# APPLIED BUSINESS MATHEMATICS

**Grado en Administración de Empresas / Bachelor in Business Administration BBA SEP-2023 ABMn-NBA.1.M.A**

Area Operations and Business Analytics

Number of sessions: 25

Academic year: 23-24

Degree course: FIRST

Number of credits: 6.0

Semester:  1º

Category: BASIC

Language: English

## Professor: **CRISTINA GARCÍA DE LA FUENTE**

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I studied Applied Mathematics in Mexico City, at my beloved alma mater, ITAM. When I finished my bachelor's degree, I came to Spain to study a master's and a PhD, both in Mathematical Engineering at the Statistics Department of the Universidad Carlos III de Madrid.

I have always been a teacher. First, I tutored young kids during my bachelor's degree. Then, I started teaching at the UC3M while I was a student there. Since I graduated, I have been a Math and Statistics professor in public and private, Spanish and international universities. Teaching really is my calling in life.

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## SUBJECT DESCRIPTION

People often think of Mathematics as a collection of different axioms and theorems, which build a complete theoretical system but have few connections (or no connections at all) with real life problems. Fortunately, this conception of Mathematics, or at least of what we could call "applied mathematics in social sciences," has changed over the last decades. From this new point of view, one must think of Mathematics, not as a subject but as a collection of tools that are needed in any rigorous and complete analysis of complex problems in different contexts such as the economy, business, society, or public policies.

We are living the birth of the fourth industrial revolution in light of some extraordinary technological advances. Simultaneous to this significant upheaval are an arrangement of financial, geopolitical, and demographic drivers of progress, each interacting in multiple directions and intensifying one another. This challenging scenario opens new opportunities for those professionals capable of managing and analyzing such complex situations.

A recently published report from the World Economic Forum states that to be able to solve complex problems is going to be the most valuable skill for coming years. A lack of proficiency in mathematics is the primary limitation to improving the power of abstraction which is a crucial requirement for complex problem-solving. Students following this course will learn useful tools to analyze economic and management problems.

## LEARNING OBJECTIVES

- The objective of this course is to provide the student with part of the quantitative tools required to analyze economic, social, or political problems. Regarding its contents, this first course comprises some elementary topics of Calculus of one-real variables. In brief, the topics covered will include functions of one variable and derivatives.
- To address economic 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.
- Plot the straight line when given the value of slope and intercept.
- Write down the equation of the straight line when given (i) the value of slope and intercept (ii) any two points on the line (iii) the slope of the line and a point on the line.
- Plot a straight line when given its equation.
- Plot linear demand, supply, cost and revenue functions.
- Verbally describe linear demand, supply, cost and revenue functions.
- Translate linear functions horizontally and vertically and write down the equation of the translated function.
- Calculate the price elasticity of demand and supply for linear demand and supply functions.
- Plot any linear function in Excel. Use Excel to find the slope and y-intercept given 2 points on the line.
- Use Excel to illustrate the rules for vertical and horizontal translations.
- Solve two equations in two unknowns and illustrate the solution graphically.
- Distinguish between unique solutions, no solutions and infinitely many solutions.
- Solve three equations in three unknowns.
- Calculate the equilibrium price and quantity in the goods market and illustrate the solution graphically.
- Use Excel to find the point of intersection of two straight lines. Goal seek function.
- Calculate and illustrate graphically break-even, profit and loss.
- Recognize the general form of the equation representing a non-linear function as well as the main characteristics of the graph representing the function.
- Manipulate non-linear functions algebraically, particularly in economic applications such as demand, supply, revenue, cost and profit.
- Use exponentials and logs in a range of applications, such as production and consumption.
- Plot quadratic, cubic and other functions using Excel.
- Calculate the derivatives of a range of functions.
- Calculate marginal and average functions.
- Determine the maximum and minimum values.
- Determine maximum and minimum values of revenue, profit, cost, and other economic functions.
- Determine points of inflection and use these to describe curvature.
- Use points of inflection in applications such as the point of diminishing returns.
- Determine the point elasticity of demand and relationships between price elasticity of demand and marginal revenue, total revenue and price changes.
- Integrate standard functions and evaluate definite integrals of standard functions.
- Determine the net area enclosed between a curve and the lines x = a and x = b.
- Calculate the consumer and producer surplus and illustrate these graphically.
- Integrate marginal functions to obtain the corresponding total function.
- 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 formal results.

