

Subject card

Subject name and code	Mathematical Analysis I, PG_00189365						
Field of study	Mathematical Modeling and Data Analysis						
Date of commencement of studies	October 2026		Academic year of realisation of subject		2026/2027		
Education level	Bachelor's studies		Subject group		Obligatory subject group in the field of study Subject group related to scientific research 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		11.0		
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		dr hab. Barbara Wolnik				
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		6.0		149.0	275
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 the set theory, - concepts, theorems and methods of differential calculus of functions of one variable.						

Learning outcomes	Course outcome	Subject outcome	Method of verification
	[MMiADL3_U02] is able to correctly use the concepts of mathematical analysis and differential equations, is able to apply the theorems and methods of these fields and is able to interpret the obtained results	The student correctly uses the concepts and the methods of mathematical analysis learned during the course, is able to use concepts from the curriculum content to solve tasks and draw correct conclusions from the obtained results in a mathematical context.	[SU4] test/exam - oral or written
	[MMiADL3_W02] knows and understands selected concepts, methods and theorems of mathematical analysis and differential equations as well as basic examples both illustrating specific concepts in this field and allowing to refute false hypotheses or invalid reasoning as well as basic examples both illustrating specific concepts from these fields and allowing to refute false hypotheses or invalid reasoning	The student understands the concepts, methods and theorems of mathematical analysis in terms of the material covered during the course, and is able to use examples and counterexamples to illustrate these concepts and verify the correctness of mathematical reasoning.	[SW4] test/exam - oral or written
	[MMiADL3_W06] knows and understands the role and importance of proof in mathematics, as well as the concept of the importance of assumptions	knows the theorems of mathematical analysis in terms of the material covered during the course.	[SW4] 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.		
Prerequisites and co-requisites			
Assessment methods and criteria	Subject passing criteria	Passing threshold	Percentage of the final grade
	colloquia	51.0%	50.0%
	exam	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. Krywicki, 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 $\sum_{n=0}^{\infty} x^n$, where $x < 1$. In the solution, refer to the corresponding theorem for convergence of series. What is the 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 $\arcsin x$. 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	