

Subject card

Subject name and code	Computational Methods of Medical Physics, PG_00182148						
Field of study	Medical Physics						
Date of commencement of studies	October 2026	Academic year of realisation of subject			2027/2028		
Education level	Bachelor'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	2	Language of instruction			Polish		
Semester of study	3	ECTS credits			3.0		
Learning profile	academic	Assessment form			credit		
Conducting unit	Laboratory for Physics Teaching -> Institute of Experimental Physics -> Faculty of Mathematics, Physics and Informatics -> Rector						
Name and surname of lecturer (lecturers)	Subject supervisor		dr Adrian Kołodziejski				
	Teachers						
Lesson types	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	0.0	0.0	45.0	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		0.0		45.0	90
Subject objectives	Familiarization with the theoretical foundations of numerical methods essential in medical physics. Mastery of the theoretical basis of numerical techniques used to solve problems encountered in medical physics. Development of practical skills in performing numerical computations using numerical libraries provided in the Python programming language. Acquisition of techniques for preparing concise research-oriented scientific reports.						

Learning outcomes	Course outcome	Subject outcome	Method of verification
	[FIZMEDL3_U05] Can program and use specialised software for calculations and data analysis, including in the field of imaging diagnostics, radiotherapy and biomedical signal analysis.	The student is able to: – use the Spyder environment as an advanced "calculator"; – write a report using the LaTeX typesetting system, documenting the implementation of a project related to medical physics that requires the use of numerical methods and the Spyder environment;	[SU2] presentation/project/paper/report
	[FIZMEDL3_W05] Knows and understands the most important computational and programming techniques used to solve physical and medical problems, present results, and analyse data.	The student knows: - the theoretical foundations of mathematical methods used in solving problems of medical physics; - the interface and command syntax of the Spyder environment and the scientific Python packages integrated with it: NumPy, SciPy, matplotlib; - selected numerical and graphical functions and procedures implemented in this environment; - the most common types of numerical problems encountered in physico-medical applications; - the principles of preparing scientific research reports.	[SW5] implementation of a problem task
	[FIZMEDL3_U01] He can formulate, analyse, and solve complex problems in physics and medicine, using mathematical formalism, based on the physical phenomena, principles, and theories he has learned.	The student is able to: – perform numerical computations using numerical libraries, – identify a given numerical problem and apply appropriate functions or procedures provided in Python to solve it, – create a script in Spyder/Python that implements a specific numerical problem and utilizes its graphical capabilities,	[SU2] presentation/project/paper/report

Subject contents	<p>1. Basics of Python programming: Spyder environment, mathematical operations, standard functions, numerical and graphical libraries, arrays: matrices and vectors.</p> <p>2. Programming in Python: importing libraries, loops, conditional statements, function definitions.</p> <p>3. Numerical computations in Python: root finding, optimization, linear systems, linear regression, least squares method, polynomial interpolation, splines, integration, ordinary differential equations (Cauchy problem), random numbers.</p> <p>4. Numerical errors and instabilities.</p> <p>5. Linear systems: Gaussian elimination, norms and condition numbers, LU and Cholesky decompositions, Jacobi and Gauss-Seidel methods.</p> <p>6. Nonlinear equations: bisection method, fixed-point iteration, regula falsi, secant and Newton-Raphson methods.</p> <p>7. Numerical differentiation, Newton-Cotes and Gaussian quadrature.</p> <p>8. Polynomial interpolation, spline functions, approximation, least squares method, linear regression.</p> <p>9. Solving the Cauchy problem for ordinary differential equations: Euler and Runge-Kutta-Fehlberg methods, single-step and multi-step methods, explicit and implicit schemes, stability.</p> <p>10. Boundary value problems for ordinary differential equations.</p> <p>11. Elliptic partial differential equations.</p> <p>12. Fourier and Radon transforms.</p> <p>13. Elements of probability and statistics Monte Carlo method.</p>								
Prerequisites and co-requisites	Completed courses: Mathematical Analysis, Linear Algebra with Geometry, Introduction to Programming.								
Assessment methods and criteria	<table border="1"> <thead> <tr> <th data-bbox="453 1323 798 1357">Subject passing criteria</th> <th data-bbox="802 1323 1142 1357">Passing threshold</th> <th data-bbox="1147 1323 1485 1357">Percentage of the final grade</th> </tr> </thead> <tbody> <tr> <td data-bbox="453 1364 798 1460">The assessment covers both the correctness of the problem task execution and the presentation of the solution.</td> <td data-bbox="802 1364 1142 1460">51.0%</td> <td data-bbox="1147 1364 1485 1460">100.0%</td> </tr> </tbody> </table>	Subject passing criteria	Passing threshold	Percentage of the final grade	The assessment covers both the correctness of the problem task execution and the presentation of the solution.	51.0%	100.0%		
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Recommended reading	Basic literature	<p>J. Kiusalaas, Numerical Methods with Python, Cambridge University Press 2013</p> <p>Ch. Dierbach, Introduction to Computer Science Using Python: A Computational Problem-Solving Focus, John Wiley & Sons, 2013 C.</p> <p>Führer, J. E. Solem, O. Verdier, Scientific Computing with Python 3, Packt Publishing 2016</p> <p>Å. Björck, G. Dahlquist, Metody numeryczne PWN 1987</p> <p>J. M. Jankowsky, Przegląd algorytmów numerycznych, Wyd. Naukowo-Techniczne 1988</p> <p>J. Stoer, R. Burlisch, Wstęp do analizy numerycznej, PWN 1987</p> <p>Z. Kamont, Równania różniczkowe zwyczajne. Wydawnictwo UG 1999</p> <p>Leah Edelstein-Keshet, Mathematical Models in Biology, SIAM, 2005</p>
	Supplementary literature	not applicable
	eResources addresses	
Example issues/ example questions/ tasks being completed	not applicable	
Work placement	Not applicable	

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