University of Gdańsk

Subject card

Subject name and code	Mathematical Analysis III, PG_00155398						
Field of study	Mathematics						
Date of commencement of studies	October 2024		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	2		Language of instruction	Polish			
Semester of study	3		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		prof. dr hab. Tomasz Natkaniec				
	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	140.0	275	
Subject objectives	The aim of the course is to familiarize students with the concepts, theorems and methods of differential and integral calculus of functions of several variables.						

Learning outcomes

Course outcome	Subject outcome	Method of verification
[MATL3_W08] knows and understands the structure of mathematical theories, is able to use mathematical formalism to build and analyze simple mathematical models in other fields of science	The student is able to precisely formulate mathematical theorems divided into assumptions and assertions, and is able to apply the theorems learned in practice.	[SW4] test/exam - oral or written [SW1] oral statement/ conversation/discussion
[MATL3_U09] is able to plan how to solve a specific problem and prepare a correct record of this solution, providing strict and precise justification for the correctness of his reasoning	The student is able to present mathematical proofs in an understandable way, both orally and in writing, and understands the significance of the assumptions in his/her reasoning.	[SU1] oral statement/conversation/ discussion [SU4] test/exam - oral or written
[MATL3_W02] knows and understands the basic concepts, methods and theorems of mathematical analysis as well as basic examples illustrating specific concepts in this field and enabling the refutation erroneous hypotheses or unauthorized reasoning	The student knows and understands the basic concepts and theorems of differential and integral calculus of functions of several variables, as well as the methods used in other branches of mathematics, including linear algebra and topology.	[SW4] test/exam - oral or written [SW1] oral statement/ conversation/discussion
[MATL3_U08] is able to formulate definitions and theorems in an understandable way, both orally and in writing, and present correct mathematical reasoning regarding the acquired issues	The student is able to logically present mathematical reasoning, formulate definitions and provide examples of applications.	[SU1] oral statement/conversation/ discussion [SU4] test/exam - oral or written
[MATL3_K09] is ready to critically evaluate arguments, find gaps in reasoning and constructively criticize other people's reasoning	The student critically approaches the presented proofs, is ready to find gaps in reasoning.	[SK1] oral statement/conversation/ discussion [SK8] observation of student's independent or team work
[MATL3_U02] is able to correctly use the known concepts of mathematical analysis, is able - at a simple and medium level of difficulty - to apply the known theorems and methods of this field and is able to interpret the obtained results	The student is able to present correct mathematical reasoning, formulate definitions and theorems in an understandable manner, both orally and in writing, is able to use the methods of differential calculus of several variables, is able to reduce an integral of a function of several variables to an iterated integral, is able to calculate surface integrals.	[SU3] text preparation/written work [SU4] test/exam - oral or written [SU8] observation of student's independent or team work
[MATL3_K01] is ready to accept the limitations of his/her own knowledge and understands the need for further education	The student understands the need for further education.	[SK1] oral statement/conversation/ discussion [SK8] observation of student's independent or team work
[MATL3_W01] knows and understands the basic concepts, methods and theorems of mathematical logic and set theory, as well as basic examples illustrating specific concepts in these fields and enabling the refutation erroneous hypotheses or unauthorized reasoning	The student recognizes the influence of basic concepts and theorems of mathematical logic and set theory on the way of formulating and proving theorems of mathematical analysis.	[SW4] test/exam - oral or written
[MATL3_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 understands the need (and has the courage) to ask questions that serve to deepen the understanding of the content being learned	[SK1] oral statement/conversation/ discussion
[MATL3_U03] is able to correctly use the acquired concepts of linear algebra and geometry, is able - at a simple and medium level of difficulty - to apply the known theorems and methods in these fields and is able to interpret the obtained results	The student is able to use the basic concepts of linear algebra and analytic geometry appearing in the theorems of mathematical analysis of functions of several variables.	[SU1] oral statement/conversation/ discussion [SU4] test/exam - oral or written [SU8] observation of student's independent or team work
[MATL3_W09] knows and understands the role and importance of proof in mathematics, as well as the concept of the importance of assumptions	The student understands the concept of a mathematical theorem, is able to divide the theorem into three parts: assumption, assertion and proof, understands the role of assumptions in proof.	[SW4] test/exam - oral or written [SW1] oral statement/ conversation/discussion

