**Mathematics**

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***COURSE AIMS AND EXPECTED LEARNING OUTCOMES***

*Course aims*

The course aims to provide students with the mathematical tools necessary for understanding banking, financial and insurance models, whose phenomena under consideration are expressed in quantitative terms.

*Expected learning outcomes*

The expected learning outcomes are the ability to read, interpret and manipulate the quantitative aspects of banking, financial and insurance phenomena.

At the end of the course, students will possess technical skills accompanied by an understanding of their specific applications. In particular:

* *They will be familiar with* the mathematical tools necessary to understand and interpret economic models, which will be further analyzed in future courses.
* *They will be able to* analytically study a function and its derivatives and analyze its graph; maximize a function subject to equality constraints; solve linear systems; calculate integrals.
* *They will be able to* understand and interpret a problem and its data, identifying the appropriate mathematical tool needed to reach the solution, which will then be communicated in clear and rigorous language.

***COURSE CONTENT***

The course syllabus is structured as follows:

FIRST MODULE (5 credits)

* Real numbers: operations with real numbers; ordering real numbers; sets and intervals of real numbers; operations between sets; definitions of supremum and infimum of a set of real numbers; accumulation (limit) points; neighborhoods of a point.
* Real-valued functions of 1 real variable: domain and codomain of a function; asymptotes; summary of elementary functions; definition of composite functions; definition of inverse functions.
* Limits: definitions of the limits ­of functions; hierarchy of infinitesimals and infinities.
* Continuous functions: definition of continuous functions; elementary functions as continuous functions; limits of continuous functions; points of discontinuity.
* Differential calculus: difference quotient of continuous functions; definition of the first derivative; geometric interpretation of the first derivative; equation of the tangent line to the graph of a continuous function.
* Finding maxima and minima of a function: definition of local and global extrema; necessary and sufficient conditions for a local extremum; Fermat’s theorem; definition of an inflection point; concavity and convexity; relation between the first derivative and monotonicity; relation between the second derivative and concavity; study of the graphs of real-valued functions.
* Taylor and Maclaurin formulae.
* Real-valued functions of 2 real variables: domain and graphs; level curves; definition of partial derivatives and their calculations; determination of free and constrained extrema (Lagrange multiplier method).

SECOND MODULE (5 credits)

* Integral calculus: antiderivatives of a function; its definition and properties; indefinite integrals; elementary integrals.
* Integration methods: by decomposition, by parts, by substitution. Integration of some algebraic fractions.
* Definite integral (Riemann): definition, geometric meaning and properties; integral functions; the fundamental theorem of integral calculus; improper integrals on an unbounded interval.
* Linear algebra: the space $R^{n}$; vectors in $R^{n}$; operations between vectors; linearly independent and dependent vectors.
* Matrices: definition; operations between matrices; determinant of a square matrix; inverse matrix; rank of a matrix.
* Solving linear systems; Cramer’s theorem. Rouché-Capelli’s theorem.

***READING LIST***

Selected materials (slides, exercises, mock exams) will be made available on the course Blackboard site.

L. Peccati-S. Salsa-A. Squellati, *Mathematics for Economics and Business,* Bocconi University Press, Milano, 2016.

K. Sydsaeter – P. Hammond – a. Strom – A. Carvajal, *Essential Mathematics for Economic Analysis,* Pearson, 2021.

***TEACHING METHOD***

The course will consist of classroom lectures in which theoretical content will be presented, accompanied by extensive examples and exercises with a focus on economic applications.

In addition to the lectures, exercise sessions will be held that will focus on properly solving exercises in preparation for the exam. Students are encouraged to actively participate during lectures and exercise sessions by asking questions and offering solutions.

***ASSESSMENT METHOD AND CRITERIA***

*Assessment methods*

The exam will be a written assessment consisting of open-ended questions and/or multiple-choice questions, both theoretical and applied, covering the topics of the entire course (first and second modules). The point value of each question will be indicated in the exam text. The maximum score is 32 points. The points obtained on the written exam, rounded to the nearest integer (rounded up if the decimal part is greater than or equal to 0.5), will constitute the final mark obtained in the course. Honors marks will be awarded in the event the student obtains a final rounded score of at least 31. A mock test with the same format as the actual exam will be published on Blackboard.

Alternatively, the exam can be passed by taking two partial exams, one for each module, administered at the end of the respective module. Further details regarding the structure and procedure of the partial exams will be provided during the course and on the Blackboard platform.

*Evaluation criteria*

During the exam, students are expected to demonstrate knowledge they have acquired in the course. The ability to solve the exam exercises will demonstrate the student’s level of learning achieved, as well as their ability to apply knowledge and exercise independent judgment. The presentation of solutions will showcase their ability to communicate using technical language.

***NOTES AND PREREQUISITES***

*Notes*

Attendance, although not mandatory, is strongly encouraged.

Course materials and additional resources for exam preparation will be made available online.

Detailed information regarding organization and exam procedures will be provided during the course and on the Blackboard platform.

*Prerequisites*

Students should have a basic understanding of algebra and analytic geometry, typically covered in high school (properties of exponents, linear and quadratic equations and inequalities, fractional equations and inequalities, equations of lines and parabolas).

An online preparatory course of 20 hours is planned to reinforce the prerequisite knowledge of algebraic operations.

*office hours*

The time and location for office hours will be published on the instructors’ personal pages.