GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	, PG_00056110		
Field of study	Mechatronics		
Date of commencement of studies	October 2024	Academic year of realisation of subject	2026/2027
Education level	first-cycle studies	Subject group	
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	assessment
Conducting unit	Institute of Mechanics and Machine Design -> Faculty of Mechanical Engineering and Ship Technology -> Faculties of Gdańsk University of Technology		
Name and surname of lecturer (lecturers)	Subject supervisor	dr hab. inż. Rafał Hein	
	Teachers		

Lesson types

Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
Number of study hours	15.0	0.0	15.0	0.0	0.0	30

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	30	0.0	0.0	30

Subject objectives

The aim of the course is to present the methods of modeling and solving differential equations.

Learning outcomes

Course outcome	Subject outcome	Method of verification
[K6_U05] is able to use properly chosen tools to compare design solutions of elements and mechatronics systems according to given application and economic criteria (e.g. power demand, speed, costs)	Is able to use appropriately selected computer tools and numerical methods to modelling, analyze and compare design solutions for mechanical or mechatronic elements and systems according to specified technical and economic criteria.	[SU3] Assessment of ability to use knowledge gained from the subject [SU4] Assessment of ability to use methods and tools
[K6_U02] is able to elaborate on specific mechatronic topics as well as topics from engineering and technology sciences and disciplines such as Mechanical Engineering, Automation, Electronics, Electrical Engineering and Space Technologies	Is able to independently formulate and solve detailed engineering problems in the field of mechanics and mechatronics using computer methods, including numerical analysis, modeling, and simulation of physical phenomena in mechanical and mechatronic systems.	[SU1] Assessment of task fulfilment [SU4] Assessment of ability to use methods and tools

Subject contents

Course content – lecture

Introduction to modeling of dynamical systems. Basic notion and terms - physical model, mathematical model, numerical model. Ordinary differential equations in modeling and analysis of dynamic systems. Analytical and numerical methods of solving ordinary differential equations on computational examples. Partial differential equations in modeling and analysis of physical systems. Application of distributed transfer function method in analysis of mechatronic systems. Computational examples of applications analytical and numerical methods to solving partial differential equations. Finite difference method. Finite volume method. Finite element method.

Course content – laboratory

Introduction to engineering software applied in the modeling and analysis of mechanical and mechatronic systems, including MATLAB, Simulink, and ANSYS.
Development of physical and mathematical models of lumped-parameter mechatronic systems described by ordinary differential equations.
Development of physical and mathematical models of distributed-parameter mechatronic systems described by partial differential equations.
Formulation of hybrid modal models of systems combining lumped and distributed parameters.
Implementation of finite difference, central difference, and finite volume methods in the MATLAB environment for selected examples.
Application of the finite element method (FEM) to the modeling of mechanical systems.
Final project modeling and analysis of a selected mechatronic system: method selection, model development, numerical computation, and computer simulation.

<table>
<tr><td>Prerequisites and co-requisites</td><td colspan="2">Mathematics including linear algebra, matrix algebra, differential and integral calculus, linear ordinary and partial differential equations. Strength of materials including the theory of elasticity.</td></tr>
<tr><td>Assessment methods and criteria</td><td colspan="2"><table>
<tr><th>Subject passing criteria</th><th>Passing threshold</th><th>Percentage of the final grade</th></tr>
<tr><td>Lecture</td><td>56.0%</td><td>50.0%</td></tr>
<tr><td>Laboratory</td><td>56.0%</td><td>50.0%</td></tr>
</table></td></tr>
<tr><td rowspan="3">Recommended reading</td><td>Basic literature</td><td>1. Rao S.S.: The finite element method in engineering, Elsevier 2005.

2. Rakowski G., Kacprzyk Z.: Metoda elementów skończonych w mechanice konstrukcji, Oficyna Wydawnicza Politechniki Warszawskiej, Warszawa 2005.

3. Gołębiowski L., Kulig T.S.: Metody numeryczne w technice, Oficyna Wydawnicza Politechniki Rzeszowskiej, Rzeszów 2012.

4. Pietrzak J., Rakowski G., Wrześniowski K.: Macierzowa analiza konstrukcji, PWN 1989.

5. Gawroński W. i inni: Metoda elementów skończonych w dynamice konstrukcji, Arkady, Warszawa 1984.

6. Kruszewski J., Sawaik S., Wittbrodt E.: Metoda sztywnych elementów skończonych w dynamice konstrukcji,WNT 1999.</td></tr>
<tr><td>Supplementary literature</td><td>Zienkiewicz O.C, Taylor R.L., Zhu J.Z.:The Finite Element Method: Its Basis and Fundamentals, Elsevier 2013.</td></tr>
<tr><td>eResources addresses</td><td></td></tr>
<tr><td>Example issues/ example questions/ tasks being completed</td><td colspan="2">1. Model a given mechanical system using the central difference method.

2. Using the finite element method, develop a mathematical model of the selected mechanical system.

3. Using hybrid modal modeling methods, model a given mechatronic system.</td></tr>
<tr><td>Practical activites within the subject</td><td colspan="2">Not applicable</td></tr>
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