

APPLIED BUSINESS MATHEMATICS

IE University

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Academic year: 22-23

Degree course: FIRST

Semester: 1º

Category: BASIC

Number of credits: 5.0

Language: English

PREREQUISITES

Basic elements of algebra (pre-calculus) such as operations with powers (including negative and fractional powers) and fractions. Factorization, solving basic equations, working with inequalities and absolute values. It is also recommended to have a basic knowledge of elementary functions (polynomial, rational, power, exponential, and logarithmic). Good knowledge of MS-EXCEL(1) is highly recommendable.

(1) EXCEL is available to all IE students within the Office 365 Campus license (see <http://it.ie.edu/services/detail/06-office-365>)

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.

OBJECTIVES AND SKILLS

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 variable. In brief, topics covered will include functions of one variable and derivatives.

We classify the skills into two groups: specific and generic. Regarding the general skills, the student will develop the abilities:

- 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.

Regarding the specific skills, the student will be able to:

- 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.
- Calculate consumer and producer surplus.
- 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.

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.

The course lectures will be based on a combination of theoretical explanations and several practical exercises. Students should attempt to solve the exercises that will be given to them as homework in each lecture. Student participation is considered very important to acquire the skills needed to pose and solve exercises.

METHODOLOGY

All the material will be covered in class, so students should be present and active during the lectures.

Students are encouraged to work in groups when solving homework problems. However, it is highly recommended that each student tries, at the same time, to solve problems by himself.

Teaching methodology	Weighting	Estimated time a student should dedicate to prepare for and participate in
Lectures	8.0 %	10 hours
Discussions	4.0 %	5 hours
Exercises	36.0 %	45 hours
Group work	8.0 %	10 hours
Other individual studying	44.0 %	55 hours
TOTAL	100.0 %	125 hours

PROGRAM

SESSION 1 (LIVE IN-PERSON)

TOPIC 1: LINEAR MODELS AND BUSINESS APPLICATIONS [Sessions 1-5]

T. Bradley: Chapters 2 and 3. EXCEL exercises: Chapters 2 and 3.

. **Course presentation. The Straight Line. Excel for linear functions (graphs and the Excel functions: SLOPE and INTERCEPT).**

Readings: T. Bradley: 2.1, 2.4, and 2.8.

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

SESSION 2 (LIVE IN-PERSON)

- **Business applications: Demand, Supply, Cost and Revenue, and Break-even Points.**

Readings: T. Bradley: 2.3.

- *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.*

SESSION 3 (LIVE IN-PERSON)

- **Elasticity of Demand and Supply. Arc Elasticity.**

Readings: T. Bradley: 2.6.

- *Worked examples: 2.19.*
- *Progress exercises: 2.7.*
- *EXCEL Exercises Chapter 2. 12.*

SESSION 4 (LIVE IN-PERSON)

- **Translations of linear functions. Budget constraints**

Readings: T. Bradley: 2.5 and 2.7.

- *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*

SESSION 5 (LIVE IN-PERSON)

- **Market Equilibrium. Excel for linear functions (equilibrium point-goal seek function). Taxes and subsidies. Consumer and Producer Surplus.**

Readings: T. Bradley: 3.1., 3.2.1., 3.2.3, 3.2.4, 3.2.5, 3.3, and 3.5.

- *Worked examples: 3.1-3.8, 3.11, 3.12, 3.13, 3.14 and 3.15.*
- *Progress exercises: 3.1., 3.2., 3.3., and 3.4.*
- *EXCEL Exercises Chapter 3: 1-9.*

SESSION 6 (LIVE IN-PERSON)

TOPIC 2: NON-LINEAR FUNCTIONS AND BUSINESS APPLICATIONS [Sessions 6-12]

T. Bradley: Chapter 4. EXCEL exercises Chapter 4.

- **Quadratic Functions. Graphs and equations of translated quadratics. Non-linear Demand and Supply Functions. Excel for non-linear functions.**

Readings: T. Bradley: 4.1. and 4.5.

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

SESSION 7 (LIVE IN-PERSON)

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

Readings: T. Bradley: 4.1.

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

SESSION 8 (LIVE IN-PERSON)

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

Readings: T. Bradley: 4.2, 4.3.

- *Worked examples: 4.13-4.18, and 4.20, 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.*

SESSION 9 (LIVE IN-PERSON)

Hyperbolic (Rational) Functions.

Readings: T. Bradley: 4.4

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

SESSION 10 (ASYNCHRONOUS)

Asynchronous activities/exercises on Blackboard.

SESSION 11 (LIVE IN-PERSON)

Review session.

SESSION 12 (LIVE IN-PERSON)

Exam 1

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

SESSION 13 (LIVE IN-PERSON)

TOPIC 3: DIFFERENTIATION AND APPLICATIONS [Sessions 13-21]

T. Bradley: Chapter 6. EXCEL exercises Chapter 6.

The slope of a Curve and Differentiation. Differentiation Rules. Further Differentiation. Online calculator for derivatives.

Readings: T. Bradley: 6.1 and 6.6.

