Subject card

Subject name and code	Mathematical Analysis I, PG_00155232						
Field of study	Mathematical Modeling and Data Analysis						
Date of commencement of studies	October 2025			Academic year of realisation of subject		2025/2026	
Education level	Bachelor’s studies			Subject group		Obligatory subject group in the field of study	
Mode of study	full-time studies			Mode of delivery		at the university	
Year of study	1			Language of instruction		Polish	
Semester of study	1			ECTS credits		9.0	
Learning profile	academic			Assessment form		exam	
Conducting unit	Institute of Mathematics -> Faculty of Mathematics, Physics and Informatics -> Rector						
Name and surname of lecturer (lecturers)	Subject supervisor		dr hab. Barbara Wolnik				
	Teachers						
Lesson types	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	60.0	60.0	0.0	0.0	0.0	120
	E-learning hours included: 0.0						
Learning activity and number of study hours	Learning activity	Participation in didactic classes included in study plan		Participation in consultation hours	Self-study		SUM
	Number of study hours	120		15.0	90.0		225
Subject objectives	The purpose of the course is to familiarize students with • elements of mathematical logic, in particular, logical calculus of statements and quantifiers and the application of them in conducting reasoning, • elements of multiplicity theory and topology, • concepts, theorems and methods of differential calculus of functions of one variable.						

Learning outcomes	Course outcome	Subject outcome	Method of verification
	[MMiADL3_K02] is ready to precisely formulate questions to deepen his/her own understanding of a given topic or to find missing elements of reasoning	The student is ready to accurately formulate questions to deepen his own understanding of a given topic or to find missing elements of reasoning in the scope of the material covered during the course.	[SK8] observation of student's independent or team work
	[MMiADL3_K09] is ready to critically evaluate arguments, find gaps in reasoning, and constructively criticise other people's reasoning	The student is ready to critically evaluate arguments, find gaps in reasoning and constructively criticize the reasoning of others on the material covered during the course.	[SK8] observation of student's independent or team work
	[MMiADL3_W01] knows the basic concepts, methods and theorems of mathematical logic and set theory	The student knows the basic concepts and selected methods and theorems of mathematical logic and the set theory in the scope of the material realized during the course.	[SW4] test/exam - oral or written
	[MMiADL3_U08] is able to plan a way to solve a given problem and make a correct record of this solution, providing accurate and precise justifications for the correctness of their reasoning	The student is able to solve problems in the scope of the material realized during the course.	[SU4] test/exam - oral or written
	[MMiADL3_U07] can comprehensively, in speech and in writing, formulate definitions and theorems and present correct mathematical reasoning regarding the issues learned	The student correctly uses the learned definitions, methods and theorems of mathematical analysis in terms of the material covered during the course.	[SU4] test/exam - oral or written
	[MMiADL3_W02] knows the basic concepts, methods and theorems of mathematical analysis, and basic examples both illustrating specific concepts in this field, and allowing to refute incorrect hypotheses or unauthorized reasoning	The student understands the concepts, methods and theorems of mathematical analysis in terms of the material covered during the course.	[SW4] test/exam - oral or written
	[MMiADL3_W06] knows the selected concepts, methods and theorems of topology	The student knows the basic concepts and selected methods and theorems of topology in terms of the material discussed during the course.	[SW4] test/exam - oral or written
	[MMiADL3_K06] is ready to formulate opinions on basic mathematical issues	The student is ready to formulate an opinion on basic mathematical issues within the scope of the material covered during the course.	[SK8] observation of student's independent or team work
	[MMiADL3_U02] correctly uses the concepts of mathematical analysis, is able - on a simple and medium level of difficulty - to apply the learned theorems and methods in this field, and is able to interpret the results obtained	The student correctly uses the concepts and the methods of mathematical analysis learned during the course.	[SU4] test/exam - oral or written
	[MMiADL3_K01] is ready to accept the limitations of his/her own knowledge and understands the need for further education	The student knows the limitations of his own knowledge in mathematical analysis and is ready for further education.	[SK8] observation of student's independent or team work
	[MMiADL3_W08] knows and understands well the role and importance of proof in mathematics, as well as the concept of the significance of assumptions	The student knows the theorems of mathematical analysis in terms of the material covered during the course.	[SW4] test/exam - oral or written
	[MMiADL3_W07] knows and understands the construction of mathematical theories, can use mathematical formalism to build and analyse simple mathematical models in other fields of science	The student is familiar with the methods of mathematical analysis in the range of the material covered in the course.	[SW4] test/exam - oral or written
	[MMiADL3_U06] correctly uses the learned concepts of topology	The student correctly uses the concepts of topology learned during the course.	[SU4] test/exam - oral or written