## TEACHING METHODOLOGY

| Learning Activity | Weighting | Estimated time a student should dedicate to prepare for and participate in |
|---|---|---|
| Lectures | 8.0 % | 12.0 hours |
| Discussions | 5.0 % | 7.5 hours |
| Exercises in class, Asynchronous sessions, Field Work | 32.0 % | 48.0 hours |
| Group work | 10.0 % | 15.0 hours |
| Individual studying | 45.0 % | 67.5 hours |
| TOTAL | 100.0 % | 150.0 hours |

## PROGRAM

## SESSION 1 (LIVE IN-PERSON)

**Sustainability Topics:**

- Economic Development

?Topic 1. Linear Models and Business Applications. The Straight Line. Excel as a calculator and Excel for linear functions.?

Worked examples: 2.2, 2.11-2.13. Progress exercises: 2.5. EXCEL Exercises Chapter 2: 1-4.?

*Book Chapters: Essential Mathematics for Economics and Business; chapters 2.1, 2.4, and 2.8 (See Bibliography)*

## SESSION 2 (LIVE IN-PERSON)

?Business applications: Demand, Supply, Cost and Revenue, and break-even points. Excel for linear functions (point of intersection-goal seek function)?.

Worked examples: 2.6, 2.7, 2.8, 2.9, 2.10a, and 2.10b. Progress exercises: 2.3 and 2.4. EXCEL Exercises Chapter 2. 5-11.?

*Book Chapters: Essential Mathematics for Economics and Business; chapter 2.3 (See Bibliography)*

## SESSION 3 (LIVE IN-PERSON)

Elasticity of Demand and Supply. Arc Elasticity.?

Worked examples: 2.19. Progress exercises: 2.7. EXCEL Exercises Chapter 2.12?.

*Book Chapters: Essential Mathematics for Economics and Business; chapter 2.6 (See Bibliography)*

## SESSION 4 (LIVE IN-PERSON)

??Translations of linear functions. Budget constraints.??

Worked examples: 2.14, 2.15, 2.16, 2.22, 2.23, and 2.24. Progress exercises: 2.6, 2.8, and 2.9.). EXCEL Exercises Chapter 2. 13 and 14?.

*Book Chapters: Essential Mathematics for Economics and Business; chapters 2.5 and 2.7 (See Bibliography)*

## SESSION 5 (LIVE IN-PERSON)

?Market Equilibrium. Excel for linear functions (equilibrium point-goal seek function). Taxes and subsidies.?

Worked examples: 3.1-3.8, 3.11, 3.12 and 3.13. Progress exercises: 3.1., 3.2., and 3.3. EXCEL Exercises Chapter 3: 1-6.?

*Book Chapters: Essential Mathematics for Economics and Business; chapters 3.1, 3.2.1, 3.2.3, 3.2.4, and 3.5 (See Bibliography)*

## SESSION 6 (LIVE IN-PERSON)

**Sustainability Topics:**

- Economic Development

?Topic 2. Non-linear functions and business applications. Quadratic Functions. Graphs and equations of translated quadratics. Non-linear Demand and Supply Functions. Excel for non-linear functions.?

Worked examples: 4.1, 4.2, 4.3, 4.5, and 4.7. Progress exercises: 4.2. EXCEL Exercises Chapter 4: 1-6.

*Book Chapters: Essential Mathematics for Economics and Business; chapters 4.1. and 4.5 (See Bibliography)*

## SESSION 7 (LIVE IN-PERSON)

Non-linear Total Revenue and Total Profit Functions. Break-even points. Cubic functions and General Polynomials.?

?Worked examples: 4.8, 4.9, 4.10a, 4.10b, and 4.11. Progress exercises: 4.3 and 4.4. Exercises Chapter 4: 7-10.?

