University of Gdańsk

Subject card

Subject name and code	Functional Analysis and Applications, PG_00155325						
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	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	2		ECTS credits	4.0			
Learning profile	academic		Assessment form	exam			
Conducting unit	Faculty of Mathematics, Physics and Informatics -> Rector						
Name and surname of lecturer (lecturers)	Subject supervisor		dr hab. Tomasz Człapiński				
	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		5.0		35.0	100
Subject objectives	The aim of the course is to present the basic concepts and theorems of Functional Analysis and their applications.						

Learning outcomes

Course outcome	Subject outcome	Method of verification
[MMiADMU2_U01] can construct mathematical reasoning: prove theorems and disprove hypotheses by constructions and selecting counterexamples	The student is able to prove theorems learned during the functional analysis lectures and refute erroneous hypotheses or invalid reasoning.	[SU4] test/exam - oral or written
[MMiADMU2_W02] knows and understands well the role and importance of the construction of mathematical reasoning	The student knows the basic concepts of functional analysis, knows proof methods and basic examples illustrating specific concepts in this field.	[SW4] test/exam - oral or written
[MMiADMU2_K01] is ready to recognize the limitations of his own knowledge and is ready to continue his education	The student knows the limitations of his or her knowledge in the field of functional analysis and is ready for further education.	[SK8] observation of student's independent or team work
[MMiADMU2_K02] is ready to precisely formulate questions to deepen his own understanding of a given topic or to find missing elements of reasoning	The student is able to formulate questions regarding functional analysis that serve to deepen one's understanding of a topic or to identify missing elements of reasoning.	[SK1] oral statement/conversation/ discussion
[MMiADMU2_K04] is ready to understand and appreciate the importance of intellectual honesty in the actions of himself and others; is ready to act ethically	The student understands and appreciates the importance of intellectual honesty in his/her own and other people's actions and acts ethically.	[SK8] observation of student's independent or team work
[MMiADMU2_K06] is ready to form an opinion on basic mathematical issues	The student is ready to formulate opinions on basic mathematical issues in the field of functional analysis.	[SK1] oral statement/conversation/ discussion
[MMiADMU2_K05] is ready to independently search for information in literature, also in foreign languages	The student is ready to independently search for information in literature, including in foreign languages.	[SK1] oral statement/conversation/ discussion
[MMiADMU2_U06] is able to apply methods and examples from a selected field of mathematics in related fields	The student is able to apply the learned tools of functional analysis to solve problems in related fields.	[SU4] test/exam - oral or written
[MMiADMU2_W03] knows and understands in-depth a selected field of theoretical or applied mathematics and is able to understand the formulations of issues in this field that are still being researched and knows the links between the issues of this field and other branches of mathematics	The student knows and understands the connections between functional analysis and other areas of mathematics, such as topology or linear algebra.	[SW4] test/exam - oral or written
[MMiADMU2_W01] knows and understands in-depth the theory of selected areas of mathematics	The student knows and understands the definitions and theorems of functional analysis that are the subject of the lecture, along with selected proofs and examples.	[SW4] test/exam - oral or written

Subject contents

1. Metric spaces. Cauchy sequence, completeness, compactness. Space of continuous functions C[a,b].
2. Method of contracting maps in complete metric space. Applications to the study of nonlinear equations: integral equations, Cauchy problem for first-order differential equations.
3. Normed spaces, Banach spaces. Examples of Banach spaces, l^p, L^p(a,b) spaces. Non-compactness of the ball in infinite-dimensional spaces.
4. Linear mapping in normed spaces and Banach spaces. Boundedness and continuity of linear operator, mapping norm. Kernel and image of a mapping, inverse mapping. Space of linear mappings. Closed graph theorem. Hahn-Banach theorem.
5. Linear functionals on normed space. The space conjugate to the normed space. The form of linear functionals on the spaces l^p, L^p(a,b).
6. Unitary spaces. Examples of unitary spaces. Schwarz's inequality. Parallelogram identity. Polarization formula for the dot product.
7. Hilbert spaces. Orthogonal projection theorem. Orthogonal decomposition theorem. Riesz representation theorem. Fourier series, Bessel's inequality, complete orthonormal system. Adjoint and self-adjoint operator.
8. Weak topologies in normed space.
9. Elements of operator algebra theory. Banach algebras and C*-algebras.
10. Eigenvalues and eigenvectors of a linear operator. Applications of functional analysis in quantum mechanics.

Prerequisites and co-requisites

N/A

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 in classes	51.0%	5.0%
	tests	51.0%	45.0%
	exam	51.0%	50.0%
Recommended reading	Basic literature	1. J.C. Robinson, "An Introduction to Functional Analysis", Cambridge University Press 2020. 2. J. Musielak, "Wstęp do analizy funkcjonalnej", PWN 1989.	
	Supplementary literature	1. W. Kołodziej, "Wybrane rozdziały analizy matematycznej", PWN 1982. 2. A. Alexiewicz, "Analiza funkcjonalna", PWN 1968.	
	eResources addresses		
Example issues/ example questions/ tasks being completed	not included		
Work placement	Not applicable		

Document generated electronically. Does not require a seal or signature.