COURSE OF STUDY: Business Economics
ACADEMIC YEAR: *2023/24*
ACADEMIC SUBJECT: Mathematics for Economics

General information	
Year of the course	First
Academic calendar (starting and ending date)	First Semester (from 2023/09/18 to 2023/12/15 and from 2024/01/08 to 2024/01/12)
Credits (CFU/ETCS):	10
SSD	SECS/S-06
Language	Italian
Mode of attendance	Not compulsory, but strongly recommended

Professor/ Lecturer	
Name and Surname	Antonio Attalienti
E-mail	antonio.attalienti@uniba.it
Telephone	+39 080 - 5049215
Department and address	Business and Law Studies – Largo Abbazia Santa Scolastica 53 – 70124 Bari (Italy)
Virtual room	Microsoft Team wwxog3c
Office Hours (and modalities: e.g., by appointment, online, etc.)	Each Tuesday and Wednesday, 10.45 – 11.45, in person or, in case, remotely in the Microsoft Team ry4023h

Work schedule			
Hours			
Total	Lectures	Hands-on (laboratory, workshops, working groups, seminars, field trips)	Out-of-class study hours/ Self-study hours
80	*60*	*20*	*250*
CFU/ETCS			
10	*8*	*2*	

Learning Objectives	Providing the main mathematical tools frequently occurring in problems related to business administration, economics and finance; developing suitable techniques of quantitative analysis to face up problems of evaluation and choice in the same areas.
Course prerequisites	Algebraic elementary calculus and basics of analytic geometry (equation of a straight line and related topics).

Teaching strategie	Lectures and tutorials
Expected learning outcomes in terms of	
Knowledge and understanding on:	○ Knowledge of the main mathematical tools often used in business, economic and financial studies.
Applying knowledge and understanding on:	○ Ability to apply suitable quantitative analysis techniques in order to understand and face up problems of evaluation and optimal choice in business, economic and financial issues.
Soft skills	• *Making informed judgments and choices:* ○ To be able to make suitable optimal choices in business, economic and financial settings.

	• *Communicating knowledge and understanding:*
	  ○ To make use of an appropriate and unambiguous language in communicating the results referred to the problems.
	• *Capacities to continue learning:*
	  ○ To be able to use independently the analytic instruments studied during the lessons in order to understand and solve problems arising in business, economic and financial topics.

Syllabus	
Content knowledge	Basics on set theory: logical symbols, sets, elements and related properties. Set operations: union, intersection, difference, complement, symmetric difference. Cartesian product. The numerical sets **N**, **Z, Q** and related properties. The set **R** of real numbers: algebraic and order properties. Upper and lower bound of a subset of **R**. Bounded and unbounded sets. Maximum and minimum, supremum and infimum of a subset of **R**. The completeness property and equivalent versions. Some applications: n-roots, exponentials and logarithms. Absolute value, integer part and fractional part of a real number. Intervals of **R.** The density of **Q** in **R**. The extended real line: neighborhoods, cluster points and isolated points. Functions: domain, range and graph. Injective, surjective, bijective and invertible functions. Composition of two or more functions. Inverse function. Restrictions of a function. Real functions of one real variable: upper and lower bound, supremum and infimum, maximum and minimum. Local and global extrema. Bounded, odd, even, periodic, monotone and convex functions. Sequences of real numbers. Sequences defined by recurrence. Arithmetic and geometric progressions with applications: simple and continuous compounding in finance. The factorial of a natural number. The study of some elementary functions: constant function, identity function, affine function, piecewise affine function, absolute value function, power function, n-root function, exponential function, logarithmic function, power function with real exponent, trigonometric functions and the corresponding inverse functions. Equations and inequations. Determining the domain of a function. Limits: basic definitions and corresponding interpretation. Limit of sequences. **Uniqueness of the limit**. Local character of the limit. Limit of a restriction of a function. Non – regularity test. Right-hand and left-hand limit and related theorem. Comparison theorems. **Squeeze theorem.** Divergence criterion. Operations with the limits. Indeterminate forms. Limit of the composition of functions. Theorem about the limit of monotone functions/sequences. Limits of the elementary functions. Some fundamental limits. Neper's number and its financial meaning. Asymptotic analysis for computing limits in indeterminate forms and Landau's symbols. An estimate of the growth of n! : DeMoivre-Stirling's formula. Continuity: definition of the continuity of a function at a point and basic properties. Points of discontinuity and the corresponding classification. Integer part and fractional part functions and the related discontinuities. Functions everywhere continuous in their domains. Sum, product, quotient and composition of continuous functions. Continuity criterion for monotone functions. Continuity of the elementary functions. Intermediate value property and Bolzano's theorem. **Existence of zeros theorem, fixed point theorem and** Weierstrass's theorem. Differentiation: the concept of derivative and its meaning in different frameworks. Differentiable functions Left and right derivative. Geometric interpretation: tangent line and rate of approximation. Angular and cusp points. **Continuity of the differentiable functions**. Differentiation rules. Higher order derivatives and Lagrange's spaces. The chain rule and the differentiability of the