*Book Chapters: Essential Mathematics for Economics and Business; chapter 4.1 (See Bibliography)*

## SESSION 8 (LIVE IN-PERSON)

??Exponential Functions and Logarithmic Functions. Applications: limited and unlimited growth.??

Worked examples: 4.13-4.18, and 4.21, and 4.22. Progress exercises: 4.5, 4.6, 4.7, 4.8, 4.10, and 4.11. EXCEL Exercises Chapter 4: 11-15.

*Book Chapters: Essential Mathematics for Economics and Business; chapter 4.2 and 4.3 (See Bibliography)*

## SESSION 9 (LIVE IN-PERSON)

Hyperbolic (Rational) Functions.?

Worked examples: 4.23, and 4.24. Progress exercises: 4.12 and 4.13. EXCEL Exercises Chapter 4: 16-17.

*Book Chapters: Essential Mathematics for Economics and Business; chapter 4.4 (See Bibliography)*


## SESSION 10 (ASYNCHRONOUS)

?Asynchronous activities/exercises on Blackboard.?

During this session, you will work at home to solve some exercises. Be aware that the exercises will be available online only on the day the session is scheduled.?


## SESSION 11 (LIVE IN-PERSON)

Review session.?

Review the topics studied in previous sessions.?


## SESSION 12 (LIVE IN-PERSON)

?Midterm Exam 1.?

Materials: ?Excel, formula sheet (provided by the professor), and an online calculator (provided by the professor)?. Physical calculators, Windows calculators, Apple calculators, mobile phones, etc. are forbidden.?


## SESSION 13 (LIVE IN-PERSON)

**Sustainability Topics:**

- Economic Development

?Topic 3. Differentiation and Applications. Slope of a Curve and Differentiation. Differentiation Rules. Further Differentiation. Online calculator for derivatives.?

Worked examples: 6.1, 6.2, 6.3, 6.4, 6.33, 6.34, 6.35, and 6.36. Progress exercises: 6.1, 6.12, 6.13, 6.14, and 6.15. EXCEL Exercises Chapter 6: 1, 2, and 3.?

*Book Chapters: Essential Mathematics for Economics and Business; chapters 6.1 and 6.6 (See Bibliography)*


## SESSION 14 (LIVE IN-PERSON)

?Business Applications of Differentiation: Marginal Functions and Average Functions.?

Worked examples: 6.6, 6.8, 6.10. Progress exercises: 6.3. EXCEL Exercises Chapter 6: 4, 5, and 6.?

*Book Chapters: Essential Mathematics for Economics and Business; chapters 6.2.1 and 6.2.2 (See Bibliography)*


## SESSION 15 (LIVE IN-PERSON)

?Optimization for Functions of One Variable.?

Worked examples: 6.16, 6.17, 6.18, and 6.19.). Progress exercises: 6.5, 6.6, 6.7, and 6.8.?

*Book Chapters: Essential Mathematics for Economics and Business; chapter 6.3 (See Bibliography)*

## SESSION 16 (LIVE IN-PERSON)

**Sustainability Topics:**

- Economic Development

?Economic Applications of Maximum and Minimum Points. Price discrimination.?

?Worked examples: 6.21, 6.22, 6.23, and 6.24. Progress exercises: 6.9. EXCEL Exercises Chapter 6: 7, 8, and 9.?

*Book Chapters: Essential Mathematics for Economics and Business; chapter 6.4 (See Bibliography)*

## SESSION 17 (LIVE IN-PERSON)

?Curvature and Other Applications.?

Worked examples: 6.27, 6.28, 6.31, 6.32, 6.37, and 6.38.). Progress exercises: 6.10, 6.11, and 6.16. EXCEL Exercises Chapter 6: 10.?

*Book Chapters: Essential Mathematics for Economics and Business; chapter 6.5 (See Bibliography)*

## SESSION 18 (LIVE IN-PERSON)

**Sustainability Topics:**

- Economic Development

Elasticity and the Derivative.?

Worked examples: 6.39, 6.40, and 6.41. Progress exercises: 6.17.

