Academic subject: Mathematical Analysis 1				
Degree Class: L-35- Scienze Matematiche		**Degree Course:** Mathematics	**Academic Year:** 2021/2022	
		Kind of class: mandatory	**Year:** 1	**Period:** 1
			ECTS: 8 divided into **ECTS lessons:** 5 **ECTS exe:** 3	
Time management, hours, in–class study hours, out–of–class study hours lesson: 40 exe: 30 tutoring: 25 in–class study: 95 out–of–class study:105				
Language: Italian	**Compulsory Attendance:** no			
Subject Teacher: Prof. Silvia Cingolani (in collaboration with Dr. Gabriele Mancini, Dr. Marco Gallo, Prof. Elvira Mirenghi)	**Tel:** +390805442660 **e–mail:** silvia.cingolani@uniba.it **Home page:** https://www.dm.uniba.it/members/cingolani	**Office:** Department of Mathematics Room 11, Floor II	**Office days and hours:** Wednesday 3:30 p.m. - 6:30 p.m. for appointment via email	
Prerequisites: Basic notions about set theory and logic.				
Educational objectives: Acquiring basic notions of Mathematical Analysis, in particular concerning generalities on real functions, sequences and limits of real functions.				
Expected learning outcomes (according to Dublin Descriptors)	**Knowledge and understanding:** Acquiring fundamental concepts and results of Mathematical Analysis. 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:** Acquiring mathematical language and formalism necessary to read and understand textbooks, to explain the acquired knowledge, and to describe, analyze and solve problems. **Lifelong learning skills:** Acquiring suitable learning methods, supported by consultation of texts and by solving exercises and problems related to the contents of the course.			

Course program

1.Real Numbers

Set theory preliminaries. Inclusion, union, intersection, complement set and Cartesian product. Ordered sets.
Real numbers. Axioms. Real line. Completeness of R. Absolute value and Euclidean distance. Upper bound, lower bound, minimum, maximum, infimum, supremum and their properties. Theorem of existence of the supremum (infimum) in R. Characterization of the infimum and the supremum. Intervals in R and characterizations. Inductive sets. The set of natural numbers N as the intersection of all the inductive subsets of R. Inductive Principle. Generalized Inductive Principle. Bernouilli Inequality. The sum and the product in N. Theorem on the discreteness of N. Theorem on the unboundedness of N. Archimedean Property of R. Principle of the minimal integer in N. The set of integers Z, the set of rational numbers Q and their structures. Density of Q in R. Incommensurability of the diagonal of the unit square. Incompleteness of Q. Elements of combinatorics and Newton's binomial. Theorem of existence of the nth root. Density theorem of irrationals in R. Rational and real powers and properties. General properties on functions. Injective,

surjective, bijective functions. Composition of functions. Invertible functions and their inverses. Cardinality of a set. Equipotent sets. Finite sets and infinite sets. Countable sets. Properties on the cardinality of the union, intersection and product sets. Cardinality of the set of subsets of a finite set. Cantor's theorem on the cardinality of infinite sets. R is uncountable. Continuous power. Topology in R. Internal, external and boundary points of a subset of R. Boundary of a set. Open and closed sets of R. Isolated points. The extended real line. Points of adherence and points of accumulation of a subset of R. Complex numbers. Principle of identity of complex numbers. Complex Powers and n-th Roots.

2. **Numerical sequences**

Regular sequences and their limits. Operations with regular sequences and their limits. Every convergent sequence is bounded. Inequalities for sequences and for their limits. Comparison theorems for sequences. Theorem on the limit of a monotonic sequence. Neper number. Subsequences and their limits. Upper and lower limit of a sequence and their properties. Limit points of a sequence. Theorem about the upper limit and the lower limit of a sequence. Bolzano-Weierstrass theorem about bounded numerical sequences. Compact sets of R and their properties. Cauchy sequences. Cauchy criterion for the convergence of sequences. Ratio test for limits of sequences. Cesaro criteria (arithmetic/geometric mean, n-th root). Sequences defined by recurrence.

3.Limits of functions

Real functions. Bounded functions. Monotone functions. Even functions, odd functions, periodic functions. Elementary functions and graphs. Rational, irrational, transcendental inequalities. Limits of functions and first theorems on limits. Relations between limits of functions and limits of sequences. Left and right limits. Limits of monotonic functions. Theorem on locally boundedness of convergent functions. Theorem on inequalities between functions and their limits, applications. Comparison theorems for limits. Limits of elementary functions. Operations between limits. Theorem on the limit of the composition of two functions. Upper limit and lower limit of a function. Cauchy criterion for convergence. Infinite and infinitesimals. Negligible terms. Asymptotes of a function.

4.Continuous functions (I)

Continuous functions and their elementary properties. Continuity and sequential continuity. Theorems on the continuous functions. The continuity of the composition of continuous functions. Discontinuity points and their classification. Bolzano theorem. The intermediate value theorem. Any continuous function maps intervals into intervals. Existence of the n-th root. Continuity of the inverse function for a continuous function defined on an interval, or on a bounded closed set.

Teaching methods:

Lectures and exercise sessions.

Auxiliary teaching:

Didactic material available at platform Microsoft Teams.

Assessment methods:

Written and oral exam. Joint exam with Mathematical Analysis 1.

ibliography:

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