
APPLIED BUSINESS MATHEMATICS

Dual Degree in Business Administration & Data and Business Analytics BBADBA SEP-2024 ABMn-NBDA.1.M.A

Area Operations and Business Analytics

Number of sessions: 30

Academic year: 24-25

Degree course: FIRST

Number of credits: 6.0

Semester: 1º

Category: BASIC

Language: English

Professor: **JUAN CARLOS MARCOS YERVES**

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ACADEMIC BACKGROUND:

Juan Carlos Marcos studied Civil Engineering at the U. Politécnica – Madrid. Postgraduate Degree in Advanced Calculus Applied to Foundations and Structures (1989). Certified by the American Production and Inventory Control Society (APICS, 1992) in Supply Chain. APICS is the premier professional association for Supply Chain and Operations Management. Management Program by IESE Business School (2000).

ACADEMIC EXPERIENCE:

Juan Carlos works as an associated professor with several business schools and universities:

- IE Business School and IE University.
- Universidad Politécnica de Catalunya.
- Universidad del Pacífico (Perú).

In addition to his experience delivering Mathematics applied to business in the BBA grade, he shares his Management experience delivering courses and lectures related with Global Operations & Strategy, Digital Innovation, Industry 4.0, Supply Chain and Operations Strategy.

BUSINESS EXPERIENCE:

Juan Carlos has more than 25 years of experience in leadership positions in Global Companies. In 2004, he reached the position of Global Managing Director of the Supply Chain Practice at Accenture, the #1 Global Management Consulting and Technology Firm with more than 700,000 professionals worldwide. He gained extensive experience assessing leading global companies across various industries in their transformation and digital innovation programs.

He also actively collaborates with several NGOs as a volunteer and consultant.

Office Hours

Office hours will be on request. Please contact at:

jmarcos@faculty.ie.edu

I am happy to meet with students either on Campus or by Zoom upon request. Please, let me know in class or preferably email me at the following address: jmarcos@faculty.ie.edu.

Remember to include your group identification in all emails and communications. I can only respond to requests sent using the student email account of IE University.

SUBJECT DESCRIPTION

The conception of Mathematics, or at least of what we could call “applied mathematics in social sciences,” has changed over the last decades. Rather than viewing Mathematics as a standalone subject, we now recognize it as a powerful collection of tools essential for rigorous analysis across diverse domains such as the economy, business, society, and public policies.

Our era is marked by extraordinary technological advancements, including AI generative tools. Simultaneously, we grapple with a complex interplay of financial, geopolitical, and demographic forces, each influencing the other. Amidst this challenging landscape, professionals who can navigate and analyze intricate situations are in high demand.

The World Economic Forum’s “Future of Jobs 2023” report underscores the enduring importance of analytical and creative thinking skills for workers. Interestingly, Mathematical thinking shares fundamental principles with analytical thinking, making them complementary in problem-solving and understanding societal challenges. Students enrolled in this course will acquire valuable mathematical tools to dissect economic and management problems effectively.

LEARNING OBJECTIVES

- Address economic problems through abstract models.
- State and solve formal models.
- Use the tools required to analyze economic and business issues. What are the key learnings of this course?
- Discover the multiple applications of matrix algebra to real-life applications.
- Economic analysis, cryptography, 3D graph animation.
- Know when and how to use a specific function to model some social and business phenomena. For example, logarithms are essential to model growth, innovation adoption, or even pandemics.
- Use derivatives for finding critical information for decision-making. - Elasticities, MRS, maximizing revenues and profit or minimizing costs. - Marginal products of labor and capital.
- Connect math tools with economic policy or management decisions.
- Use Math in real-life scenarios by adding constraints to any problem.
- How to deal with budget constraints or scheduling workers.
- Perform a dynamic analysis by using integration and differential equations.
- You must be able to translate a real-life problem into Math and interpret the results. How are you going to learn about the above issues?

The objective of this course is to provide the student with the quantitative tools required to analyze economic, business, or political problems. At the end of the term, students will take a good knowledge of relevant tools and methods. They will be able to know when and how to use them. We will guide the students through a new approach to Math learning with an entirely practical approach.

TEACHING METHODOLOGY

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

We will use a blend of learning methodologies, including Peer Instruction, Flipped Classroom, and Case method, minimizing the classical lecture-based teaching. Prof. Erik Mazur (Harvard University) developed peer instruction, a methodology that involves students in their learning during lectures, focusing their attention on underlying concepts. At the beginning of most face-to-face sessions, students will take a Quiz twice: the first time individually and the second after a brief discussion with a small group of classmates.

To complete the learning process, after most of the F2F sessions, students must work on some exercises that will be available online (on Blackboard).

