GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Numerical methods, PG_00031921		
Field of study	Technical Physics		
Date of commencement of studies	February 2024	Academic year of realisation of subject	2023/2024
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	Department of Theoretical Physics and Quantum Information -> Faculty of Applied Physics and Mathematics		
Name and surname of lecturer (lecturers)	Subject supervisor	prof. dr hab. Julien Guthmuller	
	Teachers	prof. dr hab. Julien Guthmuller	

Lesson types and methods of instruction

Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
Number of study hours	30.0	0.0	30.0	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	12.0	28.0	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_W04] Has enhanced knowledge of mathematical, numerical and simulation methods applied 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
[K7_U02] Has enhanced knowledge of programming languages and can use software packages.	Has the practical ability to program in the language.	[SU4] Assessment of ability to use methods and tools
[K7_U05] Can plan and conduct theoretical calculations, experimental research and computer simulations, critically analyze their results, draw conclusions and form reasoned opinions.	Can perform numerical calculations.	[SU1] Assessment of task fulfilment

<table>
<tr><td>Subject contents</td><td>1. (2h) Ordinary differential equations: Euler methods, Runge-Kutta methods, adaptive step sizes, the Runge-Kutta-Fehlberg method.
2. (2h) Second order ordinary differential equations. Examples: oscillators equations, Schroedinger equation, several dependent variables.
3. (2h) Continuation: finite differences, discretisation error.
4. (2h) Eigenvalues via finite differnces. An example of vibriting string.
5. (2h) Continuation: the power method and the finite elements method.
6. (2h) The Fourier series and the Fourier transform. Convolution and correlation. The discrete Fourir transform.
7. (2h) Spectrum analysis. Computerized tomography.
8. (2h) Classes of partial differential equations. Finite difference equations.
9. (2h) Examples: the vibrating string and the steady-state heat equation.
10. (2h) Irregular physical boundary conditions.
11. (2h) More on finite difference equations.
12. (2h) Spectral methods.
13. (2h) The pseudo-spectral method.
14. (2h) Examples: a stationary wavepacket evolving in free space, the potential step, the well and the barier.
15 Final tests.</td></tr>
<tr><td>Prerequisites and co-requisites</td><td>Taking courses in mathematical analysis, algebra and discrete mathematics. Introduction to numerical methods during undergraduate studies.</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>Midterm colloquium</td><td>56.0%</td><td>50.0%</td></tr>
<tr><td>Practical exercise</td><td>56.0%</td><td>50.0%</td></tr>
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<tr><td rowspan="3">Recommended reading</td><td>Basic literature</td><td>(1) P.L. DeVries "A first course in computational physics" John Willey 1994</td></tr>
<tr><td>Supplementary literature</td><td>(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</td></tr>
<tr><td>eResources addresses</td><td>Adresy na platformie eNauczanie:</td></tr>
<tr><td>Example issues/ example questions/ tasks being completed</td><td>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</td></tr>
<tr><td>Work placement</td><td>Not applicable</td></tr>
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