

Heat pumps

Faculty of	Mechanical and Power Engineering
Name in English	Heat pumps
Name in Polish	Pompy ciepła
Main field of study	Power Engineering
Specialization	-
Level of studies	II level
Form of studies	full-time
Kind of subject	optional-specialization
Subject code	W09ENG-SM2358
Group of courses	NO

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	15			15	
Number of hours of total student workload (CNPS)	25			25	
Form of crediting	Crediting with grade			Crediting with grade	
For group of courses mark final course with (X)					
Number of ECTS points	1			1	
including number of ECTS points for practical (P) classes				1	
including number of ECTS points for direct teacher-student contact (BU) classes	0,68			0,76	

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1.	Technical Thermodynamics
2.	Fluid Mechanics.

SUBJECT OBJECTIVES

C1	Teaching of practical knowledge, regarding heat pump technology, their design and application.
C2	Teaching of skills how to design and analyze heat pumps, their behavior and consequences of its cooperation with various heat sources.

SUBJECT LEARNING OUTCOMES

relating to knowledge:	
PEU_W01	Has knowledge of rules and standards for design and operation of heat pumps
PEU_W02	Knows the classification of heat pump system
relating to skills:	
PEU_U01	Can choose the proper cycle for a given heat pump system
PEU_U02	Can calculate the capacity of the heat pump system and can design a heat pump system

PROGRAMME CONTENT

Form of classes - lecture		Number of hours
Lec1	Overview of the lecture. Introduction. Principle of operation of the heat pump. Historical overview. Classification and application.	2
Lec2 – Lec7	Heat pumps thermodynamics basis, reversible Carnot Cycle. Heat pump cycle implementing methods. The ideal, comparative and real cycle. Low temperature heat sources: natural, artificial, waste heat. Guidelines for the design of heat exchanger. Ground, water, solar radiation and air as a low temperature heat source. Horizontal, vertical and spiral heat exchangers. Heat transfer coefficients. Thermal and operational parameters. Waste heat as the low temperature heat source. Usefulness assessment of low-temperature heat sources. Refrigerants and coolants. Special features, properties, classification, application possibilities. Heat pump in the heating and DHW system. Hydraulic installations and accumulation tanks. Heat pumps development trends. Ways of meeting energy needs with heat pumps in the context of climate change.	12
Lec8	Colloquium	1
Total hours		15

project		Number of hours
Pr1	Overview and introduction to the project. Distribution of the individual data for the project.	2
Pr2	Calculation of the heat pump cycle. Refrigerant selection. logP-h diagram description. Description of the necessary computer software.	2
Pr3 – Pr7	Calculation of the heat exchangers, selection of the compressor, selection of additional components, individual consultations.	10
Pr8	Submission of completed projects.	1
Total hours		15

TEACHING TOOLS USED	
N1	Traditional lecture with presentation of slides
N2	Self-study – reading of supplementary materials
N3	Self-study – working on the individual project
N4	Self-study – study and preparation to the colloquium.
N5	Consultation – improvement of knowledge

EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

Evaluation (F– forming (during semester), C– concluding (at semester end))	Educational effect number	Way of evaluating educational effect achievement
C1	PEU_W01 – PEU_W02	Mark of the colloquium
C2	PEU_U01 – PEU_U02	Mark of submitted project

PRIMARY AND SECONDARY LITERATURE

Primary literature	
1	2017 ASHRAE Handbook - Fundamentals (SI Edition), © 2009 American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.
2	2016 ASHRAE Handbook - Heating, Ventilating, and Air-Conditioning Applications (SI Edition), © 2016 American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.
3	Refrigeration, Air Conditioning and Heat Pumps (5th Edition), BOOK•ByHundy, G. F.; Trott, A. R.; Welch, T. C.(2016)
Secondary literature	
1	McQuay International, Geothermal heat pump – Design Manual
2	RETScreen Int. Training Material, Ground Source Heat Pump Project Analysis – Textbook
3	International Renewable Energy Agency. (2013). Heat Pumps - Technology Brief. International Renewable Energy Agency, IRENA

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

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