The case method is widely used in Business Schools. It is a teaching approach that utilizes decision-forcing cases to put students in the role of people who have faced difficult decisions. We will use the Case method in Sessions #4 and #26.

Learning Activity	Weighting	Estimated time a student should dedicate to prepare for and participate in
Lectures	20.0 %	30.0 hours
Discussions	5.0 %	7.5 hours

Exercises in class, Asynchronous sessions, Field Work	25.0 %	37.5 hours
Group work	25.0 %	37.5 hours
Individual studying	25.0 %	37.5 hours
TOTAL	100.0 %	150.0 hours

AI POLICY

Restricted use of GenAI

In today's world, generative artificial intelligence (GenAI) is changing how we work, study and, in general, how we get things done. However, in the context of this course, the use of GenAI is not permitted, unless it is otherwise stated by the instructor. The use of GenAI tools would jeopardize the students' ability to acquire fundamental knowledge or skills of this course.

If a student is found to have used AI-generated content for any form of assessment, it will be considered academic misconduct, and the student might fail the respective assignment or the course.

PROGRAM

SESSION 1 (LIVE IN-PERSON)

Sustainability Topics:

- Economic Development

Matrix Algebra. Basic matrix operations.

Learning goals:

- Use the notation and terminology of matrix algebra.
- Find the transpose of a matrix.
- Elementary matrix operations.
- Multiply matrices together.
- Represent a system of linear equations in matrix notation.
- MS-Excel: TRANSPOSE, MMULT

Teaching comments:

- Before the session, you must watch the video announced on Campus online (using the link published on Blackboard) or read the book chapter/s corresponding to this session.
- Failing to complete the "Before the session" activities will negatively impact your ability to follow the session and, therefore, could affect your continuous grading results.
- During the session, you'll be asked to complete quizzes about the subject's scope. The grade corresponding to the delivery of these exercises will be part of your class contribution grade. After the session, you should work on the "Session 1" list of exercises (Available on Blackboard).

Multimedia Material: Video: Session 1: Matrix operations

Book Chapters: Book Chapters Mathematics for Economics and Business. Section 7.1 (Available on IE Campus "MyLab Math") (See Bibliography)

SESSION 2 (LIVE IN-PERSON)

Determinants. Matrix inversion.

Learning goals:

- Understand the matrix equations involving the inverse matrix.
- Write down any identity matrix.
- Calculate the determinant of any square matrix (EXCEL).
- Detect whether a matrix is singular or non-singular (EXCEL).
- Find the inverse of any non-singular matrix (EXCEL).
- Use matrix inverses to solve systems of linear equations (EXCEL).

Teaching comments:

- Before the session, you must watch the video announced on Campus online (using the link published on Blackboard) or read the book chapter/s corresponding to this session.
- Failing to complete the "Before the session" activities will negatively impact your ability to follow the session and, therefore, could affect your continuous grading results.
- During the session, you'll be asked to complete quizzes about the subject's scope. The grade corresponding to the delivery of these exercises will be part of your class contribution grade. After the session, you should work on the "Session 2" list of exercises (Available on Blackboard).

Multimedia Material: Video: Session 2: Matrix inversion (Available on Blackboard)

Multimedia Material: Video: How to find an inverse matrix by using EXCEL (Available on Blackboard)

Book Chapters: Mathematics for Economics and Business; Section 7.2. Matrix Inversion (See Bibliography)

SESSION 3 (LIVE IN-PERSON)

Systems of Linear Equations. Cramer's rule.

Learning goals:

- Understand the limitations of using inverses to solve Systems of Linear Equations (SLE)
- Use the Cramer's rule to solve SLE.
- Apply Cramer's rule to solve some economic problems.

Teaching comments:

- Before the session, you must watch the video announced on Campus online (using the link published on Blackboard) or read the book chapter/s corresponding to this session.
- Failing to complete the "Before the session" activities will negatively impact your ability to follow the session and, therefore, could affect your continuous grading results.
- During the session, you'll be asked to complete some quizzes about the scope of the subject. The grade corresponding to the delivery of these exercises will be part of your class contribution grade. After the session, you should work on the "Session 3" list of exercises (Available on Blackboard).

Multimedia Material: Video: Session 3: Cramer's Rule (Available on Blackboard)

Multimedia Material: Video: How to use EXCEL for solving Systems of Linear Equations (Available on Blackboard)

Book Chapters: Mathematics for Economics and Business; Section 7.3. Cramer's rule (See Bibliography)

SESSION 4 (LIVE IN-PERSON)

In this session, you will work in groups to discover some of the fantastic applications of matrices to real-life problems. The groups will compete to solve the case, and their results will determine the grade obtained by each team member.

Teaching comments: Review contents and exercises corresponding to the previous sessions to be ready for this session.

