GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Numerical Methods, PG_00047626		
Field of study	Automatic Control, Cybernetics and Robotics		
Date of commencement of studies	October 2021	Academic year of realisation of subject	2023/2024
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	3	Language of instruction	Polish
Semester of study	5	ECTS credits	2.0
Learning profile	general academic profile	Assessment form	exam
Conducting unit	Department of Decision Systems and Robotics -> Faculty of Electronics, Telecommunications and Informatics		
Name and surname of lecturer (lecturers)	Subject supervisor	mgr inż. Sebastian Dziedziewicz	
	Teachers	mgr inż. Sebastian Dziedziewicz	

Lesson types and methods of instruction

Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
Number of study hours	15.0	0.0	0.0	0.0	0.0	15

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	15	2.0	33.0	50

Subject objectives

Learning modern numerical algorithms necessary to solve many engineering problems.

Learning outcomes

Course outcome	Subject outcome	Method of verification
[K6_U04] can apply knowledge of programming methods and techniques as well as select and apply appropriate programming methods and tools in computer software development or programming devices or controllers using microprocessors or programmable elements or systems specific to the field of study	Student is able to implement numerical methods algorithms. Student is able to assess the correctness of numerical algorithms.	[SU2] Assessment of ability to analyse information [SU4] Assessment of ability to use methods and tools
[K6_U01] can apply mathematical knowledge to formulate and solve complex and non-typical problems related to the field of study and perform tasks, in an innovative way, in not entirely predictable conditions, by:n- appropriate selection of sources and information obtained from them, assessment, critical analysis and synthesis of this information,n- selection and application of appropriate methods and toolsn	Student is able to analyze mathematical problems and choose appropriate numerical methods to solve them. Student is able to use external sources when solving numerical problems.	[SU2] Assessment of ability to analyse information [SU3] Assessment of ability to use knowledge gained from the subject
[K6_W01] Knows and understands, to an advanced extent, mathematics necessary to formulate and solve simple issues related to the field of study	Student understands the problems associated with the implementation of numerical methods algorithms. Student selects the appropriate numerical methods for the given problems.	[SW1] Assessment of factual knowledge

<table>
<tr><td>Subject contents</td><td>1. Numbers representation, errors, numerical stability.
2. Solution of linear algebraic equations: Gauss elimination.
3. LU factorization, Cholesky factorization, the matrix inverse, vector and matrix norms, matrix condition number.
4. Solution of linear algebraic equations using iterative methods: Gauss-Seidel method.
5. Solution of nonlinear equations: iterative method, bisection method, linear interpolation method.
6. Solution of systems of nonlinear equations: Newton-Raphson method, secant method.
7. Optimization. Finding optima using golden-section search and parabolic interpolation. LQR optimal control.
8. Approximation. Linear and nonlinear regression. Least squares method.
9. Interpolation. Newton and Lagrange polynomials. Splines and piecewise interpolation.
10. Numerical integration. Newton-Cotes method. Trapezoidal rule. Simpson's rules.
11. Numerical integration of functions. Romberg method. Gauss quadrature. Numerical differentiation, ordinary and partial derivatives.
12. Solution of ordinary differential equations: Euler’s method, Heun's method, midpoint method.
13. Solution of systems of ordinary differential equations: Runge-Kutta method. Lorenz oscillator as an example of a chaotic system.
14. Solution of systems of ordinary differential equations: adaptive methods. Stiff systems.
15. Equations and systems of differential equations: boundary-value problems. Finite-difference method.</td></tr>
<tr><td>Prerequisites and co-requisites</td><td></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>Exam</td><td>50.0%</td><td>100.0%</td></tr>
</table></td></tr>
<tr><td>Recommended reading</td><td><table>
<tr><td>Basic literature</td><td>• Anthony Ralston, A First Course in Numerical Analysis, 2nd edition, Dover Publications, 2001.
• Numerical Recipes in C, Second Edition (1992), http://http://www.nrbook.com/a/bookcpdf.php.
• Steven C. Chapra, Applied Numerical Methods with MATLAB for Engineers and Scientists, 2nd edition, McGraw-Hill, 2006.</td></tr>
<tr><td>Supplementary literature</td><td></td></tr>
<tr><td>eResources addresses</td><td>Adresy na platformie eNauczanie:
Metody numeryczne w AiR - Moodle ID: 34088
https://enauczanie.pg.edu.pl/moodle/course/view.php?id=34088</td></tr>
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<tr><td>Example issues/ example questions/ tasks being completed</td><td>Determine the upper triangular matrix in the given system of linear equations.

Give the result after 2 iterations of the Euler method for a given ordinary differential equation.</td></tr>
<tr><td>Work placement</td><td>Not applicable</td></tr>
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