University of Gdańsk

Subject card

Subject name and code	Mathematical Methods of Physics II, PG_00182571		
Field of study	Physics		
Date of commencement of studies	October 2026	Academic year of realisation of subject	2027/2028
Education level	Bachelor's studies	Subject group	Obligatory subject group in the field of study Optional subject group 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	2	Language of instruction	Polish
Semester of study	4	ECTS credits	4.0
Learning profile	academic	Assessment form	credit
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	15.0	0.0	0.0	0.0	45
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	45	0.0	55.0	100

Subject objectives	Familiarizing students with basic notions, theorems and methods of functional analysis and their applications in physics.

Learning outcomes	(see table below)

Course outcome	Subject outcome	Method of verification
[FIZL3_W04] knows the methods of higher mathematics, including differential and integral calculus of functions of one and many variables, and the basics of algebra to the extent necessary to describe physical phenomena and solve physical problems	The student knows: the basic structures used in linear algebra, topology, and measure theory; the fundamentals of Banach space theory: the concept of metric, norm, completeness; the Hölder and Minkowski inequalities; the basics of Hilbert space theory; the concept of dual space and linear functional, Riesz's representation theorem; the definition and examples of linear mappings, bounded operators; the concept of resolvent operator, operator spectrum, the eigenvalue problem, and decomposition of the spectrum; properties of self-adjoint and unitary operators; applications and properties of orthogonal polynomials; elements of distribution theory.	[SW4] test/exam - oral or written [SW1] oral statement/ conversation/discussion [SW3] text preparation/written work
[FIZL3_U01] can use advanced mathematical formalism to define, describe, and solve problems in physics	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 of an operator and the concept of spectrum and justify the significance of self-adjoint operators in quantum mechanics; define the concept of distributions and provide examples of them; define the concept of orthogonal polynomials and provide examples of them.	[SU1] oral statement/conversation/ discussion [SU3] text preparation/written work [SU4] test/exam - oral or written

Subject contents	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
Prerequisites and co-requisites	Knowledge of linear algebra and mathematical analysis at the level of the first three semesters of studies in the field of Physics. Earlier completion of the course *Mathematical Methods of Physics I*.
Assessment methods and criteria	(see table below)

Subject passing criteria	Passing threshold	Percentage of the final grade
Classwork	51.0%	100.0%

Recommended reading		
	Basic literature	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

	Supplementary literature	1. W. A. Majewski, *Matematyczne metody fizyki 1*, UG 1989 2. W. A. Majewski, *Wstęp do fizyki matematycznej*, UG 1990 3. L. Górniewicz, R. Ingarden, *Analiza matematyczna dla fizyków*, t. 1. i 2., PWN 1981
	eResources addresses	
Example issues/ example questions/ tasks being completed	Sample exam topics: 1. Define the concept of a topological vector space. 2. Characterize Banach and Hilbert spaces and provide examples of them. 3. Characterize the concept of a dual space. Provide Riesz's representation theorem. 4. Define the concept of a bounded operator and operator norm. Describe the relationship between continuity and boundedness. 5. Provide the definition of a resolvent operator, regular value, and operator spectrum. Describe the classification of the spectrum. 6. Formulate the spectral theorem for a normal operator on a Hilbert space. Sample tasks covered during classes: 1. Investigating selected algebraic and topological properties of various linear spaces and algebras, e.g., l^p and L^p spaces. 2. Verifying properties of metrics, norms, and inner products. 3. Investigating selected linear operators on Hilbert and Banach spaces and their properties, such as symmetry and self-adjointness. Basic spectral analysis.	
Work placement	Not applicable	

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