Practical Case : A Mysterious Message for Natalie: A Case for discovering the power of Math (QME010106-U-ENG-WOD-BC)

SESSION 5 (LIVE IN-PERSON)

Linear Functions. Graphs of linear equations.

Learning goals:

- Sketch a line by finding the coordinates of two points of the line.
- Sketch a line by using its slope and intercept.
- Use EXCEL to plot linear functions and solve simultaneous linear equations graphically.

Teaching comments:

- Before the session, you must watch the video announced on Campus online (using the link published on Blackboard) or read the book chapter/s corresponding to this session.
- Failing to complete the "Before the session" activities will negatively impact your ability to follow the session and, therefore, could affect your continuous grading results.
- During the session, you'll be asked to complete some quizzes about the scope of the subject. The grade corresponding to the delivery of these exercises will be part of your class contribution grade. After the session, you should work on the "Session 5" list of exercises (Available on Blackboard).

Multimedia Material: Video: Session 5 (Available on Blackboard)

Book Chapters: Mathematics for Economics and Business; Section 1.3 (See Bibliography)

SESSION 6 (LIVE IN-PERSON)

Sustainability Topics:

- Economic Development

Demand and Supply Analysis: Market equilibrium.

Learning goals:

- Use the functions' notation.
- Identify endogenous and exogenous variables in an economic model.
- Identify and sketch linear demand and supply functions.
- Determine the market equilibrium (i.e., price and quantity).
- Use MS Excel to represent market equilibrium conditions.

Teaching comments:

- Before the session, you must watch the video announced on Campus online (using the link published on Blackboard) or read the book chapter/s corresponding to this session.
- Failing to complete the "Before the session" activities will negatively impact your ability to follow the session and, therefore, could affect your continuous grading results.

- During the session, you'll be asked to complete some quizzes about the scope of the subject. The grade corresponding to the delivery of these exercises will be part of your class contribution grade. After the session, you should work on the "Session 6" list of exercises (Available on Blackboard).

Multimedia Material: Video: Session 6 (Available on Blackboard)

Book Chapters: Mathematics for Economics and Business; Section 1.5 (See Bibliography)

SESSION 7 (LIVE IN-PERSON)

Non-linear Equations.

Learning goals:

- Solve quadratic equations.
- Sketch the graph of a quadratic function.
- Solve quadratic inequalities.
- Determine the market equilibrium (i.e., price and quantity) given a pair of quadratic demand and supply functions.
- Use MS Excel as a support tool to solve and represent quadratic and cubic exercises.

Teaching comments:

- Before the session, you must watch the video announced on Campus online (using the link published on Blackboard) or read the book chapter/s corresponding to this session.
- Failing to complete the "Before the session" activities will negatively impact your ability to follow the session and, therefore, could affect your continuous grading results.
- During the session, you'll be asked to complete quizzes about the subject's scope. The grade corresponding to the delivery of these exercises will be part of your class contribution grade. After the session, you should work on the "Session 7" list of exercises (Available on Blackboard).

Multimedia Material: Video: Session 7 (Available on Blackboard)

Book Chapters: Mathematics for Economics and Business; Section 2.1 (See Bibliography)

SESSION 8 (LIVE IN-PERSON)

Sustainability Topics:

- Economic Development

Revenue, Cost, and Profit.

Learning goals:

- Introduction, definition, and construction of the revenue, cost, and profit functions.
- Sketch the graphs for the total revenue, total cost, average revenue, average cost, and profit function (EXCEL).
- Find the level of output that maximizes total revenue.
- Find the level of output that maximizes profit.
- Find the break-even levels of output.

Teaching comments:

- Before the session, you must watch the video announced on Campus online (using the link published on Blackboard) or read the book chapter/s corresponding to this session.

- Failing to complete the "Before the session" activities will negatively impact your ability to follow the session and, therefore, could affect your continuous grading results.
- During the session, you'll be asked to complete quizzes about the subject's scope. The grade corresponding to the delivery of these exercises will be part of your class contribution grade. After the session, you should work on the "Session 8" list of exercises (Available on Blackboard).

Multimedia Material: Video: Session 8 (Available on Blackboard)

Book Chapters: Mathematics for Economics and Business; Section 2.2 (See Bibliography)

SESSION 9 (LIVE IN-PERSON)

Indices and logarithms.

Learning goals:

- Evaluate b^n when n is positive, negative, a whole number, or a fraction.
- Simplify algebraic expressions using the rules of indices.
- Returns to scale of a production function.
- Evaluate logarithms in simple cases.
- Use the rules of logarithms to solve equations in which the unknown occurs as a power.

