



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 2026	Academic year of realisation of subject			2027/2028		
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 -> Faculties of Gdańsk University of Technology						
Name and surname of lecturer (lecturers)	Subject supervisor		dr inż. Mariusz Domżałski				
	Teachers		dr inż. Mariusz Domżałski				
Lesson types	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_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.		[SU3] Assessment of ability to use knowledge gained from the subject [SU2] Assessment of ability to analyse information		
	[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.		[SU5] Assessment of ability to present the results of task [SU4] Assessment of ability to use methods and tools [SU1] Assessment of task fulfilment		

Subject contents	<p>Course content – project</p> <ol style="list-style-type: none"> <li>1. Introduction and topic selection.</li> <li>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.</li> <li>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.</li> <li>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.</li> <li>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 results does the simulation reflect the expected behavior of the system?</li> <li>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.</li> </ol>								
Prerequisites and co-requisites									
Assessment methods and criteria	<table border="1"> <thead> <tr> <th data-bbox="456 629 794 658">Subject passing criteria</th> <th data-bbox="799 629 1137 658">Passing threshold</th> <th data-bbox="1142 629 1469 658">Percentage of the final grade</th> </tr> </thead> <tbody> <tr> <td data-bbox="456 665 794 714">Project completion and presentation</td> <td data-bbox="799 665 1137 714">50.0%</td> <td data-bbox="1142 665 1469 714">100.0%</td> </tr> </tbody> </table>			Subject passing criteria	Passing threshold	Percentage of the final grade	Project completion and presentation	50.0%	100.0%
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Recommended reading	Basic literature	<p>E.A. Bender, An Introduction to Mathematical Modeling, Dover Publications, 2000.</p> <p>M. Tenenbaum, H. Pollard, Ordinary Differential Equations, Dover Publications, 1985.</p> <p>Technical documentation of programming environments.</p>							
	Supplementary literature	<p>Research papers from IEEE Xplore and ScienceDirect databases on system modeling in automatics and robotics.</p>							
	eResources addresses								
Example issues/ example questions/ tasks being completed	<ol style="list-style-type: none"> <li>1. Dynamic model of a mathematical or physical pendulum.</li> <li>2. Simulation of a vehicle suspension system (mass-spring-damper model).</li> <li>3. Dynamic model of a DC (Direct Current) motor.</li> <li>4. Predator-prey model (Lotka-Volterra equations).</li> <li>5. Simulation of a simple RLC circuit.</li> <li>6. Ballistic model of projectile motion with air resistance.</li> <li>7. Heat flow model in a one-dimensional rod.</li> </ol>								
Practical activities within the subject	Not applicable								

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