GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Heat pumps and reversible cooling systems, PG_00057353		
Field of study	Power Engineering		
Date of commencement of studies	February 2024	Academic year of realisation of subject	2024/2025
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	Zakład Ogrzewnictwa, Wentylacji, Klimatyzacji i Chłodnictwa -> Institute of Energy -> Faculty of Mechanical Engineering and Ship Technology		
Name and surname of lecturer (lecturers)	Subject supervisor	mgr inż. Piotr Jasiukiewicz	
	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_U05] is able to integrate technical and economic analysis of the use of various energy technologies, including technologies using renewable energy sources and conventional and nuclear energy	The student has knowledge of heating installations in which the heat source is a heat pump. He can identify different sources of renewable energy. He can assess the practical possibilities of using a given heat source for a heat pump. The student is able to perform a heat balance for residential/public facilities, selecting in technical and economic terms the size of the lower heat source and the heat pump.	[SU1] Assessment of task fulfilment
[K7_W07] knows the environmental effects of energy technologies used; is familiar with the issues of effective energy management and use of renewable energy sources, has a broad and well-established knowledge of the processes of energy production and use	The student knows the environmental effects that can be achieved by using renewable heat sources to heat buildings. The student knows ways to effectively manage thermal energy to heat buildings and DHW using renewable heat sources combined with heat pumps. The student has knowledge about founding and use of renewable energy sources.	[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
written assessment of the lecture	56.0%	60.0%
project	56.0%	40.0%

Recommended reading	Basic literature	Grassi W.: Heat pumps. Fundamentals and Applications, Springer International Publishing, 2018, doi:10.1007/978-3-319-62199-9
	Supplementary literature	Nowak T.: Heat pumps. Integrating technologies to decarbonise heating and cooling, European Copper Institute, 2018, https://www.ehpa.org/fileadmin/user_upload/White_Paper_Heat_pumps.pdf
	eResources addresses	Adresy na platformie eNauczanie:
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	