*Book Chapters: Essential Mathematics for Economics and Business; chapter 6.7 (See Bibliography)*

## SESSION 19 (ASYNCHRONOUS)

?Exercises on Blackboard.

During this session, you will work at home to solve some exercises. Be aware that the exercises will be available online only on the day the session is scheduled.??

## SESSION 20 (LIVE IN-PERSON)

?Review Session.?

??Review the topics studied in previous sessions.??

## SESSION 21 (LIVE IN-PERSON)

Midterm Exam 2.??????

Materials: Excel, formula sheet (provided by the professor), and an online calculator (provided by the professor). ??Physical calculators, Windows calculators, Apple calculators, mobile phones, etc. are forbidden.??

## SESSION 22 (LIVE IN-PERSON)

**Sustainability Topics:**

- Economic Development

Topic 4. Integration and Applications. Integration as the Reverse of Differentiation. Rules for Integration (Power, exponential and logs). Integration of functions of linear functions. Online Calculator for integrals.

Worked examples: 8.1, 8.2, 8.3, 8.4, 8.5, 8.6, and 8.7. ?Progress exercises: 8.1 and 8.2.

*Book Chapters: Essential Mathematics for Economics and Business; chapters 8.1, 8.2, 8.3, and 8.4 (See Bibliography)*

## SESSION 23 (LIVE IN-PERSON)

?The Definite Integral and the Area under a Curve. Consumer and Producer Surplus.?

Worked examples: 8.8, 8.9, 8.12, 8.13, and 8.14. Progress exercises: 8.3 and 8.4.??

*Book Chapters: Essential Mathematics for Economics and Business; chapters 8.5 and 8.6 (See Bibliography)*

## SESSION 24 (LIVE IN-PERSON)

?Some Economic Applications of integration.?

Worked examples: 8.15, 8.16, 8.17, 8.18, and 8.19. Progress exercises: 8.5, 8.6, and 8.7.?

*Book Chapters: Essential Mathematics for Economics and Business; chapter 8.7 (See Bibliography)*

## SESSION 25 (LIVE IN-PERSON)

**Sustainability Topics:**

- Environment
- Economic Development

Final Exam?.

Materials: ??Excel, formula sheet (provided by the professor), and an online calculator (provided by the professor)?.? ??Physical calculators, Windows calculators, Apple calculators, mobile phones, etc. are forbidden?.?

## 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:

**FINAL GRADE = 0.10x(CP) + 0.20x(A) + 0.15x(E1) +0.15x(E2) + 0.40x(FE)**

(According to the table below)

**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 inappropriately.

**ASYNCHRONOUS ACTIVITIES and Others (A)**

It will be worth 20% 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 5% will be obtained from a different activity announced in advance by the professor.

**INTERMEDIATE EXAMS (E):**

It will be worth 30% of the overall grade. There will be 2 intermediate exams (15% each).

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

**FINAL EXAM (FE):**

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 (Topics 1-4).

**Excel, a formula sheet (provided by the professor), and an online calculator (provided by the professor) are allowed. Physical calculators, Windows calculators, Apple calculators, mobile phones, etc. are forbidden.**

| criteria | percentage | Learning Objectives | Comments |
|---|---|---|---|
| Final Exam | 40 % | | Session 25 |
| Class Participation | 10 % | | Ongoing |
| Other | 20 % | | Asynchronous activities and others (A): Sessions 10 and 19 (15%). And other sessions (5%) |
| Intermediate tests | 30 % | | (E1 and E2): Sessions 12 and 21 |

**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 your 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 in a previous Academic Year and are now reenrolled 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:

- Asynchronous activities: 15%
- Intermediate exams: 40%
- Final exam: 45%

$$\text{FINAL GRADE} = 0.15x(A) + 0.20x(E1) + 0.20x(E2) + 0.45x(FE)$$

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)

## 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 70% 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 70% (example: If in a class of 30 sessions, 3 sessions have been marked as?Excused, the student cannot miss more than 8, instead of the 9 that would correspond if there were no?Excused?sessions).
7. ?Retaker students are nor required to attend class. PM will notify the professors and they will marked 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.