

Subject card

Subject name and code	Functional Analysis, PG_00155369						
Field of study	Mathematics						
Date of commencement of studies	October 2025		Academic year of realisation of subject		2025/2026		
Education level	Master'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		6.0		
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. inż. Jacek Gulowski				
	Teachers						
Lesson types	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	30.0	30.0	0.0	0.0	0.0	60
	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	60		10.0		80.0	150
Subject objectives	The aim of the course is to present the basic concepts and theorems of Functional Analysis.						

Learning outcomes	Course outcome	Subject outcome	Method of verification
	[MATMU2_W02] knows and understands well the role and importance of the construction of mathematical reasoning	knows and understands the basic concepts and theorems of Functional Analysis	[SW4] test/exam - oral or written
	[MATMU2_U02] can express mathematical content in speech and writing, in mathematical texts of various nature	knows how to apply basic concepts and theorems of Functional Analysis is selected, classical functional and sequence spaces	[SU1] oral statement/conversation/discussion [SU4] test/exam - oral or written [SU8] observation of student's independent or team work
	[MATMU2_K02] is ready to precisely formulate questions to deepen his/her understanding of a given topic or find missing elements of reasoning	is able to precisely formulate questions to deepen understanding of a given topic	[SK1] oral statement/conversation/discussion
	[MATMU2_K05] is ready to independently search for information in literature, also in foreign languages	searches for information in the literature	[SK1] oral statement/conversation/discussion [SK8] observation of student's independent or team work
	[MATMU2_K04] is ready to understand and appreciate the importance of intellectual honesty in one's own and other people's actions; ethical conduct	understands and appreciates the importance of intellectual honesty	[SK8] observation of student's independent or team work
	[MATMU2_K01] is willing to acknowledge the limitations of his or her own knowledge and is willing to pursue further education	knows the limits of his or her own knowledge and shows readiness for further education	[SK8] observation of student's independent or team work
	[MATMU2_K06] is ready to formulate opinions on basic mathematical issues	can formulate opinions on mathematical issues	[SK1] oral statement/conversation/discussion
	[MATMU2_W01] knows and understands in-depth the theory of selected areas of mathematics	known and understands the basic concepts and theorems of Functional Analysis	[SW4] test/exam - oral or written
Subject contents	[MATMU2_U01] can construct mathematical reasoning: prove theorems and refute hypotheses through construction and selection of counterexamples	knows how to apply basic concepts and theorems of Functional Analysis is selected, classical functional and sequence spaces	[SU1] oral statement/conversation/discussion [SU4] test/exam - oral or written
	1. Normed spaces, Banach spaces and their properties. Examples of normed and Banach spaces. Lack of compactness of closed ball in infinitely dimensional normed spaces.		
	2. Linear maps between normed and Banach spaces. Boundedness and continuity of linear operator. The space of linear operators, norm of the linear operator.		
	3. Classical theorems of functional analysis: open map theorem, bounded inverse theorem, closed graph theorem, Hahn-Banach theorem		
	4. Linear functionals on normed spaces. Dual space. The representation of linear and bounded functionals in l^p , $L^p(a,b)$.		
	5. Inner product spaces, Hilbert spaces. The basic properties of inner product spaces. Orthogonal decomposition theorem (orthogonal projection theorem).		
	6. Riesz representation theorem in Hilbert spaces.		
Recommended reading	7. Fourier series, Bessel inequality, complete orthonormal systems in Hilbert spaces.		
	Prerequisites and co-requisites		
	Assessment methods and criteria	Subject passing criteria	Passing threshold
		student's attitude evaluation	51.0%
		final exam	51.0%
		tests	51.0%
		Percentage of the final grade	
Recommended reading	Basic literature	1. J. Musielak - Wstęp do analizy funkcjonalnej, PWN 1989.	
	Supplementary literature	1. A. Alexiewicz - Analiza funkcjonalna, PWN 1968.	
		2. W. Kołodziej - Wybrane rozdziały analizy matematycznej, PWN 1982.	
	eResources addresses		

Example issues/ example questions/ tasks being completed	not applicable
Work placement	Not applicable

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