Teaching comments:

- Before the session, you must watch the video announced on Campus online (using the link published on Blackboard) or read the book chapter/s corresponding to this session.
- Failing to complete the "Before the session" activities will negatively impact your ability to follow the session and, therefore, could affect your continuous grading results.
- During the session, you'll be asked to complete quizzes about the subject's scope. The grade corresponding to the delivery of these exercises will be part of your class contribution grade. After the session, you should work on the "Session 9" list of exercises (Available on Blackboard).

Multimedia Material: Video: Session 9 (Available on Blackboard)

Book Chapters: Mathematics for Economics and Business; Section 2.3 (See Bibliography)

SESSION 10 (LIVE IN-PERSON)

The exponential and natural logarithms functions ($\ln x$).

Learning goals:

- Sketch graphs of general exponential functions.
- Modeling growth and decay.
- Use the $y = \ln x$ to solve equations.

Teaching comments:

- Before the session, you must watch the video announced on Campus online (using the link published on Blackboard) or read the book chapter/s corresponding to this session.
- Failing to complete the "Before the session" activities will negatively impact your ability to follow the session and, therefore, could affect your continuous grading results.
- During the session, you'll be asked to complete some quizzes about the scope of the subject. The grade corresponding to the delivery of these exercises will be part of your class

contribution grade. After the session, you should work on the "Session 10" list of exercises (Available on Blackboard).

Multimedia Material: Video: Session 10 (Available on Blackboard)

Book Chapters: Mathematics for Economics and Business; Section 2.4 (See Bibliography)

SESSION 11 (ASYNCHRONOUS)

In this session, you will solve a mock midterm exam consisting of questions covering the contents of sessions 1-10.

Materials: Review the topics studied in previous sessions.

Teaching comments: During this session, you will work at home to solve some exercises. The exercises will be available online only on the day the session is scheduled.

SESSION 12 (LIVE IN-PERSON)

Derivatives. Rules of Differentiation.

Learning goals:

- The derivative of a function. The slope of a tangent.
- Lagrange ($f'(x)$) and Leibniz (dy/dx) notations for the derivative.
- Differentiate power functions.
- The constant rule to differentiate $y = c + f(x)$ vs $y = c \cdot f(x)$
- The sum (difference rule to differentiate $y = f(x) \pm g(x)$
- Evaluate and interpret second-order derivatives.

Teaching comments:

- Before the session, you must watch the video announced on Campus online (using the link published on Blackboard) or read the book chapter/s corresponding to this session.
- Failing to complete the "Before the session" activities will negatively impact your ability to follow the session and, therefore, could affect your continuous grading results.
- During the session, you'll be asked to complete some quizzes about the scope of the subject. The grade corresponding to the delivery of these exercises will be part of your class contribution grade. After the session, you should work on the "Session 12" list of exercises (Available on Blackboard).

Multimedia Material: Video: Session 12 (Available on Blackboard)

Book Chapters: Mathematics for Economics and Business; Sections 4.1 and 4.2 (See Bibliography)

SESSION 13 (LIVE IN-PERSON)

Midterm Exam.

The mid-term exam consists of some exercises and questions from Sessions 1-10. This exam will be administered through Blackboard and will take 35 minutes.

Materials: No calculators are allowed. Excel is permitted, but you only have to use the file provided by the professor. You can use your notes on paper in a single PDF format. Only ONE device (laptop or tablet) will be allowed.

During the exam, proctoring software will monitor and prevent cheating. Any incidents reported will be submitted to the Ethical Committee.

SESSION 14 (LIVE IN-PERSON)

Sustainability Topics:

- Economic Development

Marginal Functions.

Learning goals:

- Calculate marginal revenue and marginal cost.
- Derive the relationship between marginal and average revenue.
- Calculate the marginal product of labor.
- State the law of diminishing marginal productivity.
- Calculate the marginal propensity to consume and marginal propensity to save.

Teaching comments:

- Before the session, you must watch the video announced on Campus online (using the link published on Blackboard) or read the book chapter/s corresponding to this session.
- Failing to complete the "Before the session" activities will negatively impact your ability to follow the session and, therefore, could affect your continuous grading results.
- During the session, you'll be asked to complete some quizzes about the scope of the subject. The grade corresponding to the delivery of these exercises will be part of your class contribution grade. After the session, you should work on the "Session 14" list of exercises (Available on Blackboard).

Multimedia Material: Video: Session 14 (Available on Blackboard)

Book Chapters: Mathematics for Economics and Business; Section 4.3 (See Bibliography)

SESSION 15 (LIVE IN-PERSON)

Further rules of differentiation.

Learning goals:

- Differentiate the exponential and the natural logarithm functions.
- Use the chain rule to differentiate a function of a function.
- Use the product rule to differentiate the product of two functions.
- Use the quotient rule to differentiate the quotient of two functions.
- Using combinations of differentiation rules.

