GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Mathematical modelling of energy plants, PG_00065886		
Field of study	Nuclear Engineering		
Date of commencement of studies	February 2026	Academic year of realisation of subject	2025/2026
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	Full-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 -> Wydziały Politechniki Gdańskiej		
Name and surname of lecturer (lecturers)	Subject supervisor	dr inż. Paweł Ziółkowski	
	Teachers		

Lesson types and methods of instruction	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	30.0	0.0	0.0	15.0	0.0	45
	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	45	10.0	45.0	100

Subject objectives	The purpose of the course is to learn the basics and methods of mathematical modeling of the processes and technical devices that make up power plants, including VHTR-type nuclear cycles.

Learning outcomes	see table below

Course outcome	Subject outcome	Method of verification
[K7_U02] formulates and tests hypotheses concerning problems related to processes occurring in Nuclear Power Technologies, their efficiency, rationality, operation, safety and impact on the environment, as well as simple research problems	The student formulates and tests hypotheses related to problems concerning the processes occurring in Nuclear Power Engineering, in particular their efficiency and environmental impact. The student analyzes simple research problems in terms of the use of VHTR in energy systems.	[SU2] Assessment of ability to analyse information [SU3] Assessment of ability to use knowledge gained from the subject [SU4] Assessment of ability to use methods and tools [SU5] Assessment of ability to present the results of task
[K7_W02] demonstrates structured and theory supported knowledge encompassing key issues in the field of Nuclear Power Technologies enabling modeling and analysis of processes, systems, machines and devices of a nuclear power plant	The student demonstrates a structured knowledge of the mathematical modeling of power plant equipment with a theoretical foundation of the physical phenomena occurring in them. The modeling knowledge is related to specific examples and covers key issues in Nuclear Power Engineering allowing modeling and analysis of nuclear power plant processes, systems, machinery and equipment including VHTR cycles.	[SW1] Assessment of factual knowledge [SW3] Assessment of knowledge contained in written work and projects
[K7_U01] utilizes acquired analytical, simulation, and experimental methods, as well as mathematical models to analyse and evaluate processes occurring in nuclear power sector and related industries	The student uses mathematical models to simulate and evaluate processes occurring in Nuclear Power and related industries including mass, momentum and energy balances. Uses analytical models to compare numerical results.	[SU1] Assessment of task fulfilment [SU3] Assessment of ability to use knowledge gained from the subject [SU4] Assessment of ability to use methods and tools
[K7_W04] recognizes and interprets selected issues in the field of advanced detailed knowledge, particularly in the scope of methods, techniques, tools, algorithms and standards specific to Nuclear Power Technologies taking into account the principles of safety and radiological protection	mathematically describes an engineering task, identifies the type of mathematical model suitable for describing an engineering task, applies simulation methods suitable for an engineering task including in the context of VHTR cycles	[SW1] Assessment of factual knowledge [SW2] Assessment of knowledge contained in presentation

Subject contents	1. introduction to the issues related to the subject2. thermodynamic properties of agents and equations necessary to describe thermodynamic processes3. balance of mass, momentum and energy4. mathematical modeling software for power equipment for three-dimensional analysis of CFD, CSD and FSI types5. determination of efficiency and performance factors of power plants6. mathematical models of key thermodynamic processes7. software for mathematical modeling of power plants at the design level8. introduction to process control in power plants9. basic control methods and systems and stability of the control process10. mathematical modeling of control with feedback for heat exchangers11. control system of gas-fired power plants and combined heat and power plants12. mathematical modeling of regulation and control systems of steam power plants - classical, vs. nuclearProject: familiarization with computational tools and mathematical models in commercial computational codes. Modeling of selected equipment and the entire nuclear VHTR system based on computational tools (e.g. Ebsilon, EcoPG, Aspen).
Prerequisites and co-requisites	
Assessment methods and criteria	see table below

Subject passing criteria	Passing threshold	Percentage of the final grade
Performing calculation tasks during the project	56.0%	40.0%
Written credit for the lecture	56.0%	60.0%

Recommended reading	Basic literature	1: Stephen Turns: Thermal-Fluid Sciences an integrated approach. Cambrige University Press, New York 2006.2: Wolfgang Altmann: Practical process control for engineers and technicians. Newnes, Oxford 2005.3: Rolf Kehlhofer: Combined-cycle gas & steam turbine power plant. The Fairmont Press, Lilburn, 1991.4: Janusz Badur (2005): Pięć wykładów ze współczesnej termomechaniki płynów. 2005 www.imp.gda.pl/fileadmin/doc/o2/z3/.../2005_piecwykladow.pdf, Gdańsk.5: INTERNATIONAL ATOMIC ENERGY AGENCY High Temperature Gas Cooled Reactor Fuels and Materials. VIENNA, 2010 https://www-pub.iaea.org/mtcd/publications/pdf/te_1645_cd/pdf/tecdoc_1645.pdf6: Olgierd C. Zienkiewicz (1972): Metoda elementów skończonych. Arkady, Warszawa.
	Supplementary literature	J. Głuch et al: Thermodynamic Efficiency of an Advanced 4th Generation VHTR Propulsion Engine for Large Container Ships. Polish Maritime Research Tom 31 (2024): Zeszyt 4 (Grudzień 2024). str 76 - 88 DOI: https://doi.org/10.2478/pomr-2024-0052
	eResources addresses	
Example issues/ example questions/ tasks being completed	Mass, momentum and energy balances in 0D and 3D terms, the role of mathematical modeling, modeling principles, mathematical model identification and verification.	
Work placement	Not applicable	

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