	inverse function Determining the derivatives of the elementary functions. Elasticity, semi elasticity and applications in Economics and Finance. Applications of the differential calculus: functions which are strictly monotone at a point: necessary condition and sufficient condition. Local extrema. Stationary points. **Fermat's theorem**. **Main theorems in differentiation: Rolle's theorem** Cauchy's theorem and Lagrange's theorem. Darboux's theorem. **Consequences of Lagrange's theorem**. Monotonicity test for differentiable functions. Some sufficient conditions for local extrema. Convexity/concavity test through the sign of the second derivative. Inflection points: a necessary condition and some sufficient conditions. De L'Hospital's rule and applications for computing limits in indeterminate forms. Discontinuity of the first derivative. Second-order Taylor's expansion and some applications. Asymptotes and graph - sketching. Basics of integration theory: antiderivatives, **indefinite integral and main properties.** The standard rules of integration. Integration by parts and by substitution. Riemann lower and upper integral sums. The Riemann integrability and the corresponding integral. Criterion of integrability and the integral as a limit. Properties of the definite integrals. Computing areas of normal domains. Some classes of integrable functions: the integrability of continuous functions and of monotone functions. **Mean value theorem.** Torricelli-Barrow's theorem. **Newton-Leibnitz's theorem (or Fundamental theorem of integral calculus)**. Some elements of linear algebra: vectors in $\mathbf{R}^n$ and basic operations. Linearly independent vectors and basis in Euclidean spaces. Matrices, determinants and related properties. The rank of a matrix. Kronecker's theorem. Solving systems of linear equations: Cramer's formula and Rouchè-Capelli's theorem. Functions of two variables: graph, coordinate lines and level curves. Cobb-Douglas functions in Economics. Limits and continuity. Partial derivatives and gradient vector. Differentiability and tangent plane. The chain rule. Directional derivatives and the gradient formula. Some properties of the vector gradient. Second-order partial derivatives and Schwarz's theorem. Hessian matrix. Unconstrained optimization. Something about constrained optimization: Lagrange multipliers and their economic meaning. The students must know all the definitions and statements of the theorems indicated above; **the proof is required if the corresponding theorem is marked in boldface.**
Texts and readings	1) G. Anichini, A. Carbone, P. Chiarelli, G. Conti, Precorso di Matematica, Pearson 2018. 2) A. Guerraggio, Matematica, terza edizione, Pearson 2020. 3) A. Attalienti, S. Ragni, Esercitazioni di Matematica, Giappichelli 2010, Torino. 4) M. Bramanti, C. D. Pagani, S. Salsa, Matematica: calcolo infinitesimale e algebra lineare, Zanichelli, Bologna. 5) S. Salsa, A. Squellati, Esercizi di Matematica: calcolo infinitesimale e algebra lineare, Volume 1, Zanichelli, Bologna.
Notes, additional materials	Teaching material can be downloaded at http://www.uniba.it/docenti/attalienti-antonio/attivita-didattica.
Repository	Teaching material available in the teacher site indicated above as well as in the Teams class wwxog3c

Assessment	
Assessment methods	The exam consists of a preliminary written test and a subsequent oral test and is structured according to the following methods: Written test

	The written test lasts 120 minutes and is intended to verify the basic knowledge of the topics covered in the course by solving some exercises. For each exam session, admission to the written test is allowed only to students who have duly booked via internet on the Esse3 portal on schedule. Reservations made in different ways will not be accepted in any way. The student must present himself for the written test with a valid identification document. During the written test, the use of personal sheets, books, notes, workbooks, formularies, and programmable scientific/graphic calculators is not permitted. All devices capable of receiving and/or transmitting data (mobile phones, smartphones, tablets, earphones, computers, electronic equipment equipped with a Bluetooth/wi-fi connection) must be kept strictly switched off for the entire duration of the test; the non-compliance with this rule will result in the cancellation of the test itself. It is possible for the student to withdraw from the written test at any time. Valuation of the written test and subsequent oral test The Examination Board evaluates each written test as Sufficient or Insufficient. The students who have obtained the Sufficient evaluation are admitted to the oral exam and will then be summoned for this purpose: all the necessary information in this regard will be reported online. The oral test will determine the outcome and the final evaluation of the exam. In general, the oral test has a more theoretical character and aims to verify the knowledge of the main definitions and theorems covered during lessons. If the evaluation of the written test is Insufficient, the student is deemed to have failed the exam and he will have to rebook at any future time, since it is not possible to appear for the oral test without having passed the preliminary written test before. In the days following the written test, the list of the valuations of the written tests together with the solutions of the proposed exercises will be published online on the Department website. The students who have successfully passed the written test and nevertheless do not take the oral exam must repeat again the written exam in a subsequent session.
Assessment criteria	• *Knowledge and understanding:* ○ The student must show that he has acquired a sufficient knowledge of the basic theoretical and applicative mathematical tools for solving problems concerning limits, continuity, differentiability in one and two variables, indefinite and definite integration. • *Applying knowledge and understanding:* ○ The student must be able to apply the theoretical instruments in solving the exercises proposed in the written test. • *Autonomy of judgment:* ○ The student must be able to use techniques and tools in order to understand, formalize and solve different types of exercises. • *Communicating knowledge and understanding:* ○ The student must employ a clear and rigorous scientific language while giving definitions and stating theorems and proofs during the oral exam. • *Communication skills:* ○ The student must use fluently the mathematical language in communicating his opinions and solutions to the problems. • *Capacities to continue learning:* ○ The student must possess a knowledge of the arguments treated

	during the lessons so that he may identify properly some problems and find out an optimal solution.
Final exam and grading criteria	The final grade is expressed in thirties and the exam is deemed to be passed if the final grade is equal to or higher than 18/30. In turn, the final grade is an average of the evaluation of the written test and the subsequent oral test, also in consideration of the soft skills, as explained in the Dublin 3-5 descriptors. The preliminary written test is deemed to be passed and deserves a Sufficient valuation if it points out an appropriate knowledge of the topics related to the exercises thereof. It is foreseen to award the highest grades with praise (30 and praise) in case the student performs an excellent exam (both written and oral tests), showing the ability of solving autonomously difficult and challenging exercises.
Further information	
	.