Teaching comments:

- Before the session, you must watch the video announced on Campus online (using the link published on Blackboard) or read the book chapter/s corresponding to this session.
- Failing to complete the "Before the session" activities will negatively impact your ability to follow the session and, therefore, could affect your continuous grading results.
- During the session, you'll be asked to complete quizzes about the subject's scope. The grade corresponding to the delivery of these exercises will be part of your class contribution grade. After the session, you should work on the "Session 15" list of exercises (Available on Blackboard).

Multimedia Material: Video: Session 15 (Available on Blackboard)

Book Chapters: Mathematics for Economics and Business; Section 4.4 (See Bibliography)

SESSION 16 (LIVE IN-PERSON)

Sustainability Topics:

- Economic Development

Applications of the derivative to real-life problems: Elasticity.

Learning goals:

- Price elasticity (point and arc).
- Decide whether a supply and demand function is inelastic, unit elastic, or elastic.
- Understand the relationship between price elasticity of demand and revenue.
- Price elasticity for general linear demand functions.

Teaching comments:

- Before the session, you must watch the video announced on Campus online (using the link published on Blackboard) or read the book chapter/s corresponding to this session.
- Failing to complete the "Before the session" activities will negatively impact your ability to follow the session and, therefore, could affect your continuous grading results.
- During the session, you'll be asked to complete some quizzes about the scope of the subject. The grade corresponding to the delivery of these exercises will be part of your class contribution grade. After the session, you should work on the "Session 16" list of exercises (Available on Blackboard).

Multimedia Material: Video: Session 16 (Available on Blackboard)

Book Chapters: Mathematics for Economics and Business; Section 4.5 (See Bibliography)

SESSION 17 (LIVE IN-PERSON)

Sustainability Topics:

- Economic Development

Applications of the derivative to real-life problems: Optimisation of economic functions.

Learning goals:

- Use the first-order derivative to find the stationary points of a function.
- Use the second-order derivative to classify the stationary points of a function.
- Find the maximum and minimum points of an economic function.
- Use stationary points to sketch graphs of economic functions.

Teaching comments:

- Before the session, you must watch the video announced on Campus online (using the link published on Blackboard) or read the book chapter/s corresponding to this session.
- Failing to complete the "Before the session" activities will negatively impact your ability to follow the session and, therefore, could affect your continuous grading results.
- During the session, you'll be asked to complete some quizzes about the scope of the subject. The grade corresponding to the delivery of these exercises will be part of your class contribution grade. After the session, you should work on the "Session 17" list of exercises (Available on Blackboard).

Multimedia Material: Video: Session 17 (Available on Blackboard)

Book Chapters: Mathematics for Economics and Business; Section 4.6 (See Bibliography)

SESSION 18 (LIVE IN-PERSON)

Sustainability Topics:

- Economic Development

Description: Further optimization of economic functions.

Learning goals:

- Show that, at the point of maximum profit, marginal revenue equals marginal costs.
- Show that, at the point of maximum profit, the slope of the marginal revenue curve is less than that of marginal cost.
- Maximize a firm's profit with and without price discrimination in different markets.
- Show that, at the maximum average product of labor, the average product of labor equals the marginal product of labor.

Teaching comments:

- Before the session, you must watch the video announced on Campus online (using the link published on Blackboard) or read the book chapter/s corresponding to this session.
- Failing to complete the "Before the session" activities will negatively impact your ability to follow the session and, therefore, could affect your continuous grading results.
- During the session, you'll be asked to complete some quizzes about the scope of the subject. The grade corresponding to the delivery of these exercises will be part of your class contribution grade. After the session, you should work on the "Session 18" list of exercises (Available on Blackboard).

Multimedia Material: Video: Session 18 (Available on Blackboard)

Book Chapters: Mathematics for Economics and Business; Section 4.7 (See Bibliography)

SESSION 19 (LIVE IN-PERSON)

Functions of several variables. Partial differentiation.

Learning goals:

- Use the function notation $z = f(x,y)$
- Determine the first-order partial derivatives, f_x and f_y
- Determine the second-order partial derivatives, f_{xx} , f_{xy} , f_{yx} , and f_{yy}
- Use the small increments formula
- Perform implicit differentiation

Teaching comments:

- Before the session, you must watch the video announced on Campus online (using the link published on Blackboard) or read the book chapter/s corresponding to this session.
- Failing to complete the "Before the session" activities will negatively impact your ability to follow the session and, therefore, could affect your continuous grading results.
- During the session, you'll be asked to complete some quizzes about the scope of the subject. The grade corresponding to the delivery of these exercises will be part of your class contribution grade. After the session, you should work on the "Session 19" list of exercises (Available on Blackboard).