Course outcome	Subject outcome	Method of verification
[MATL3_U01] is able to correctly use the known concepts of mathematical logic and set theory, is able - at a simple and medium level of difficulty - to apply the known theorems and methods of these fields and is able to interpret the obtained results	The student is able to correctly use the basic concepts of mathematical logic and set theory appearing in the theorems and their proofs.	[SU3] text preparation/written work [SU4] test/exam - oral or written [SU8] observation of student's independent or team work
[MATL3_K06] is ready to formulate opinions on basic mathematical issues	The student is able to formulate critical opinions on the issues studied.	[SK1] oral statement/conversation/ discussion [SK8] observation of student's independent or team work
[MATL3_K04] is ready to understand and appreciate the importance of intellectual honesty in one's own and other people's actions; is willing to act ethically	The student understands the importance of intellectual honesty and ethical conduct.	[SK1] oral statement/conversation/ discussion [SK4] test/exam - oral or written [SK8] observation of student's independent or team work
[MATL3_W07] knows and understands selected concepts, methods and theorems of topology, as well as basic examples illustrating specific concepts in this field and enabling the refutation of erroneous hypotheses or unauthorized reasoning	The student knows and understands the basic topological definitions in Euclidean spaces R^k (as the convergence of sequences, open sets, closede sets, compact sets) and properties of functions between R^k and R^n (as continuity, differentiability).	[SW4] test/exam - oral or written [SW1] oral statement/ conversation/discussion
[MATL3_U07] is able to correctly use the acquired concepts of topology, is able - at a simple and medium level of difficulty - to apply the known theorems and methods of this field and is able to interpret the obtained results	The student is able to use the language of metric topology (with particular emphasis on Euclidean spaces) in formulating theorems concerning functions of several variables.	[SU1] oral statement/conversation/ discussion [SU3] text preparation/written work [SU4] test/exam - oral or written [SU8] observation of student's independent or team work

Subject contents

1. Derivatives of functions of several variables. Partial derivatives, directional derivative, derivative (differential) - connections between these concepts.

2. Higher order derivatives, Schwartz's theorem on the commutativeness of partial differentiation. Taylor's formula, local extrema.

3. Mappings R^n in R^m , Jacobian, diffeomorphism, theorem on local diffeomorphism. Theorem on implicit functions. Conditional extrema.
4. Jordan measure in R^k.
5. Riemann integral in R^k. Fubini's theorem, theorem on the change of variables in a multiple integral.
6. Line integral. 1- and 2-forms. Integral of 1- and 2-forms. Gren and Stokes' theorems.

Prerequisites and co-requisites

Knowledge of the issues of mathematical analysis of functions of one variable at the level of lectures on Mathematical Analysis I and II.

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
observation of the student's attitude	51.0%	0.0%
activity	51.0%	5.0%
exam	51.0%	50.0%
tests	51.0%	45.0%

Recommended reading	Basic literature	1. A. Birkholc, Mathematical Analysis. Functions of several variables (in Polish). PWN Warszawa, 1995. 2. G.M. Fichtenholz, Differential and Integral Calculus, Parts I-III (in Polish). PWN Warszawa 1978. 3. W. Krysicki, L. Włodarski, Mathematical Analysis in Problems, Parts I-II. (in Polish) PWN Warszawa 1986. 4.M. Laczkovich, V. Sos, Real Analysis, Series, Functions of Several Variables, and Applications. Springer 2013. 5. W. Rudin, Principles of Mathematical Analysis (in Polish). PWN Warszawa 1982.
	Supplementary literature	none
	eResources addresses	
Example issues/ example questions/ tasks being completed	(1) Give the definition of the derivative of the function f :R^k->R^n at a\in R^k. Write the derivative matrix using partial derivatives. (2) State and prove Schwarz's theorem on the symmetry of the second-order differential. (3) State the implicit function theorem. Define the concepts that appear in it. (4) State Fubini's theorem for continuous functions of two variables f :R^2->R. (5) State and prove Green's theorem.	
Work placement	Not applicable	

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