GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Engineering mathematical modelling, PG_00067466		
Field of study	Automatic Control, Cybernetics and Robotics		
Date of commencement of studies	October 2025	Academic year of realisation of subject	2026/2027
Education level	first-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	2	Language of instruction	Polish
Semester of study	4	ECTS credits	1.0
Learning profile	general academic profile	Assessment form	assessment
Conducting unit	Department of Decision Systems and Robotics -> Faculty of Electronics Telecommunications and Informatics -> Wydziały Politechniki Gdańskiej		
Name and surname of lecturer (lecturers)	Subject supervisor	dr inż. Mariusz Domżalski	
	Teachers	dr inż. Mariusz Domżalski	

Lesson types and methods of instruction

Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
Number of study hours	0.0	0.0	0.0	15.0	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	1.0	9.0	25

Subject objectives

The objective of the course is to acquire practical skills in transforming engineering problems into mathematical models, followed by their implementation and simulation in a computer environment. Students will learn how to describe dynamic phenomena using differential equations and how to apply numerical methods to analyze the behavior of the modeled systems. The course serves as a bridge between theoretical mathematical knowledge and its practical application in automatics and robotics.

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 design software for the analysis and simulation of real world systems and control systems.	[SU1] Assessment of task fulfilment [SU4] Assessment of ability to use methods and tools [SU5] Assessment of ability to present the results of task
[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 and synthesize mathematical models used to describe real world systems.	[SU2] Assessment of ability to analyse information [SU3] Assessment of ability to use knowledge gained from the subject

<table>
<tr><td>Subject contents</td><td>1. Introduction and topic selection.

2. From problem to model: Analysis of a selected phenomenon or physical system. Identification of key variables and parameters. Formulation of a mathematical model as a system of ordinary differential equations.

3. From model to algorithm: Selection of a suitable numerical method to solve the system of equations (e.g., Euler's method, Runge-Kutta methods). Discretization of the continuous-time model.

4. Implementation and simulation: Creating a computer program (e.g., in Python with libraries like NumPy) that implements the selected numerical algorithm and allows for the simulation of the model's behavior.

5. Analysis and visualization of results: Running simulations for various parameters and initial conditions. Graphical presentation of the results (plots). Interpretation and verification of the obtained resultsdoes the simulation reflect the expected behavior of the system?

6. Documentation and final presentation: Preparing documentation and delivering a short presentation that summarizes the completed project: from the problem description, through the mathematical model, to the analysis of the simulation results.</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>Project completion and presentation</td><td>50.0%</td><td>100.0%</td></tr>
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<tr><td>Recommended reading</td><td><table>
<tr><td>Basic literature</td><td>E.A. Bender, An Introduction to Mathematical Modeling, Dover Publications, 2000.

M. Tenenbaum, H. Pollard, Ordinary Differential Equations, Dover Publications, 1985.

Technical documentation of programming environments.</td></tr>
<tr><td>Supplementary literature</td><td>Research papers from IEEE Xplore and ScienceDirect databases on system modeling in automatics and robotics.</td></tr>
<tr><td>eResources addresses</td><td></td></tr>
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<tr><td>Example issues/ example questions/ tasks being completed</td><td>1. Dynamic model of a mathematical or physical pendulum.

2. Simulation of a vehicle suspension system (mass-spring-damper model).

3. Dynamic model of a DC (Direct Current) motor.

4. Predator-prey model (Lotka-Volterra equations).

5. Simulation of a simple RLC circuit.

6. Ballistic model of projectile motion with air resistance.

7. Heat flow model in a one-dimensional rod.</td></tr>
<tr><td>Work placement</td><td>Not applicable</td></tr>
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