Multimedia Material: Video: Session 19 (Available on Blackboard)

Book Chapters: Mathematics for Economics and Business; Section 5.1 (See Bibliography)

SESSION 20 (LIVE IN-PERSON)

Sustainability Topics:

- Economic Development

Partial elasticity and marginal functions.

Learning goals:

- Calculate partial elasticities
- Calculate marginal utilities
- Calculate the MRS (marginal rate of substitution along an indifference curve).
- Calculate marginal products.
- Calculate the MRTS (marginal rate of technical substitution along an isoquant)
- Euler's theorem.

Teaching comments:

- Before the session, you must watch the video announced on Campus online (using the link published on Blackboard) or read the book chapter/s corresponding to this session.
- Failing to complete the "Before the session" activities will negatively impact your ability to follow the session and, therefore, could affect your continuous grading results.
- During the session, you'll be asked to complete some quizzes about the scope of the subject. The grade corresponding to the delivery of these exercises will be part of your class contribution grade. After the session, you should work on the "Session 20" list of exercises (Available on Blackboard).

Multimedia Material: Video: Session 20 (Available on Blackboard)

Book Chapters: Mathematics for Economics and Business; Section 5.2 (See Bibliography)

SESSION 21 (ASYNCHRONOUS)

In this session, you will solve questions covering contents from sessions 14-20.

Materials: Review the topics studied in previous sessions.

Teaching comments: During this session, you will work at home to solve some exercises. The exercises will be available online only on the day the session is scheduled.

SESSION 22 (LIVE IN-PERSON)

Unconstrained Optimization.

Learning goals:

- Use the first-order partial derivatives to find the stationary points of a function of two variables.
- Use the second-order partial derivatives to classify the stationary points of a function of two variables.
- Find the maximum profit of a firm that produces two goods.
- Other optimization problems.

Teaching comments:

- Before the session, you must watch the video announced on Campus online (using the link published on Blackboard) or read the book chapter/s corresponding to this session.
- Failing to complete the "Before the session" activities will negatively impact your ability to follow

the session and, therefore, could affect your continuous grading results.

- During the session, you'll be asked to complete some quizzes about the scope of the subject. The grade corresponding to the delivery of these exercises will be part of your class contribution grade. After the session, you should work on the "Session 22" list of exercises (Available on Blackboard).

Multimedia Material: Video: Session 22. (Available on Blackboard)

Book Chapters: Mathematics for Economics and Business; Section 5.4 (See Bibliography)

SESSION 23 (LIVE IN-PERSON)

Sustainability Topics:

- Economic Development

Constrained optimization.

Learning goals:

- Give a graphical interpretation of constrained optimization.
- Use the method of Lagrange multipliers to solve constrained optimization problems.
- Give an economic interpretation of Lagrange multipliers.
- Use Lagrange multipliers to maximise a Cobb-Douglas production function subject to a cost constraint.
- Use Lagrange multipliers to maximize a utility production function subject to a budgetary constraint.
- Use of SOLVER for finding constrained extrema.

Teaching comments:

- Before the session, you must watch the video announced on Campus online (using the link published on Blackboard) or read the book chapter/s corresponding to this session.
- Failing to complete the "Before the session" activities will negatively impact your ability to follow the session and, therefore, could affect your continuous grading results.
- During the session, you'll be asked to complete some quizzes about the scope of the subject. The grade corresponding to the delivery of these exercises will be part of your class contribution grade. After the session, you should work on the "Session 23" list of exercises (Available on Blackboard).

Multimedia Material: Video: Session 23 (Available on Blackboard)

Book Chapters: Mathematics for Economics and Business; Sections 5.5 and 5.6 (See Bibliography)

SESSION 24 (LIVE IN-PERSON)

Economic Applications of Constraint Optimization.

Learning goals:

- Show that when a firm maximizes output subject to a cost constraint, the ratio of marginal product to price is the same for all inputs.
- Show that when a consumer maximizes utility subject to a budgetary constraint, the ratio of marginal utility to price is the same for all goods.
- Constrained optimization subject to inequality constraints (Karush-Khun-Tucker).

Teaching comments:

- Before the session, you must watch the video announced on Campus online (using the link published on Blackboard) or read the book chapter/s corresponding to this session.
- Failing to complete the "Before the session" activities will negatively impact your ability to follow the session and, therefore, could affect your continuous grading results.
- During the session, you'll be asked to complete some quizzes about the scope of the subject. The grade corresponding to the delivery of these exercises will be part of your class contribution grade. After the session, you should work on the "Session 24" list of exercises (Available on Blackboard).

