University of Gdańsk

Subject card

Subject name and code	Introduction to Functional Analysis, PG_00208787						
Field of study	Mathematical Modeling and Data Analysis						
Date of commencement of studies	October 2024		Academic year of realisation of subject	2026/2027			
Education level	Bachelor's studies		Subject group	Optional subject group			
Mode of study	full-time studies		Mode of delivery	at the university			
Year of study	3		Language of instruction	Polish			
Semester of study	6		ECTS credits	6.0			
Learning profile	academic		Assessment form	exam			
Conducting unit	Division of Mathematical Methods of Physics -> Institute of Theoretical Physics and Astrophysics -> Faculty of Mathematics, Physics and Informatics -> Rector						
Name and surname of lecturer (lecturers)	Subject supervisor		dr Krzysztof Szczygielski				
	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	Familiarizing students with basic notions, theorems and methods of functional analysis and their exemplary applications in natural sciences.						

Learning outcomes	Course outcome	Subject outcome	Method of verification
	[MMiADL3_U11] knows how to arrange and analyse an algorithm in accordance with the specification and save it in the selected programming language		
	[MMiADL3_U10] is able to recognise problems, including practical issues, that can be solved algorithmically; can make a specification of such a problem		
	[MMiADL3_U09] is able to use the learned software package or the learned programming language to solve selected problems from the known fields, in particular from mathematical analysis, linear algebra and statistics		
	[MMiADL3_W09] knows and understands the basics of computational and programming techniques supporting mathematician's work and understands their limitations		
		The student is able to: provide and characterize the basic concepts of Hilbert and Banach space theory; use the conceptual apparatus of functional analysis in Hilbert space; characterize the eigenvalue problem and the concept of spectrum of linear operator; justify the significance of functional analysis in quantum mechanics; define the concept of distribution and provide examples of them; define the concept of orthogonal polynomials and provide examples of them.	[SU4] 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: provide and characterize the basic concepts of Hilbert and Banach space theory; use the conceptual apparatus of functional analysis in Hilbert space; characterize the eigenvalue problem and the concept of spectrum of linear operator; justify the significance of functional analysis in quantum mechanics; define the concept of distribution and provide examples of them; define the concept of orthogonal polynomials and provide examples of them.	[SU4] test/exam - oral or written
	[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 basic structures used in linear algebra, topology, and measure theory; the fundamentals of Banach and Hilbert space theory; the concept of dual space and the Riesz representation theorem; the concept of a linear operator and its spectrum; spectral theorem; properties of selected classes of bounded operators; applications and properties of orthogonal polynomials; the concept of a distribution.	[SW4] test/exam - oral or written
	[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 knows/understands/is aware that: theorems and methods of reasoning developed by mathematics have a direct impact on how phenomena occurring in the world are understood; he/she is aware of the significance of functional analysis in various aspects of effective modeling of natural reality and data analysis.	[SK4] test/exam - oral or written

<table>
<tr><td>Subject contents</td><td>1. Theory of Banach and Hilbert spaces

2. Linear operators and functionals

3. Spectrum of linear operator, eigenvectors and eigenvalues

4. Self-adjoint and unitary operators

5. Compact, trace class and Hilbert-Schmidt operators

6. Orthogonal polynomials. Properties and applications

7. Elements of theory of distributions with applications</td></tr>
<tr><td>Prerequisites and co-requisites</td><td>Knowledge of linear algebra and mathematical analysis at the level of the first five semesters of studies in Mathematical Modeling and Data Analysis.</td></tr>
<tr><td>Assessment methods and criteria</td><td><table>
<tr><th>Subject passing criteria</th><th>Passing threshold</th><th>Percentage of the final grade</th></tr>
<tr><td>problem solving</td><td>51.0%</td><td>50.0%</td></tr>
<tr><td>test (written)</td><td>51.0%</td><td>50.0%</td></tr>
</table></td></tr>
<tr><td rowspan="3">Recommended reading</td><td>Basic literature</td><td>1. J. Conway, A Course in Functional Analysis, Springer Science 1985
2. J. Conway, A course in Operator Theory, AMS 1991
3. W. Rudin, Functional analysis, PWN 2001</td></tr>
<tr><td>Supplementary literature</td><td>1. W. A. Majewski, Matematyczne metody fizyki 1, UG 1989
2. W. A. Majewski, Wstęp do fizyki matematycznej, UG 1990</td></tr>
<tr><td>eResources addresses</td><td></td></tr>
<tr><td>Example issues/ example questions/ tasks being completed</td><td></td></tr>
<tr><td>Work placement</td><td>Not applicable</td></tr>
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