Subject card

Subject name and code	Advanced Numerical Methods of Medical Physics, PG_00182187		
Field of study	Medical Physics		
Date of commencement of studies	October 2026	Academic year of realisation of subject	2026/2027
Education level	Master’s 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	2	ECTS credits	5.0
Learning profile	academic	Assessment form	exam
Conducting unit	Institute of Theoretical Physics and Astrophysics -> Faculty of Mathematics, Physics and Informatics -> Rector		
Name and surname of lecturer (lecturers)	Subject supervisor	dr Marcin Łobejko	
	Teachers		

Lesson types	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	0.0	65.0	125

Subject objectives	Familiarizing the student with advanced numerical methods used in the study of physical processes described by ordinary or partial differential equations; teaching the application of these methods to problems occurring in medical physics; introducing optimization methods (linear and nonlinear).

<table>
<tr><td rowspan="5">Learning outcomes</td><td>Course outcome</td><td>Subject outcome</td><td>Method of verification</td></tr>
<tr><td>[FIZMEDMU2_U04] Can formulate and test hypotheses related to simple research problems within the scope of acquired knowledge in physics and medicine.</td><td>The student is able to: formulate a differential equation describing a simple physical process; formulate a linear optimization problem for a given physical or medical problem.</td><td>[SU2] presentation/project/paper/report
[SU5] implementation of a problem task</td></tr>
<tr><td>[FIZMEDMU2_W02] Knows and understands in depth the issues of mathematics and mathematical methods used in physics and medicine, as well as the relationships between them.</td><td>The student knows: the theory of ordinary and partial differential equations; the classification of differential equations (order, linear/nonlinear, ordinary/partial); the eigenvalue problem (eigenvalues and eigenvectors); the theory of initial and boundary conditions; basic partial differential equations (the wave equation, the heat conduction equation, the Laplace equation).</td><td>[SW4] test/exam - oral or written</td></tr>
<tr><td>[FIZMEDMU2_W05] Knows and understands in depth the theoretical foundations of computational methods and computer techniques used to model and simulate physical and biological systems.</td><td>The student knows: finite difference methods for ordinary differential equations with initial and boundary conditions (Euler’s method, the midpoint method, Runge–Kutta algorithms); finite difference methods adapted to solving stationary and initial problems with given boundary conditions for various types of partial differential equations; the finite element method using a triangular function basis; linear optimization methods (linear programming) and nonlinear optimization methods.</td><td>[SW4] test/exam - oral or written</td></tr>
<tr><td>[FIZMEDMU2_U01] Can apply the scientific method in solving physical and medical problems, carrying out experiments and drawing conclusions in the field of physics, medical physics and other fields, based on in-depth knowledge, appropriate selection of sources, and mathematical and computer science methods and tools.</td><td>The student is able to: use an appropriate numerical method to obtain a numerical solution of a differential equation based on given initial and boundary conditions; distinguish and determine the precision and accuracy of the applied numerical method.</td><td>[SU2] presentation/project/paper/report
[SU5] implementation of a problem task</td></tr>
<tr><td>Subject contents</td><td colspan="3">Theory and classification of differential equations. Ordinary and partial differential equations (the wave equation, the heat equation, the Laplace equation). Initial and boundary value problems. Numerical methods (numerical approximation, precision, and accuracy). Finite difference methods (Euler, midpoint, RungeKutta). Finite element method (triangular function basis). Optimization: linear (linear programming) and nonlinear.</td></tr>
<tr><td>Prerequisites and co-requisites</td><td colspan="3"></td></tr>
<tr><td rowspan="3">Assessment methods and criteria</td><td>Subject passing criteria</td><td>Passing threshold</td><td>Percentage of the final grade</td></tr>
<tr><td>not applicable</td><td>51.0%</td><td>50.0%</td></tr>
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<tr><td rowspan="3">Recommended reading</td><td>Basic literature</td><td colspan="2">not applicable</td></tr>
<tr><td>Supplementary literature</td><td colspan="2">not applicable</td></tr>
<tr><td>eResources addresses</td><td colspan="2"></td></tr>
<tr><td>Example issues/ example questions/ tasks being completed</td><td colspan="3">not applicable</td></tr>
<tr><td>Work placement</td><td colspan="3">Not applicable</td></tr>
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