Multimedia Material: Video: Session 24 (Available on Blackboard)

Book Chapters: Mathematics for Economics and Business; Sections 5.5 and 5.6 (See Bibliography)

SESSION 25 (LIVE IN-PERSON)

Sustainability Topics:

- Environment
- Economic Development

Linear Programming.

Learning goals:

- Identify the objective and constraint functions of a real-life problem.
- Graphical solutions of linear programming problems.
- Apply SOLVER to linear programming problems.
- Some applications of linear programming.
- Interpret the results.

Teaching comments:

- Before the session, you must watch the video announced on Campus online (using the link published on Blackboard) or read the book chapter/s corresponding to this session.
- Failing to complete the "Before the session" activities will negatively impact your ability to follow the session and, therefore, could affect your continuous grading results.
- During the session, you'll be asked to complete some quizzes about the scope of the subject. The grade corresponding to the delivery of these exercises will be part of your class contribution grade. After the session, you should work on the "Session 25" list of exercises (Available on Blackboard).

Multimedia Material: Video: Session 25 (Available on Blackboard)

Multimedia Material: Video: How to use SOLVER for LP (Available on Blackboard)

Book Chapters: Mathematics for Economics and Business; Sections 8.1 and 8.2 (See Bibliography)

SESSION 26 (LIVE IN-PERSON)

Sustainability Topics:

- Environment
- Economic Development

Case: Solving real-life problems using Solver. In this session, you will work in groups to use Solver in real life. The groups will compete to solve the case, and their results will determine the grade obtained by each team member.

Teaching comments: Review the contents and exercises corresponding to the previous sessions to prepare for this session.

Multimedia Material: Video: Some examples using SOLVER for LP (Available on Blackboard)

Book Chapters: Microsoft Excel 2016 Data Analysis and Business Modeling; Chapters 29 and 30 (Available on Blackboard)

SESSION 27 (LIVE IN-PERSON)

Indefinite Integration.

Learning goals:

- Recognize the notation for indefinite integration.
- Solve the integrals from simple powers and exponentials.
- Integrate functions of the form $a \cdot f(x) + b \cdot g(x)$
- Find the total cost function given any marginal cost function.
- Find the total revenue function given any marginal revenue function.
- Find other total functions.

Teaching comments:

- Before the session, you must watch the video announced on Campus online (using the link published on Blackboard) or read the book chapter/s corresponding to this session.
- Failing to complete the "Before the session" activities will negatively impact your ability to follow the session and, therefore, could affect your continuous grading results.
- During the session, you'll be asked to complete some quizzes about the scope of the subject. The grade corresponding to the delivery of these exercises will be part of your class contribution grade. After the session, you should work on the "Sessions 27-28" list of exercises (Available on Blackboard).

Multimedia Material: Video: Session 27 (Available on Blackboard)

Book Chapters: Mathematics for Economics and Business; Section 6.1 (See Bibliography)

SESSION 28 (LIVE IN-PERSON)

Definite Integration. Consumer and producer surplus.

Learning goals:

- Recognize the notation for definite integration.
- Evaluate definite integrals in simple cases.
- Calculate the consumer surplus for linear and non-linear demand functions.
- Calculate the producer surplus for linear and non-linear supply functions.
- Other applications of integration (Capital stock formation, the present value of a continuous revenue stream).

Teaching comments:

- Before the session, you must watch the video announced on Campus online (using the link published on Blackboard) or read the book chapter/s corresponding to this session.
- Failing to complete the "Before the session" activities will negatively impact your ability to follow the session and, therefore, could affect your continuous grading results.
- During the session, you'll be asked to complete some quizzes about the scope of the subject. The grade corresponding to the delivery of these exercises will be part of your class

contribution grade. After the session, you should work on the "Sessions 27-28" list of exercises (Available on Blackboard).

Multimedia Material: Video: Session 28 (Available on Blackboard)

Book Chapters: Mathematics for Economics and Business; Section 6.2 (See Bibliography)

SESSION 29 (LIVE IN-PERSON)

Sustainability Topics:

- Economic Development

Final Exam Review.

Materials: Review the topics studied in previous sessions.

SESSION 30 (LIVE IN-PERSON)

FINAL EXAM.

The exam covers the whole subject. It consists of 5 questions worth 2 points each, plus a bonus question that awards an extra point. Hence, you may earn up to 11 points out of 10 in this exam.

This exam will be administered through Blackboard and will take 35 minutes.

Materials: No calculators are allowed. Excel is permitted, but you only have to use the file provided by the professor. You can use your notes on paper in a single PDF format. Only ONE device (laptop or tablet) will be allowed.

During the exam, proctoring software will monitor and prevent cheating. Any incidents reported will be submitted to the Ethical Committee.

