GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Numerical methods, PG_00064606		
Field of study	Technical Physics		
Date of commencement of studies	February 2027	Academic year of realisation of subject	2026/2027
Education level	second-cycle studies	Subject group	Obligatory subject group in the field of study 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	1	Language of instruction	Polish
Semester of study	1	ECTS credits	4.0
Learning profile	general academic profile	Assessment form	assessment
Conducting unit	Division of Computational Chemical 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	prof. dr hab. Julien Guthmuller	
	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	5.0	50.0	100

Subject objectives

The aim of the course is to equip students with advanced tools for numerical methods.

Learning outcomes

Course outcome	Subject outcome	Method of verification
[K7_U05] is able, individually or as part of a team (including in a leadership role), to plan and conduct advanced theoretical calculations, experimental studies and computer simulations aimed at solving complex and non-standard scientific and engineering problems, and to critically analyse results and formulate well-founded conclusions	Can perform numerical calculations.	[SU1] Assessment of task fulfilment
[K7_U02] demonstrates advanced programming skills in a selected language and the ability to use specialised software packages.	Has the practical ability to program in the language.	[SU4] Assessment of ability to use methods and tools
[K7_W04] possesses advanced knowledge of mathematical, numerical and simulation methods used in the description and modelling of physical phenomena.	He has knowledge of numerical methods for the description of physical phenomena.	[SW1] Assessment of factual knowledge

Subject contents	Course content – lecture 1. Ordinary differential equations: Euler methods, Runge-Kutta methods, adaptive step sizes, the Runge-Kutta-Fehlberg method. 2. Second order ordinary differential equations. Examples: oscillators equations, Schroedinger equation, several dependent variables. 3. Continuation: finite differences, discretization error. 4. Eigenvalues via finite differences. An example of vibrating string. 5. Continuation: the power method and the finite elements method. 6. The Fourier series and the Fourier transform. Convolution and correlation. The discrete Fourier transform. 7. Spectrum analysis. Computerized tomography. 8. Classes of partial differential equations. Finite difference equations. 9. Examples: the vibrating string and the steady-state heat equation. 10. Irregular physical boundary conditions. 11. More on finite difference equations. 12. Spectral methods. 13. The pseudo-spectral method. 14. Examples: a stationary wavepacket evolving in free space, the potential step, the well and the barrier.
	Course content – laboratory Ordinary differential equations: Euler methods, Runge-Kutta methods, adaptive step sizes, the Runge-Kutta-Fehlberg method. Second order ordinary differential equations. Finite differences, discretization error. Classes of partial differential equations. Finite difference equations. An example of vibrating string. Linear equation systems. Spectral methods. Steady-state heat equation.
Prerequisites and co-requisites	Taking courses in mathematical analysis, algebra and discrete mathematics. Introduction to numerical methods during undergraduate studies.

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
Midterm colloquium	50.0%	50.0%
Practical exercise	50.0%	50.0%

Recommended reading

Recommended reading	Basic literature	(1) P.L. DeVries "A first course in computational physics" John Willey 1994 (2) K. E. Atkinson, W. Han, D. E. Steward, "Numerical solution of ordinary differential equations", Wiley 2009 (3) W. H. Press et al. "Numerical recipes", Cambridge University Press 2007
	Supplementary literature	(1) D. Kincaid, W. Cheney "Analiza numeryczna" WNT 2006 (2) A. Ralston "Wstęp do analizy numerycznej" PWN 1975 (3) D. Potter "Metody obliczeniowe fizyki" PWN 1977
	eResources addresses	

Example issues/ example questions/ tasks being completed	1. Methods of Euler 2. The method of Adams. Derivation. Basic patterns. Advantages and disadvantages. 3, Finite Difference Method. Introduce explicit iterative scheme to solve the diffusion equation. 4. The method of Crank-Nickolson
Practical activites within the subject	Not applicable

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