UNIVERSITÀ DEGLI STUDI DI BARI ALDO MORO

CONSIGLIO INTERCLASSE IN MATEMATICA

COURSE OF STUDY THREE-YEAR BACHELOR PROGRAMME IN MATHEMATICS

ACADEMIC YEAR 2023-2024

ACADEMIC SUBJECT MATHEMATICAL ANALYSIS 2

General information	
Programme year	First
Term	Second semester (February 26, 2024 – May 31, 2024)
European Credit Transfer and Accumulation System credits (ECTS)	8
SSD	MAT/05 – Mathematical Analysis
Language	Italian
Mode of attendance	Not mandatory

Lecturers		
Name and surname	Silvia Cingolani (instructor of record)	Gabriele Mancini
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Department and office	Department of Mathematics room 11 second floor	Department of Mathematics room 30 second floor
Virtual meeting room	Microsoft Teams, code keflfij	Microsoft Teams, code keflfij
Web page	https://www.dm.uniba.it/en/members/cingolani	https://www.dm.uniba.it/en/members/mancini
Office hours	Wednesday 15:30-17:30 and by appointment via email	Monday 14:30-16:30

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

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.

Syllabus	
Course contents	**Uniform Continuous functions.** Uniform continuity and Cantor theorem. Lipschitz functions. Hölder 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. L'Hospital's Theorem and Indeterminate Forms. The Taylor's approximation formula with Peano remainder. Uniqueness of Taylor Polynomial. Sufficient conditions for existence of local minimum, maximum. The Taylor's approximation formula with Lagrange remainder. Irrationality of the Neper number. Convex functions defined on intervals. Geometrical interpretation of the convexity. Monotonicity of the incremental ratio. Continuity of the convex functions in the interior. 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. **Integration.** Partitions. Integral sums. Riemann integrals of real functions. Geometrical interpretation of the integral. Pluri-rectangles, area of a pluri-rectangle. Area under a graph. Dirichlet function. Theorem on the Riemann integrability of monotone functions. Theorem on the Riemann integrability of continuous functions. Properties of Riemann integrals. Mean value theorem. Definite integrals. Integral functions. Primitives. Fundamental theorems of calculus. Torricelli Theorems. Mean value theorem for definite integrals. Applications of the integration to problems in Geometry and Mechanics. Indefinite integrals. Integration methods for rational functions. Integration by parts. Integration by substitution. Taylor formula with the integral remainder. **Improper Integration.** Improper integration on the half-line. Improper integration of an unbounded function on a bounded interval. Criteria for improper integrals. Comparison tests. Absolute convergence of improper integrals. Theorem of the absolute convergence. The Euler Gamma function. **Numerical series.** Definition of series and generalities. The character of a numerical series: convergent series, divergent series, undetermined series. Sum of the series. Mengoli series. Telescoping series. Geometric series. Harmonic series. Necessary condition for the convergence of a series. Operations on series. Cauchy criterion for the convergence of a series. Absolutely convergent series. Theorem on the absolute convergence of a series. Regular series. Numerical series with nonnegative terms. Comparison tests. Asymptotic comparison test. Generalized harmonic series. Infinitesimal comparison test. Root test. Corollary of the Root test. Ratio test. Corollary of the Ratio test. Alternating series. Leibnitz test for alternating series. Harmonic alternating series. Integral test. The remainder series of a numerical series and the relative theorem. Cauchy product of series. Rearrangements of numerical series. Riemann Theorem. Sequences numbers. Series of complex numbers. Taylor polynomials and the sum of Taylor series.
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, (Part 1, Part 2), Liguori Editore
Additional course materials	
Repository	Didactic material available at platform Microsoft Teams.

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.
Soft skills	*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.

Teaching methods	
	The mode of delivery of teaching is frontal. Lectures and exercises will be held in presence. After each tutorial, support learning material will be made available through the Microsoft Teams platform. At the end of the course, a simulation of the written exam will be held in the classroom.

Assessment	
Assessment methods	The exam consists of a written test and a subsequent oral test. The written test includes a pre-set number of exercises relating to the main topics of the program. It lasts about two hours. The written tests of previous appeals are made available to students via the MT platform. The oral exam includes an interview concerning the main theoretical results of the course.
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 judgement*: 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 that the student is able to correctly carry out the exercises proposed on the main topics of the program or at least a part of them. A score is assigned to each exercise of the written test and the test is approved if the final score is greater than or equal to 18/30. The assessment of the written test is based on the achievement of the learning

	objectives. After passing the written test, the student takes the oral test, which is approved if the final score is greater than or equal to 18/30. The student must show mastery of the language, methodological rigor and have acquired the fundamental notions and concepts of the course. Assessment is based on the achievement of the intended learning objectives. To achieve a high evaluation, the student must have developed independent judgment and adequate capacity for argumentation and exposition. The written test and the oral test have equal value. The exam is passed if both tests are passed. The final mark of the exam expresses the overall evaluation of the written test and the oral test. It is awarded out of thirty and the exam is considered passed if the final grade is greater than or equal to 18/30. The laude is awarded in case of further study on some topic of the course.

Further information	
	Attendance is strongly recommended.