GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Mathematical and numerical modelling, PG_00059366		
Field of study	Mechanical Engineering		
Date of commencement of studies	February 2024	Academic year of realisation of subject	2023/2024
Education level	second-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	Part-time studies	Mode of delivery	at the university
Year of study	1	Language of instruction	Polish
Semester of study	1	ECTS credits	4.0
Learning profile	general academic profile	Assessment form	assessment
Conducting unit	Division of Thermal Power Systems -> Institute of Energy -> Faculty of Mechanical Engineering and Ship Technology		
Name and surname of lecturer (lecturers)	Subject supervisor	dr hab. inż. Jacek Barański	
	Teachers	dr inż. Michał Pysz dr hab. inż. Jacek Barański dr hab. inż. Jerzy Głuch	

Lesson types and methods of instruction	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	18.0	0.0	0.0	9.0	0.0	27
	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	27	9.0	64.0	100

Subject objectives	The main aim of the lectures is to teach the students the problems and solutions connected with the mathematical modeling and numerics.

Learning outcomes	Course outcome	Subject outcome	Method of verification
	[K7_W01] possesses a profound mathematical knowledge useful in the analysis and description of the operation of complex mechanical systems, technological processes and operating properties of machines and devices; is familiar with the main development trends	The student solves the Fourier equation for a simple multi-layer wall and the Peclet equation for diaphragm heat exchangers. The student is able to find and apply thermodynamic properties of fluids used for calculations. Student presents and solves basic problems of 2- and 3-dimensional finite element methods. The student is able to solve problems related to fluid mechanics and heat transfer in various fields of technology.	[SW3] Assessment of knowledge contained in written work and projects [SW2] Assessment of knowledge contained in presentation [SW1] Assessment of factual knowledge
	[K7_U08] is able to design a procedural equipment or device compliant with the specifications using a design aid system in the form of a design documentation, selecting the appropriate model, performing critical analysis with the proper selection of tools and technologies	The student has the ability to analyze basic issues related to research, design and operation of thermal-flow devices, in terms of theory and solving simple tasks and practical problems. The student is able to work in a group observing all the rules that determine professionalism. The student has the ability to solve basic problems related to the research, design and operation of thermal-flow devices, in the assessment of functionality, efficiency, temperature, pressure and velocity fields, including the performance of simple engineering tasks. The student is able to analyze the basic issues related to the research, design and operation of complex thermal-flow systems, in terms of theory and solving practical problems, including the selection of methods and tools. The student understands the impact of the mesh density on the results of numerical analyzes and is able to conduct a study of its impact. The student is able to critically analyze the obtained results and verify them using available methods.	[SU5] Assessment of ability to present the results of task [SU4] Assessment of ability to use methods and tools [SU3] Assessment of ability to use knowledge gained from the subject [SU2] Assessment of ability to analyse information [SU1] Assessment of task fulfilment
	[K7_W02] possesses a wide and profound knowledge on continuum mechanics and materials strength within the range of modelling and simulating multi-function mechanical systems	The student recognizes phenomena related to fluid flow in pipelines, heat exchangers and other mechanical systems. The student assesses the influence of individual properties and thermal-flow parameters on the mechanical system. The student is able to assess what affects the results of numerical simulations and verify the correctness of the calculations. The student has the ability to analyze basic issues related to fluid mechanics and heat transfer, in terms of theory and solving simple tasks and practical problems.	[SW3] Assessment of knowledge contained in written work and projects [SW2] Assessment of knowledge contained in presentation [SW1] Assessment of factual knowledge

Subject contents	As part of the course, the following elements of knowledge will be presented: 1. Thematic scope. Basic concepts. Problems of fluid mechanics and heat transfer 2. Influence of the mesh density on the results of numerical simulations 3. Validation of numerical simulation results 4. Turbulence models in computational fluid dynamics 5. Modeling of fluid-solid systems 6. Finite element method - spatial issues 7. Parameterization of the considered model 8. Selected numerical methods 9. Special issues 10. Applications
Prerequisites and co-requisites	The student should have basic knowledge of physics and applied mathematics, mathematical analysis, numerical methods, fluid mechanics, heat transfer, technical drawing and basic programming. Ability to solve ordinary and partial differential equations. Knowledge of Mathematics: linear algebra, analytic geometry, trigonometry, differential and integral calculus. Fluid mechanics knowledge. Knowledge of the subject Heat exchange.

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
lecture assessment	60.0%	60.0%
project tasks	60.0%	40.0%

Recommended reading

Basic literature	Basic literature: 1. Thompson J. F., Soni B. K., Weatherill N. P.: Handbook of Grid Generation. CRC Press 1999. 2. Tu J., Yeoh G. H., Liu C.: Computational Fluid Dynamics A Practical Approach. Elsevier 2013. 3. Fortuna Z., Macukow B., Wąsowski J.: Metody numeryczne. Wydawnictwa Naukowo-Techniczne 2001.
Supplementary literature	Supplementary literature: 1. Tesch K.: Numeryczna Mechanika Płynów. Wydawnictwo politechniki Gdańskiej 2021. 2. Madejski J.: Teoria Wymiany Ciepła. Państwowe Wydawnictwo Naukowe 1963.
eResources addresses	Adresy na platformie eNauczanie: Modelowanie matematyczne i numeryczne, W/P, MiBM, sem.1, letni 23/24 - Moodle ID: 37436 https://enauczanie.pg.edu.pl/moodle/course/view.php?id=37436

Example issues/ example questions/ tasks being completed	1. Modeling of thermal-flow systems 2. Validation methods of numerical simulation results 3. Influence of the mesh density on the results of numerical simulations 4. Pre-processor, Processor, Post-processor 5. Examples of numerical and mathematical modeling applications 6. Selected numerical methods 7. Selected issues of modeling heat exchangers
Work placement	Not applicable

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