General information		Academic year 2022-2023
Academic subject	**Mathematical Analysis 2**	
Degree programme	Mathematics	
Programme year	First	
Term	Second semester (February 27, 2023 – May 26, 2023)	
European Credit Transfer and Accumulation System credits (ECTS)	8	
Language	Italian	
Attendance	Not compulsory	

Lecturers		
Name and surname	Silvia Cingolani (instructor of record)	Gabriele Mancini
E-mail	silvia.cingolani@uniba.it	gabriele.mancini@uniba.it
Telephone	+39 080 544 2660	+39 080 544 2676
Department and office	Department of Mathematics, room 11 second floor	Department of Mathematics, room 30 second floor
Virtual meeting room	Microsoft Teams code: m83lm0p	Microsoft Teams code: m83lm0p
Web page	https://www.dm.uniba.it/members/cingolani	https://www.dm.uniba.it/members/mancini
Office hours	Wednesday 15:30-17:30 and by appointment via email	Monday 14:30-16:30 and by appointment via email

Syllabus	
Learning objectives	Acquiring fundamental concepts and results of Mathematical Analysis 2. Acquiring main tools and proof techniques. Acquiring main notions and fundamental concepts of Mathematical Analysis, in particular concerning the study of numerical series and the differential and integral calculus for real functions of real variable.
Course prerequisites	Mathematical knowledge acquired in the course of Mathematical Analysis 1.
Course contents	**Continuous functions (II).** Uniform continuity and Cantor theorem. Lipschitz functions. Hoelder continuous functions. **Differentiation.** Derivative of a real function. Geometrical and cinematic examples. Theorems on the continuity of differentiable functions. Algebraic operations and derivatives. Chain rule. Derivative of the inverse function. Elementary functions and their derivatives. Tangent line to a function graph. Pointwise strictly increasing functions. Local minimum, maximum of a function. Fermat Theorem. Stationary points. Properties of differentiable functions in an interval: Rolle, Cauchy, Lagrange theorems. Monotonicity test for differentiable functions. Functions with vanishing derivative. Strictly monotonicity test. The theorems of de l'Hopital. The Taylor's approximation formula with Peano remainder and with Lagrange remainder. Uniqueness of Taylor Polynomial. Sufficient conditions for existence of local minimum, maximum. Convex functions in intervals. Regularity of convex functions. Differentiable convex functions and their properties. The test of the second derivative for the of convexity of a function. Inflection points. Study of the graph of a function. **Numerical series.** Definition of series and generalities. The character of a

	numerical series: convergent series, divergent series, irregular series. Mengoli series. Telescoping series. Geometric series. Applications to the decimal representation of real numbers. Harmonic series. Necessary condition for the convergence of a series. Cauchy criterion for the convergence of a series. The remainder series of a numerical series and the relative theorem. Numerical series with nonnegative terms. Comparison tests. Asymptotic comparison test. Generalized harmonic series. Infinitesimal comparison test. Root test, ratio test. Absolutely convergent series. Alternating series. Leibnitz test for alternating series. Harmonic alternating series. Integral test. Cauchy product of series. Rearrangements for absolutely convergent series. Riemann Theorem. Infinite products. Sequences and series of complex numbers. Relations between Taylor polynomials and the sum of Taylor series. **Integration.** Riemann integration and Riemann integrals of real functions. Pluri-rectangles, area of a pluri-rectangle. Integrability of monotonic functions. Integrability of continuous functions. Properties of Riemann integrals. Mean value theorem. Definite integrals. Integral functions. Primitives and indefinite integrals. Existence of primitives of a continuous function. Fundamental theorems of calculus and their applications. Integration methods for rational functions. Integration by parts. Integration by substitution. Taylor formula with the integral remainder. Improper integrals: integration on the half-line, or of an unbounded function on a bounded interval. Comparison tests. Integral criterion for numerical series. Convergence and absolute convergence. The Euler Gamma function. Taylor Formula with integral remainder.
Reference books	E. Acerbi, G. Buttazzo, Primo corso di Analisi Matematica, Pitagora Editore E. Giusti, Analisi Matematica 1, Bollati Boringhieri Editore P. Marcellini, C. Sbordone, Analisi Matematica uno, Liguori Editore E. Giusti, Esercitazioni e complementi di Analisi Matematica 1, Bollati Boringhieri Editore P. Marcellini, C. Sbordone, Esercitazioni di Analisi Matematica, Vol 1, (Parte 1, Parte 2), Liguori Editore
Additional course materials	Didactic material available at platform Microsoft Teams.

Work schedule				
	Total	Lectures	Hands-on learning (recitations)	Self-study
Hours	200	48	30	122
ECTS credits	8	6	2	

Teaching methods	
	Lectures and exercise sessions.

Expected learning outcomes	
Knowledge and understanding	Acquiring fundamental concepts and results of Mathematical Analysis 2. Acquiring main tools and proof techniques.
Applying knowledge and understanding	The acquired theoretical knowledge is the essential background for understanding and using the techniques necessary in the mathematical applications.
Making judgements	Ability to analyze the consistency of the logical arguments used in a proof, problem solving skills and ability to choose suitable mathematical tools consistent with the theoretical knowledge.

Communication skills	Acquiring mathematical language and formalism necessary to read and understand textbooks, to explain the acquired knowledge, and to describe, analyze and solve problems.
Learning skills	Acquiring suitable learning methods, supported by consultation of texts and by solving exercises and problems related to the contents of the course.

Assessment and feedback	
Assessment methods	Written exam and subsequent oral exam.
Evaluation criteria	• *Knowledge and understanding*: mastering and deep understanding of the main theoretical course contents; • *Applying knowledge and understanding*: apply the skills acquired to solve limits and study the graph of functions; ability to study numerical series and solve integrals, also in a generalized sense; • *Making judgements*: approaching concepts in a critical way and ability to choose the methods of Mathematical Analysis useful for studying numerical series, real functions with real variable, for solving integrals, also in an improper sense; • *Communication skills*: mastering the language of the Mathematical Analysis; • *Learning skills*: organizing knowledge and autonomous learning.
Grading policy	The exam consists of a written test and a subsequent oral test. Passing the written test requires the student to be able to correctly perform the proposed exercises or at least part of them. During the oral exam the student must show mastery of the language, methodological rigor and have acquired the basic notions and concepts of the course. The final grade is awarded out of thirty and the exam is passed if the final grade is greater than or equal to 18/30.

Additional information	
	Attendance is strongly recommended.