GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Symbolic computation in physics, PG_00064058
Field of study	Technical Physics

Date of commencement of studies	October 2024	Academic year of realisation of subject	2025/2026
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 — dr inż. Paweł Wojda

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] has systematized knowledge of higher mathematics, including algebra, analysis, probability theory and numerical methods, allowing for basic description, understanding and modelling of physical phenomena and some technical processes	The student is able to explain the solution of a problem in physics or mathematics.	[SW1] Assessment of factual knowledge
	[K6_U03] knows programming languages and can use basic software packages	Student uses symbolic calculations and uses basic commands, such as loops, in C ++	[SU4] Assessment of ability to use methods and tools [SU1] Assessment of task fulfilment
	[K6_U02] analyzes and solves simple scientific and technical problems, based on possessed knowledge, using analytical, numerical, simulation and experimental methods	The student refers to the knowledge gained during the studies in physics / mathematics and uses IT tools.	[SU4] Assessment of ability to use methods and tools [SU1] Assessment of task fulfilment
	[K6_W05] has knowledge of programming methodology and techniques, and the use of selected IT tools in physics and technology	The student knows the basics of programming, computing, data reading and data processing.	[SW1] Assessment of factual knowledge

Subject contents	Course content – lecture
	Introduction.Symbolic computation program (Mathematica, Maple, etc).
	Mathematical Modelling. General mathematical notions and symbols.
	Algebraic manipulations. Algorithm. Programs.
	Polynomials, intertwine relations. Integral and difference operators factorization.
	Differential operators factorization. Differential equations solution. Eigenvectors.
	Algorithm for the tridiagonal matrix (Thomas algorithm).
	Numerical and analytical solution of ordinary differential equations and partial differential equations (finite difference method and separation of variables method).
	Mathematical description of physical phenomena.
	Course content – laboratory
	Numerical determination of differential solutions of hyperbolic and parabolic equations (finite difference method, Runge-Kutta method, and discrete Fourier transform).
	Solving the thermal conductivity equation using separation of variables.
	Determining solutions to the paraxial Helmholtz equation.

Prerequisites and co-requisites	

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

Recommended reading	Basic literature	1. D. Kincaid, W. Cheney, Numerical analisys, 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
	Supplementary literature	Journal of symbolic computations. S. Leble Skrypt.
		Ruas, Victoriano, Numerical methods for partial differential equations : an introduction finite differences, finite elements and finite volumes; Wydawca Chichester, West Sussex, England : Wiley; 2016
		Joseph W. Goodman , Introduction to Fourier optics, Englewood : Roberts & Company, 2005
		James, J. F. (John Francis), A student's guide to Fourier transforms : with applications in physics and engineering, Cambridge University Press, 2011.

	eResources addresses	
Example issues/ example questions/ tasks being completed	Determine eigenvectors, eigenvalues of the matrix. Determine the solutions of the system of first order differential equations. Description of sound propagation.	
Practical activites within the subject	Not applicable	

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