GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Applications of mathematical methods in physics and engineering, PG_00064052		
Field of study	Technical Physics		
Date of commencement of studies	October 2026	Academic year of realisation of subject	2028/2029
Education level	first-cycle studies	Subject group	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	3	Language of instruction	Polish
Semester of study	6	ECTS credits	5.0
Learning profile	general academic profile	Assessment form	assessment
Conducting unit	Division of Atomic Molecular and Optical Physics -> Institute of Physics and Applied Computer Science -> Faculty of Applied Physics and Mathematics -> Faculties of Gdańsk University of Technology		
Name and surname of lecturer (lecturers)	Subject supervisor	dr inż. Sebastian Bielski	
	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	60.0	125

Subject objectives	The aim of the course is to present and to systematize some mathematical objects, definitions or methods as tools that can be used to solve physical problems. Another aim is to develop the skills of solving problems of physics.

Learning outcomes

Course outcome	Subject outcome	Method of verification
[K6_W02] possesses structured knowledge of the fundamentals of physics, including mechanics, thermodynamics, electricity and magnetism, optics, atomic and molecular physics, solid-state physics, and nuclear and particle physics.	The student has systematized knowledge allowing for the correct mathematical formulation of selected problems in classical mechanics, electromagnetism, electrical engineering, and quantum mechanics.	[SW1] Assessment of factual knowledge
[K6_W03] possesses structured knowledge of higher mathematics, including algebra, analysis, probability and numerical methods, sufficient to describe, understand and model complex physical phenomena and selected technical processes.	The student has knowledge of advanced mathematical methods, including special functions, integral transform methods, Green's function method, and phasor method (complex impedance method), sufficient to model physical phenomena.	[SW1] Assessment of factual knowledge
[K6_U02] is able to analyse and solve complex and non-standard scientific and technical problems using appropriate analytical, computational, numerical, simulation or experimental methods.	The student is able to select and apply appropriate analytical methods to solve complex problems in mechanics, electromagnetism, electrical engineering, heat transfer, and quantum mechanics.	[SU1] Assessment of task fulfilment

Subject contents	Course content – lecture Gamma function GramSchmidt orthogonalization Hermite polynomials and their properties; the harmonic oscillator problem Legendre polynomials and their properties; associated Legendre functions; spherical harmonics The Bessel equation; Bessel functions and their properties; class of equations whose solutions involve Bessel functions; spherical Bessel functions The Greens function method: construction of Greens functions for one-dimensional problems; Greens functions for the Laplace and Helmholtz equations in three dimensions Complex functions of a real variable and their applications: the phasor method, the complex impedance method Laplace integral transform Fourier integral transform	
	Course content – exercises Application of the Gamma function to the evaluation of selected integrals Use of the GramSchmidt orthogonalization method to construct orthogonal polynomials Modifications of the harmonic oscillator problem Examples of applications of Legendre polynomials and spherical harmonics: electrostatic potential of charge distributions, the radial Schrödinger equation Applications of Bessel functions, e.g., heat transfer in an infinite cylinder; the circular membrane problem Application of the Greens function method to one-dimensional problems Use of the phasor method and the complex impedance method in problem solving Problems involving the use of integral transform methods	
Prerequisites and co-requisites	basics of differential calculus and integral calculus	
Assessment methods and criteria		

Subject passing criteria	Passing threshold	Percentage of the final grade
2 tests (90 minutes each)	42.0%	100.0%

Recommended reading	Basic literature	M. Abramowitz, I. A. Stegun, "Handbook of Mathematical Functions" F. W. Byron, R. W. Fuller, "Mathematics of Classical and Quantum Physics" H. W. Wyld, "Mathematical methods for physics"
	Supplementary literature	Donald A. McQuarrie, Mathematical Methods for Scientists and Engineers, University Science Books, 2003
	eResources addresses	

Example issues/ example questions/ tasks being completed	**Lecture** Using the generating function, derive the recurrence relations satisfied by the Hermite polynomials. Show that the spherical harmonics are eigenfunctions of the orbital angular momentum squared operator. **Tutorial** Apply the Gram-Schmidt orthonormalization method to the functions {x_n}, n=0,1,2,... on the interval [1; 1] with the weighting function rho(x)=1. Find eigenvalues and normalized eigenfunctions of the 1D harmonic oscillator subjected to a constant external force F. Determine the general solution to the differential equation describing the motion of a pendulum which length is a linear function of time. Calculate the sum of two currents i1(t)=3 cos (157 t + pi/4) and i2(t)= -4 cos (157 t - pi/4)
Practical activites within the subject	Not applicable

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