



## Subject card

Subject name and code	Modeling of two-phase flows, PG_00057267						
Field of study	Power Engineering, Power Engineering, Power Engineering						
Date of commencement of studies	February 2022	Academic year of realisation of subject			2022/2023		
Education level	second-cycle studies	Subject group			Optional subject group 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	2	ECTS credits			3.0		
Learning profile	general academic profile	Assessment form			assessment		
Conducting unit	Department of Energy and Industrial Apparatus -> Faculty of Mechanical Engineering and Ship Technology						
Name and surname of lecturer (lecturers)	Subject supervisor		dr hab. inż. Rafał Andrzejczyk				
	Teachers		dr hab. inż. Rafał Andrzejczyk				
Lesson types and methods of instruction	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	15.0	15.0	0.0	0.0	0.0	30
	E-learning hours included: 0.0						
	Modelowanie przepływów dwufazowych,W,Energetyka,sem. 02,zimowy 22/23 - Moodle ID: 25588 <a href="https://enauczanie.pg.edu.pl/moodle/course/view.php?id=25588">https://enauczanie.pg.edu.pl/moodle/course/view.php?id=25588</a> Modelowanie przepływów dwufazowych,C,Energetyka,sem. 02,zimowy 22/23 - Moodle ID: 25592 <a href="https://enauczanie.pg.edu.pl/moodle/course/view.php?id=25592">https://enauczanie.pg.edu.pl/moodle/course/view.php?id=25592</a>						
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		8.0		37.0	75
Subject objectives	Presentation of basic information regarding two-phase flows in energy installations						

Learning outcomes	Course outcome	Subject outcome	Method of verification
	[K7_W04] has advanced, ordered and theoretically grounded knowledge in the field of operation and selection of electrical machines, power transmission systems and power electronic devices, classical and forward-looking power technologies and their receivers, knows the principles of selection of power equipment and installations and their receivers and their operation	The student has knowledge of the impact of heat flux density on the operation of both individual elements and the entire power system. He can analyze and select the necessary methods of thermal stabilization of elements of machines and energy devices as well as transmission networks. The student is able to assess the influence of external conditions, operating parameters and time on the operation of the power installation.	[SW1] Assessment of factual knowledge [SW3] Assessment of knowledge contained in written work and projects
	[K7_W05] knows basic methods, techniques and tools used in solving complex engineering tasks in the field of modeling of thermal-energy systems	The student has knowledge of two-phase flow modeling at the level of a single section and the entire structure of the heat exchanger. He can also carry out calculations in the field of two-phase pressure drop. The student freely use basic tools to facilitate modeling of heat and energy systems, including in particular thermodynamic graphs for basic energy fluids, steam tables, databases of energy fluids properties available in open access applications.	[SW1] Assessment of factual knowledge [SW3] Assessment of knowledge contained in written work and projects
	[K7_U02] is able to use known mathematical and numerical methods to analyze and design elements, systems and power transmission networks and internal installations	The student is able to carry out calculations for simple energy systems in which energy conversion takes place with the use of analytical and numerical models.	[SU1] Assessment of task fulfilment [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_W01] has extended and deepened knowledge of mathematics indispensable for describing phenomena related to processes of energy conversion and transfer; uses advanced information technologies	The student is able to perform calculations for simple physical module of heat exchangers working of two-phase flow conditions. He can also analyze energy systems that use two-phase flow for mass and energy transfer. The student is able to use simple computer software and create his own calculations based on the use of available databases of the properties of working fluids used in energy installations.	[SW1] Assessment of factual knowledge [SW3] Assessment of knowledge contained in written work and projects
Subject contents	Lecture 1. Introduction, basic definitions, flow structures, flow boiling maps (2) 2. Pressure drop in two-phase flows - methods of modelling and calculation (6) 3. Void fraction in two-phase flows (4) 4. Mathematical modelling of two-phase flows - homogeneous model, separated model, two fluid model (6h) 5. Flow boiling in channels and small diameter channels (2) 6. Flow condensation (4) 7. Designing of heat exchangers with change of phase (6). 8. The influence of heat flux density on the efficiency of energy systems. 9. Modeling of two-phase flows in energetic systems.		
Prerequisites and co-requisites	mathematics I, II, heat transfer, thermodynamics, fluid mechanics		
Assessment methods and criteria	Subject passing criteria	Passing threshold	Percentage of the final grade
	successful pass on tutorial part	56.0%	50.0%
	successful pass on lecture part	56.0%	50.0%

Recommended reading	Basic literature	<p>1. D. Mikielwicz, Wrzenie i kondensacja w przepływie w kanałach i mikrokanalach, Wydawnictwo PG, Gdańsk 2009.</p> <p>2. Carey V. P., Liquid vapor phase change phenomena, Taylor and Francis, 2008.</p> <p>3. Naterer G., Heat Transfer in Single and Multiphase Systems, CRC Press, 2003.</p> <p>4. Kandlikar S.G., Heat transfer and fluid flow in minichannels and microchannels, Elsevier, 2004. 5. S. M. Ghiaasiaan, Two-Phase Flow, Boiling and Condensation, Cambridge University Press, 2008.</p>
	Supplementary literature	No requirements
	eResources addresses	
Example issues/ example questions/ tasks being completed	<p>Determination of flow resistance in two phase flows in channels</p> <p>Determination of heat transfer coefficient in flow boiling and flow condensation in channels</p>	
Work placement	Not applicable	