	Course outcome	Subject outcome	Method of verification
	[MMiADL3_K04] is ready to understand and appreciate the importance of intellectual honesty in own and other people's actions; is ready to act ethically	The student is ready to understand and appreciate the importance of intellectual honesty.	[SK8] observation of student's independent or team work
	[MMiADL3_U01] correctly uses the learned concepts of mathematical logic and set theory	The student correctly uses the concepts of mathematical logic and the set theory learned during the course.	[SU4] test/exam - oral or written

Subject contents	**1.** Real numbers. Axiomatics of real numbers. The supremum and infimum of a set. The sequences of real numbers. Concept of sequence, monotonic sequences, bounded sequences. Limit of a sequence, the theorem of limits of sums, products and quotients of convergent sequences, the theorem of three sequences, limits of monotonic sequences. Cauchy's condition. Convergence points of a sequence, lower and upper limits. Improper limits. 2. Number series. Convergence and sum of series, geometric series. Necessary condition for convergence of a series. The harmonic series. Basic criteria for the convergence of a series with non-negative expressions. Absolute, unconditional and conditional convergence. Dirichlet, Abel and Leibniz criteria. Multiplication of series. 3. Real functions of a real variable. Definition of Cauchy and Heine limit and continuity of functions. Uniform continuity. Properties of a continuous function on a closed interval. Improper limits. 4. Derivative of a function of one variable. Derivatives of elementary functions. Derivative of sum, product, quotient and superposition of functions, derivative of an inverse function. Rolle's, Lagrange's and Cauchy's theorems. Derivatives of higher orders. Taylor's formula. Necessary and sufficient conditions for the existence of a local extremum. Applications of differential calculus to the study of the variation of functions. The rules of de l'Hospital. 5.Propositional calculus and laws of quantifier calculus. Basic elements of the set theory and topology.
Prerequisites and co-requisites	**None**

Assessment methods and criteria	Subject passing criteria	Passing threshold	Percentage of the final grade
	observation of the student's behaviour	100.0%	0.0%
	exam	51.0%	50.0%
	colloquia	51.0%	50.0%

Recommended reading	Basic literature	K. Kuratowski "Rachunek różniczkowy i całkowy", PWN Warszawa 1973. K. Jankowska, T. Jankowski "Zbiór zadań z matematyki" Wydawnictwo Politechniki Gdańskiej 2003 K. Jankowska, T. Jankowski "Zadania z matematyki wyższej" Wydawnictwo Politechniki Gdańskiej 2011 J. Banaś, S. Wędrychowicz, Zbiór zadań z analizy matematycznej, Wydawnictwo Naukowo-Techniczne, Warszawa 2001. W. Marek, J. Onyszkiewicz "Elementy logiki i teorii mnogości w zadaniach", PWN Warszawa 1978
	Supplementary literature	W. Krysicki, L. Włodarski, Analiza matematyczna w zadaniach, część I i II, PWN Warszawa 1986. G.M. Fichtenholz, Rachunek różniczkowy i całkowy, tom I, II i III. PWN Warszawa 1978.

	eResources addresses	
Example issues/ example questions/ tasks being completed	State and prove Bernoulli's inequality. Show that if a numerical sequence is increasing (decreasing) and bounded, it is convergent. State at least two theorems for extending the calculus of limits to improper limits. Give definitions of generalized actions on families of sets and illustrate these concepts with examples. Discuss de Morgan's laws for generalized actions. Formulate the necessary condition for convergence of a series. Give an equivalent formulation of this condition derived from the law of transposition. Explain why it is only a necessary condition and not a sufficient condition. Give an example of a series that satisfies this condition but is divergent. Give an example of a series for which the necessary condition allows you to answer the question of its convergence. Discuss the Cauchy criterion and give an example of a series whose convergence (divergence) can be demonstrated using this criterion. Give an example of a series that does not respond to the Cauchy criterion. Using the Cauchy product, determine the formula for , where ||<1. In the solution, refer to the corresponding theorem for convergence of series. What isthe anharmonic series? Is it convergent or divergent? Which criterion from those learned in the lecture allows you to decide this? What is the sum of an anharmonic series? How can permutation of expressions affect the behavior of anharmonic series? What actions can be performed on continuous functions so that they are still continuous after transformation? For this purpose, state and discuss the relevant theorems learned in the lecture. Justify the continuity of trigonometric and cyclometric functions. State the 4 most important properties of continuous functions defined on a closed interval. For this purpose, discuss the relevant theorems learned in the lecture. Formulate and prove the necessary condition for differentiability. Using the law of transposition, write it in alternative form. Using the theorems learned, derive the formula for the derivative of the function arc sin . What is known about a continuous function that has a derivative equal to 0 at each interior point of the domain? Formulate and prove the corresponding theorem.	
Work placement	Not applicable	

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