Subject card

Subject name and code	Symbolic computation in physics, PG_00064058						
Field of study	Technical Physics						
Date of commencement of studies	October 2026			Academic year of realisation of subject		2027/2028	
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	2			Language of instruction		Polish	
Semester of study	4			ECTS credits		3.0	
Learning profile	general academic profile			Assessment form		assessment	
Conducting unit	Department of Atomic Physics and Luminescence -> Faculty of Applied Physics and Mathematics -> Faculties of Gdańsk University of Technology						
Name and surname of lecturer (lecturers)	Subject supervisor			dr inż. Paweł Wojda			
	Teachers						
Lesson types	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	15.0	0.0	30.0	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		4.0	26.0		75
Subject objectives	The aim of the course is to educate the student a coherent view on the basic issues of physics / mathematics / techniques and tools to solve these problems.						

Learning outcomes

Course outcome	Subject outcome	Method of verification
[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 can use mathematical equations to describe selected physics problems.	[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 can select and apply the appropriate method to solve selected physics/mathematics problems and use numerical methods to obtain their solutions.	[SU1] Assessment of task fulfilment [SU4] Assessment of ability to use methods and tools
[K6_W05] has knowledge of programming methodologies and techniques, as well as the use of selected IT tools in physics and engineering.	The student understands the basics of programming, calculations, data acquisition, and data processing and can use them to obtain solutions to selected physics problems.	[SW1] Assessment of factual knowledge
[K6_U03] possesses programming skills in a selected language and the ability to use selected software packages.	The student can use Python/C++ and utilize loops, arrays, and libraries for manipulating complex numbers and creating graphs.	[SU1] Assessment of task fulfilment [SU4] Assessment of ability to use methods and tools

<table>
<tr><td>Subject contents</td><td colspan="2">Course content – lecture

Course content lecture
1. Introduction.Symbolic computation program (Mathematica, Maple, etc).
2. Mathematical Modelling. General mathematical notions and symbols.
3. Algebraic manipulations. Algorithm. Programs.
4. Polynomials, intertwine relations. Integral and difference operators factorization.
5. Entanglement relations. Factorization of integral and differential operators. Factorization of ordinary differential operators.
6. Differential operators factorization. Differential equations solution. Eigenvectors.
7. Algorithm for the tridiagonal matrix (Thomas algorithm).
8. Numerical and analytical solution of ordinary differential equations and partial differential equations (finitedifference method and separation of variables method).
9. Mathematical description of physical phenomena.

Course content – laboratory

Course content laboratory
1. Numerical determination of differential solutions of hyperbolic and parabolic equations (finite differencemethod, Runge-Kutta method, and discrete Fourier transform).
2. Solving the thermal conductivity equation using separation of variables.
3. Determining solutions to the paraxial Helmholtz equation.</td></tr>
<tr><td>Prerequisites and co-requisites</td><td colspan="2"></td></tr>
<tr><td>Assessment methods and criteria</td><td colspan="2">

Subject passing criteria	Passing threshold	Percentage of the final grade
passing tests	50.0%	30.0%
passing laboratories	50.0%	70.0%

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<tr><td>Recommended reading</td><td>Basic literature</td><td>1. D. Kincaid, W. Cheney, Analiza numeryczna, 2006
2. Mathematica. Wolfram Research. https://www.wolfram.com/mathematica/online/
3. Tao Pang, Metody obliczeniowe w fizyce : fizyka i komputery,Wydawnictwo Naukowe PWN, Warszawa, 2001
4. P. Krzyżanowski, Metody numeryczne, Wydawnictwo Naukowe PWN, Warszawa, 2024</td></tr>
<tr><td></td><td>Supplementary literature</td><td>1. Journal of symbolic computations. S. Leble Skrypt.
2. Ruas, Victoriano, Numerical methods for partial differential equations :an introduction finite differences, finite elements and finite volumes; Wydawca Chichester, West Sussex, England : Wiley; 2016
3. Joseph W. Goodman , Introduction to Fourier optics, Englewood :Roberts & Company, 2005
4. James, J. F. (John Francis), A student's guide to Fourier transforms : with applications in physics and engineering, Cambridge University Press, 2011.</td></tr>
<tr><td></td><td>eResources addresses</td><td></td></tr>
<tr><td>Example issues/ example questions/ tasks being completed</td><td colspan="2">Determine eigenvectors, eigenvalues of the matrix. Determine the solutions of the system of first order differential equations. Description of sound propagation.</td></tr>
<tr><td>Practical activites within the subject</td><td colspan="2">Not applicable</td></tr>
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