University of Gdańsk

Subject card

Subject name and code	Mathematical methods of physics I - lecture, PG_00155344		
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	3	ECTS credits	3.0
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	dr Krzysztof Szczygielski	

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	45.0	75

Subject objectives	Familiarizing students with mastery of the basic concepts, theorems and methods of complex analysis, elements of the theory of analytical functions and the basics of harmonic analysis. Familiarizing the student with the concept of the integral with respect to measure, including the Lebesgue integral.

Learning outcomes	Course outcome	Subject outcome	Method of verification
	[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	Student knows: the basic topological properties of the complex plane, the concept of a holomorphic function, the concept of the contour integral of a complex function, the equivalent conditions of being holomorphic, analyticity, the concept of the Laurent series, the residue theorem and its application to the calculation of inproper integrals of real functions, the concept of the trigonometric series and the Fourier series of a real function, the formulas for coefficients in the Fourier series, the Bessel's inequality and the Parseval's identity, the theorems of convergence of the Fourier series, the definition and properties of the Fourier transformation.	[SW4] test/exam - oral or written
	[FIZL3_K08] is able to speak competently on basic problems of physics and its applications	The student knows/is aware 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, and knows the importance of complex analysis and harmonic analysis 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/is aware 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, and knows the importance of complex analysis and harmonic analysis in various aspects of effective modeling of natural reality.	[SK4] test/exam - oral or written
	[FIZL3_U16] can independently plan and implement his own learning	The student is able to: study the convergence of complex sequences and the continuity of functions in the complex domain, investigate if a complex function is holomorphic by definition and using Cauchy-Riemann equations, calculate derivatives and contour integrals of complex functions, expand them into a power series and determine its radius of convergence, investigate the type of singularity and expand a meromorphic function into a Laurent series, calculate residua, apply the residue theorem to calculate inproper integrals of the real functions, determine the expansion coefficients in the Fourier series of real function and determine its convergence.	[SU4] test/exam - oral or written

Course outcome	Subject outcome	Method of verification
[FIZL3_U08] can use mathematical apparatus and numerical methods to describe and model physical phenomena and processes	The student is able to: study the convergence of complex sequences and the continuity of functions in the complex domain, investigate if a complex function is holomorphic by definition and using Cauchy-Riemann equations, calculate derivatives and contour integrals of complex functions, expand them into a power series and determine its radius of convergence, investigate the type of singularity and expand a meromorphic function into a Laurent series, calculate residua, apply the residue theorem to calculate inproper integrals of the real functions, determine the expansion coefficients in the Fourier series of real function and determine its convergence.	[SU4] test/exam - oral or written
[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: study the convergence of complex sequences and the continuity of functions in the complex domain, investigate if a complex function is holomorphic by definition and using Cauchy-Riemann equations, calculate derivatives and contour integrals of complex functions, expand them into a power series and determine its radius of convergence, investigate the type of singularity and expand a meromorphic function into a Laurent series, calculate residua, apply the residue theorem to calculate inproper integrals of the real functions, determine the expansion coefficients in the Fourier series of real function and determine its convergence.	[SU4] test/exam - oral or written
[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	Student knows: the basic topological properties of the complex plane, the concept of a holomorphic function, the concept of the contour integral of a complex function, the equivalent conditions of being holomorphic, analyticity, the concept of the Laurent series, the residue theorem and its application to the calculation of inproper integrals of real functions, the concept of the trigonometric series and the Fourier series of a real function, the formulas for coefficients in the Fourier series, the Bessel's inequality and the Parseval's identity, the theorems of convergence of the Fourier series, the definition and properties of the Fourier transformation.	[SW4] test/exam - oral or written
[FIZL3_K02] can precisely formulate problems to deepen understanding of a given topic	The student knows/is aware 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, and knows the importance of complex analysis and harmonic analysis in various aspects of effective modeling of natural reality.	[SK4] test/exam - oral or written

<table>
<tr><td>Subject contents</td><td>1. Complex functions. Derivative of a complex function

2. Holomorphic functions. Cauchy-Riemann equations and their relationship to holomorphic function

3. Cauchy's theorem, Cauchy's integral formula

4. Analytical and meromorphic functions. Laurent series

5. Singularities, residues and calculating integrals with them

6. Elements of Hilbert's space theory and space L^2

7. Fourier series and its convergence. Orthogonal polynomials

8. Fourier transformation, its properties and applications

9. Measurable space, measure. Borel subsets in R^n

10. Integral of a measurable function with respect to a measure. Lebesgue integral</td></tr>
<tr><td>Prerequisites and co-requisites</td><td>Knowledge of linear algebra and mathematical analysis at the level of the first two semesters of studies in the field of Physics.</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>exam</td><td>51.0%</td><td>100.0%</td></tr></table></td></tr>
<tr><td>Recommended reading</td><td><table><tr><td>Basic literature</td><td>1. F. Leja, Funkcje zespolone, PWN, Warszawa 2006

2. G. M. Fichtenholz, Rachunek różniczkowy i całkowy, t. I, II, III, PWN, Warszawa 1972

3. H. Rasiowa, Wstęp do matematyki współczesnej, PWN Warszawa 1973

4. K. Kuratowski, Rachunek różniczkowy i całkowy, PWN Warszawa 1973

5. F. Leja, Rachunek różniczkowy i całkowy, PWN Warszawa 1971

6. A. W. Bicadze, Równania fizyki matematycznej, PWN Warszawa 1984

7. L. Grafakos, Classical Fourier Analysis, Springer, New York 2008

8. W. Rudin, Analiza rzeczywista i zespolona, PWN Warszawa 1998</td></tr><tr><td>Supplementary literature</td><td></td></tr><tr><td>eResources addresses</td><td></td></tr></table></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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