- *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.*

SESSION 14 (LIVE IN-PERSON)

Business Applications of Differentiation: Marginal Functions and Average Functions.

Readings: T. Bradley: 6.2.1 and 6.2.2.

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

SESSION 15 (LIVE IN-PERSON)

Optimization for Functions of One Variable.

Readings: T. Bradley: 6.3.

- *Worked examples: 6.16, 6.17, 6.18, and 6.19.*
- *Progress exercises: 6.5, 6.6, 6.7, and 6.8.*
- *EXCEL Exercises Chapter 6: None.*

SESSION 16 (LIVE IN-PERSON)

Economic Applications of Maximum and Minimum Points. Price discrimination.

Readings: T. Bradley: 6.4.

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

SESSION 17 (LIVE IN-PERSON)

Curvature and Other Applications.

Readings: T. Bradley: 6.5.

- *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.*

SESSION 18 (LIVE IN-PERSON)

Elasticity and the Derivative.

Readings: T. Bradley: 6.7.

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

SESSION 19 (ASYNCHRONOUS)

Asynchronous activities/exercises on Blackboard

SESSION 20 (LIVE IN-PERSON)

Review session.

SESSION 21 (LIVE IN-PERSON)

Exam 2

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.

SESSION 22 (LIVE IN-PERSON)

TOPIC 4: INTEGRATION AND APPLICATIONS [Sessions 22-24]

T. Bradley: Chapter 8. EXCEL exercises Chapter 8.

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

Readings: T. Bradley: 8.1, 8.2, 8.3, and 8.4.

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

SESSION 23 (LIVE IN-PERSON)

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

Readings: T. Bradley: 8.5, 8.6.

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

SESSION 24 (LIVE IN-PERSON)

Some Economic Applications of integration.

Readings: T. Bradley: 8.7.

- *Worked examples: 8.15, 8.16, 8.17, 8.18, and 8.19.*
- *Progress exercises: 8.5 (page 459), 8.6 (page 463), and 8.7 (page 467).*

SESSION 25 (LIVE IN-PERSON)

FINAL EXAM. See details in section 6.

BIBLIOGRAPHY

Compulsory

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

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:

Criteria	Percentage	Comments
Class Participation	10 %	
Intermediate Tests	40 %	
Asynchronous activities	15 %	
Final Exam	35 %	

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 inappropriately.

B. ASYNCHRONOUS ACTIVITIES (A)

It will be worth 15% of the overall grade.

It will consist of several exercises/activities on Blackboard throughout the asynchronous sessions (2).

C. EXAMS (E)

It will be worth 40% of the overall grade. There will be 2 intermediate exams (25% the best result (E1) and 15% the second-best result (E2)).

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

D. FINAL EXAM (FE)

It is worth 35% 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.

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

$$\text{FINAL GRADE} = 0.10x(\text{CP}) + 0.15x(\text{A}) + 0.25x(\text{E1}) + 0.15x(\text{E2}) + 0.35x(\text{FE})$$

Grades:

- Sobresaliente/Outstanding: 9.0-10.0 (A to A+)

Consistently produces work of the highest quality and craft; exhibits notable progress and development over the course of the semester; meets all course objectives at highest level; attendance is near-perfect, and contributions to course discussions are extremely valuable.

- Notable: 7.0-8.9 (B to B+)

Completes all assignments with work of above-average quality and craft; exhibits significant progress and development; meets most course objectives; attendance and participation are very good.

- Aprobado: 6.0-7.0 (C to C+)

Completes all assignments with work of acceptable quality and craft; exhibits some progress and development; meet a majority of course objectives. Attendance and participation are acceptable.

- Aprobado: 5.0-6.0 (D)

Assignments are delivered but are incomplete and/or of low quality and craft; exhibits little progress and development; meets few course objectives. Attendance and participation are poor, but absences do not total more than 30%.

- Suspenso: 0-4.9 (F)

Work is incomplete, missing, or does not meet course objectives. Attendance and participation are poor.

- Automatic Failure/Suspenso: 0 (F)

Please note that a student who misses 30% or more of the scheduled sessions receives an automatic 0.0, and loses his or her right to the second “convocatoria.”

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 70% 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 Intermediate exams (60 %)
- o Final exam (40%)

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.

PROFESSOR BIO

Education:

- Ph.D. in Physics. Autonomous University of Madrid . Spain.
- Master in Physics. University of Santiago de Compostela. Spain.
- Bachelor in Physics. University of Santiago de Compostela. Spain.
- Advanced expert in development of computer applications. Granada. Spain
- Data Science Professional Certificate. IBM. Online.

Research Experience:

- Researcher studying Illegal Market Dynamics at IE Business School, IE University. Spain
- Researcher studying Pyshics of laser-matter interactions at Spanish National Research Council (CSIC). Spain.
- Researcher studying Eco-toxicology in collaboration with IMDEA Agua and Cavanilles Institute for Biodiversity and Evolutionary Biology. Spain.

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OTHER INFORMATION

Office hours at Madrid Campus: *they will be announced at the beginning of the course.*

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