# Mathematics

## Prof. Marzia De Donno; Prof. Dovid Fein

***COURSE AIMS AND INTENDED LEARNING OUTCOMES***

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.

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

***COURSE CONTENT***

*Detailed learning objectives*

By the end of the course, students will have obtained technical skills accompanied by an understanding of their specific applications. In particular, students will be able to:

– analytically study a function and its derivative,

– maximize a function subject to equality constraints,

– solve a linear system,

– calculate integrals.

*Course content*

– Real numbers: operations between 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; graphs of inverse functions; injective and surjective functions; the relation between the injectivity, monotonicity and invertibility of a function.

– Limits: definitions of the limits ­of functions; hierarchy of infinitesimals and infinities; theorem on the uniqueness of the limit; operations with limits; theorem on the permanence of sign.

– 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; definition and geometric interpretation of the differential; equation of the tangent line to the graph of a continuous function; derivability on real intervals; derivability as a sufficient condition for continuity; indeterminate forms; 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 of 1 real variable; overview of Taylor and Maclaurin formulae.

– Real-valued functions of 2 real variables: representation of their domains on the $xy$-plane; definition of partial derivatives and their calculations; determination of free and constrained extrema (Lagrange multiplier method)

– Integral calculus: Antiderivatives of a function: definition and properties. Indefinite integral: definition. Elementary integrals. Integration methods: by decomposition, by parts, by substitution. Integration of some algebraic fractions.Riemanndefinite integral: definition, geometric meaning. Classes of integrable functions. First fundamental theorem of calculus. Properties of definite integrals. Integral function: definition. Second fundamental theorem of calculus. Improper integral on an unbounded interval: definition.

 - Linear algebra: the space $R^{n}$; Vectors in $R^{n}.$ Operations among vectors. Linearly independent and dependent vectors. Matrices and square matrices. Operations among matrices. Determinant of a square matrix. Inverse matrix. Rank of a matrix. 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***

Classroom lectures and exercise sessions.

### **ASSESSMENT METHOD and criteria**

The final grade is based on a written exam at the conclusion of the course consisting of open response questions and/or multiple choice questions which may be theoretical or applied, worth a maximum total of 32 points. The point value of each question will be indicated in the exam text. 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 and has demonstrated an excellent command of the material. A mock test demonstrating the format of the exam will be published to Blackboard.

### **NOTES AND PREREQUISITES**

A online 20 hour preparatory course will be held to reinforce the prerequisite algebraic operations.

In the event that the health situation relating to the COVID-19 pandemic does not allow for lessons to be held in presence, remote teaching will be guaranteed in a manner that will be communicated to students.

*Office hours and location*

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