EVALUATION CRITERIA

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:

A. CLASS PARTICIPATION

Class participation is crucial to your final grade, accounting for 10% of your overall grade. You must attend lectures fully prepared and actively participate to achieve the best possible grade. Your class participation grade will be based on your responses to quizzes during face-to-face sessions and other factors such as attendance, punctuality, answering the professor's questions, and general class conduct. Students who engage in behavior that disturbs their classmates or the professor, talk excessively, or use electronic devices for non-academic purposes, such as WhatsApp or Instagram, will be penalized.

B. MIDTERM

The mid-term exam will take place in Session #13 and is worth 30% of the overall grade. It will be deployed through Blackboard and will take 35 minutes to complete. This exam will be administered through Blackboard and will take 35 minutes.

Materials: No calculators are allowed. Excel is permitted, but you only have to use the file provided by the professor. You can use your notes on paper in a single PDF format. Only ONE device (laptop or tablet) will be allowed.

During the exam, proctoring software will monitor and prevent cheating. Any incidents reported will be submitted to the Ethical Committee.

C. DELIVERABLES

This course includes a homework component worth 20% of the final grade. A problem set will be assigned for most sessions and graded after the due date. However, please be aware that there will be no exceptions or deadline changes. If you miss a due date, your grade for the assignment will be 0 points. To ensure fairness, before computing your overall "Homework" grade, the worst FOUR scores over the semester will be excluded.

D. FINAL EXAM

It is worth 40% of the overall grade, and you need to score **at least 4.0 on the final exam to pass the general course**, even if you have already passed the continuous evaluation (i.e., class participation, homework, and midterm exam). The final exam will be administered through Blackboard and will take **65 minutes**. It will cover the entirety of the subject, comprised of 5 questions worth 2 points each and an additional bonus question that allows you to gain an extra point. This means that you may obtain up to 11 points out of 10.

Materials: No calculators are allowed. Excel is permitted, but you only have to use the file provided by the professor. You can use your notes on paper in a single PDF format. Only ONE device (laptop or tablet) will be allowed.

During the exam, proctoring software will monitor and prevent cheating. Any incidents reported will be submitted to the Ethical Committee.

Each student has four (4) chances to pass any 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.

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.

Regarding remote attendance, you must be allowed by the BBA Office upon request. During the sessions, students connecting remotely must connect their cameras and microphones fully at all times. They must actively participate during the sessions (using all necessary audiovisual equipment), just as their peers are physically present in the classroom on campus.

criteria	percentage	Learning Objectives	Comments
Final Exam	40 %		Session #30
Homework	20 %		Home Exercises
Class Participation	10 %		Ongoing
Midterm	30 %		Session #13

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 third attempt final grade will be computed as follows:

- Deliverables: (Only sessions #11 and #21) (20 %)
- Midterm (35%)
- Final exam (45%)
- The minimum weighted grade to pass is 5.0. However, you need to score at least 4.0 on the final exam to pass the overall course, even if you have already passed the course through the other course assessments.

BIBLIOGRAPHY

Compulsory

- Ian Jacques. (2018). *Mathematics for Economics and Business*. 1st. Pearson. ISBN 9781292191669 (Digital)

Recommended

- Winston, Wayne L. (2016). *Microsoft Excel 2016 Data Analysis and Business Modeling*. Microsoft Press/Pearson. ISBN 9789462390362 (Digital)

A soft copy of chapters 29, 30 and 31 will be uploaded on Blackboard.

- Alpha C. Chiang and Kevin Wainwrigth. (2004). *Fundamental Methods of*

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.

1. Students have the obligation to attend at least 80% of sessions. For in person programs, they are required to attend on Campus.
2. In each session the professor must mark as Absent any student who is not present in the classroom, even if he/she is connected online. It is recommended to take roll call first and then open Zoom.
3. When a student approaches the professor to excuse the absence, the professor must refer the student to the Program Management (PM), which is the only one able to determine if the case is among the allowed exceptions. The professor CANNOT justify any type of absence from the classroom.
4. PM will only grant exceptions for reasons of force majeure of a prolonged nature.
5. PM will inform the professor of the approved exceptions specifying the name of the student, subject, group and, if applicable, the sessions affected (session number and date). The professor must mark these sessions as Excused in the control system he/she is using.
6. Sessions marked as Excused are excluded in the calculation of 80%. For example, if in a class of 30 sessions, 3 sessions have been marked as Excused, the student cannot miss more than 5 sessions, instead of the 6 that would correspond if there were no Excused sessions.
7. Retaker students are not required to attend class. PM will notify the professors and they will mark them as Excused.
8. If two sessions are scheduled back to back, attendance must be completed for each of them so that the % is calculated correctly.
9. Late mode should not be used.

ETHICAL POLICY

Please, check the University's Ethics Code [here](#). The Program Director may provide further indications.