GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Heat pumps and reversible cooling systems, PG_00064755						
Field of study	Power Engineering						
Date of commencement of studies	February 2026		Academic year of realisation of subject	2026/2027			
Education level	second-cycle studies		Subject group	Specialty 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 Sanitary Engineering -> Faculty of Civil and Environmental Engineering -> Wydziały Politechniki Gdańskiej						
Name and surname of lecturer (lecturers)	Subject supervisor		dr hab. inż. Sylwia Fudala-Książek				
	Teachers						
Lesson types and methods of instruction	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	15.0	0.0	0.0	15.0	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		8.0	37.0		75
Subject objectives	Familiarizing students with the technology of harnessing renewable energy using heat pumps. Presentation of the theoretical basis for the operation of heat pumps. Discussion of the types and method of obtaining thermal energy from the so-called renewable heat sources, both natural and waste. Discussion of heating and cooling (air conditioning) systems in the form of reversible circuits of heat pumps. Discussion of the basics of designing the lower heat sources for heat pumps. Presentation of the methodology of thermal-flow and hydraulic calculations for installations of the lower heat sources						

Learning outcomes

Course outcome	Subject outcome	Method of verification
[K7_U04] creatively designs or modifies, either entirely or at least in part, energy systems, machines and devices, transmission grids and internal installations, considering both technical and non-technical aspects, estimating costs and utilizing design techniques appropriate for tasks within the scope of Power Engineering	The student is able to design or modify, in whole or at least in part, energy systems, machines and equipment, transmission networks or internal installations according to a given specification, taking into account technical and non-technical aspects. The student has the knowledge and skills to estimate costs using design techniques appropriate to the tasks in Power Engineering.	[SU5] Assessment of ability to present the results of task [SU1] Assessment of task fulfilment
[K7_U13] evaluates the feasibility and potential for utilizing new technical and technological achievements in accomplishing tasks characteristic for the field of study	The student is able to assess the usefulness and possibility of using new developments (techniques and technologies) in the implementation of tasks in the field of broadly understood Power Engineering.	[SU5] Assessment of ability to present the results of task [SU2] Assessment of ability to analyse information
[K7_K11] is aware of importance of professional acting, the need for critical verification of acquired knowledge and consulting experts opinion in case of facing difficulties with individual problem solving	The student is able to act professionally, to critically approach the possessed knowledge and its verification. When there is a need (difficulty in solving a problem independently), they are able to seek opinions of experts on a given topic.	[SK5] Assessment of ability to solve problems that arise in practice
[K7_W03] demonstrates structured and theory supported knowledge encompassing key issues in the field of Power Engineering, enabling design of energy systems, machines and devices, transmission grids and internal installations	The student is able to design energy systems, machinery and equipment, transmission networks and internal installations in the field of Power Engineering.	[SW3] Assessment of knowledge contained in written work and projects [SW1] Assessment of factual knowledge

Subject contents

Lecture: 1. Theoretical basis for the use of heat pumps: among others: the idea of heat pump operation, the purpose of application, renewable/waste energy resources, the basis of left-hand circuits, the principle of heat pump operation, heat pumps classification in terms of construction and application. 2. Design and principle of operation: among others: elements of the refrigeration system), thermodynamic processes occurring in the heat pump circuit, fluids used in heat pump circuits and their thermal properties. 3. Lower heat sources: among others: quantitative and qualitative features of the lower heat sources, characteristics of available natural and waste heat sources, the following will be described: availability, temperature, heat capacity, method of obtaining, availability, pollution. Calculation of the size of the lower heat sources. 4. Heating installations of buildings cooperating with heat pumps: among others: low-temperature heating installations dedicated to cooperation with heat pumps will be discussed, 5. Preparation (heating) of domestic hot water using heat pumps: among others: the method of selecting DHW heaters for heat pumps will be discussed. The design of air heat pumps for heating DHW will be discussed. The cooperation of heat pumps with solar installations will be discussed. 6. Photovoltaic installations cooperation with heat pumps: among others: the method of selecting the size of a photovoltaic installation cooperating with a building equipped with a heat pump will be discussed, 7. Air conditioning systems refrigeration systems using reversible heat pumps as a source of heat and cold for residential buildings. 8. Natural cooling using lower heat source installations to obtain "natural cooling" for building air conditioning systems.

Project: 1. Introduction to the design of heating installations cooperating with heat pumps: among others: the types, design, operating parameters of heating installations cooperating with heat pumps, guidelines for selecting the size of a heat pump for a given building, the use of installation separation buffer will be discussed. The influence of characteristic operating parameters of heat pumps on the efficiency of operation: required operating temperatures of the heating system, heat carrier flow through the condenser and evaporator of heat pump. Adaptation of the optimal temperature and flow parameters of the heat pump to the thermal capabilities of various heating systems. 2. Design of heating systems with heat pumps: among others: creating and drawing technological diagrams of heat distribution nodes with heat pumps in various configurations for different applications. 3. Heating installation for the building, in which the source of heat will be a heat pump designed by students. 4. Practical use of computer software supporting the selection and design of installations with heat pumps

Prerequisites and co-requisites

The student should have knowledge and skills in the areas of: technical thermodynamics, in particular in the field of left-hand refrigeration circuits, heat transfer, in particular in the field of heat transfer mechanisms in heating installations.

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
project	60.0%	50.0%
written assessment of the lecture	60.0%	50.0%

Recommended reading	Basic literature	Rubik M.: Technologie Energii Odnawialnej Pompy Ciepła. Wyd. MULTICO, Data wydania: 2011 Rubik M.: Pompy ciepła. Poradnik. Wyd. Instal, Data wydania: 2006 Oszczak W.: Ogrzewanie domów z zastosowaniem pomp ciepła. Wyd. Wydawnictwa Komunikacji i Łączności WKŁ, Data wydania: 2021 Strzyżewski J.: Pompy ciepła. Wyd. Wiedza i Praktyka, Data wydania: 2017 Rubik M.: Pompy ciepła w systemach geotermii niskotemperaturowej. Wyd. MULTICO, Data wydania 2011
	Supplementary literature	Zawadzki M.: Kolektory słoneczne i pompy ciepła na tak, Oficyna wydawnicza firmy Polska Ekologia, Warszawa, 2003.
	eResources addresses	
Example issues/ example questions/ tasks being completed	1. Discuss the principle of operation of the compressor heat pump. Present the characteristic processes of the refrigerant on the P-H diagram. 2. Discuss how to obtain thermal energy from the ground through the so-called horizontal ground exchanger. Provide characteristic parameters that affect the size and method of construction. 3. Discuss how to obtain thermal energy from the ground through the so-called vertical ground exchanger. Provide characteristic parameters that affect the size and method of construction. 4. Properties of the outside air as a heat carrier for an air source heat pump. 5. Present the parameters characterizing, in terms of suitability for the heat pump, the lower heat source. Compare the lower heat source, which is the ground, and the outside air.	
Work placement	Not applicable	

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