613762 (Digital)

BEHAVIOR RULES

Please, check the University's Code of Conduct here. The Program Director may provide further indications.

ATTENDANCE POLICY

Please, check the University's Attendance Policy here. The Program Director may provide further indications.

ETHICAL POLICY

Please, check the University's Ethics Code here. The Program Director may provide further indications.