University of Gdańsk

Subject card

Subject name and code	Mathematical methods of physics II - lecture, PG_00146162		
Field of study	Physics		
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	4	ECTS credits	2.0
Learning profile	academic	Assessment form	
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	0.0	0.0	0.0	0.0	30
	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	30	0.0	30.0	60

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

Learning outcomes	Course outcome	Subject outcome	Method of verification
	[FIZL3_U02] has the ability to perform measurements of basic physical quantities; can develop, describe and present the results of simple physical experiments and computer simulations; can perform quantitative analyses and formulate qualitative conclusions on this basis; can estimate measurement uncertainties	The student is able to: give and characterize the basic concepts of the theory of Hilbert and Banach spaces, use the conceptual apparatus of functional analysis in Hilbert space, characterize the operator's eigenproblem and the concept of spectrum and justify the significance of self-adjoint operators in quantum mechanics, define the concept of distribution and give their examples, define the concept of orthogonal polynomials and give their examples.	[SU4] test/exam - oral or written
	[FIZL3_U08] can use mathematical apparatus and numerical methods to describe and model physical phenomena and processes	The student is able to: give and characterize the basic concepts of the theory of Hilbert and Banach spaces, use the conceptual apparatus of functional analysis in Hilbert space, characterize the operator's eigenproblem and the concept of spectrum and justify the significance of self-adjoint operators in quantum mechanics, define the concept of distribution and give their examples, define the concept of orthogonal polynomials and give their examples.	[SU4] test/exam - oral or written
	[FIZL3_U16] can independently plan and implement his own learning	The student is able to: give and characterize the basic concepts of the theory of Hilbert and Banach spaces, use the conceptual apparatus of functional analysis in Hilbert space, characterize the operator's eigenproblem and the concept of spectrum and justify the significance of self-adjoint operators in quantum mechanics, define the concept of distribution and give their examples, define the concept of orthogonal polynomials and give their examples.	[SU4] test/exam - oral or written
	[FIZL3_K08] is able to speak competently on basic problems of physics and its applications	The student knows/understands/is aware of: that theorems and methods of inference developed by mathematics have a direct impact on the way of understanding physical phenomena occurring in the surrounding world, is aware of the importance of functional analysis and operator theory in various aspects of effective modeling of natural reality.	[SK4] test/exam - oral or written
	[FIZL3_K01] knows the limitations of his own knowledge and understands the need for further education	The student knows/understands/is aware of: that theorems and methods of inference developed by mathematics have a direct impact on the way of understanding physical phenomena occurring in the surrounding world, is aware of the importance of functional analysis and operator theory in various aspects of effective modeling of natural reality.	[SK4] test/exam - oral or written

Course outcome	Subject outcome	Method of verification
[FIZL3_W04] knows the basic techniques 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: basic structures used in linear algebra, topology and measure theory, basics of Banach space theory: the concept of metric, norms, completeness, Holder and Minkowski inequalities, basics of Hilbert space theory, the concept of dual space and linear functional, Riesz representation theorem, definition and examples of linear mappings, bounded operators, the concept of the resolvent operator, operator spectrum, definition of eigenproblem and types of spectra, properties of self-adjoint and unitary operators, applications and properties of orthogonal polynomials, elements of distribution theory.	[SW4] test/exam - oral or written
[FIZL3_W02] understands the role of physical experiments, mathematical theoretical models approximating reality and computer simulations in the methodology of scientific research; is aware of technological, equipment and methodological limitations in scientific research	The student knows: basic structures used in linear algebra, topology and measure theory, basics of Banach space theory: the concept of metric, norms, completeness, Holder and Minkowski inequalities, basics of Hilbert space theory, the concept of dual space and linear functional, Riesz representation theorem, definition and examples of linear mappings, bounded operators, the concept of the resolvent operator, operator spectrum, definition of eigenproblem and types of spectra, properties of self-adjoint and unitary operators, applications and properties of orthogonal polynomials, elements of distribution theory.	[SW4] test/exam - oral or written
[FIZL3_K02] can precisely formulate problems to deepen understanding of a given topic	The student knows/understands/is aware of: that theorems and methods of inference developed by mathematics have a direct impact on the way of understanding physical phenomena occurring in the surrounding world, is aware of the importance of functional analysis and operator theory in various aspects of effective modeling of natural reality.	[SK4] 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	Subject passing criteria	Passing threshold	Percentage of the final grade
	not applicable	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. A. Majewski, *Matematyczne metody fizyki 1*, UG 1989 4. W. A. Majewski, *Wstęp do fizyki matematycznej*, UG 1990 5. L. Górniewicz, R. Ingarden, *Analiza matematyczna dla fizyków*, t. 1. i 2., PWN 1981 6. W. Rudin, *Analiza funkcjonalna*, PWN 2001	
	Supplementary literature		
	eResources addresses		
Example issues/ example questions/ tasks being completed			
Work placement	Not applicable		

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