Załącznik nr 6 do ZW 121/2020

FACULTY OF MECHANICAL AND POWER ENGINEERING

SUBJECT CARD

Name of subject in Polish:	Pompy ciepła
Name of subject in English:	Heat pumps
Main field of study (if applicable):	Energetyka
Specialization (if applicable):	Renewable Sources of Energy
Profile:	academic
Level and form of studies:	2nd level, full-time
Kind of subject:	optional/specialization
Subject code:	W09ENG-SM0046
Group of courses:	NO

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30			15	
Number of hours of total student workload (CNPS)	60			30	
Form of crediting	Crediting with grade			Crediting with grade	
For group of courses mark (X) final course					
Number of ECTS points	**2**			1	
including number of ECTS points for practical classes (P)				1	
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1			0,75	

* delete as applicable

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Technical Thermodynamics
2. Fluid Mechanics.

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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 EDUCATIONAL EFFECTS

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

PROGRAM CONTENT		
Lectures		**Number of hours**
Lec1	Overview of the lecture. Introduction. Principle of operation of the heat pump. Historical overview.	2
Lec2	Classification and application. Monovalent and bivalent heat pumps. Thermodynamics. Reversible Carnot Cycle for variable temperature sources.	2
Lec3	Heat pump cycle implementing methods. The ideal, comparative and real cycle. Characteristic parameters. Efficiency. Coefficient of performance of a compressor heat pump.	2
Lec4	Primary and secondary heat pumps.	2
Lec5	Low temperature heat sources. Natural, artificial - waste heat. Characteristics, parameters, coherence.	2
Lec6	Possibility of low-temperature heat transporting. The location of the low temperature heat sources. Guidelines for the design of heat exchanger.	2
Lec7	Ground as a low temperature heat source. Horizontal, vertical and spiral heat exchangers. Heat transfer coefficients. Geological conditions. Technical and operational conditions.	2
Lec8	Water – thermal, surface, ground and deep sources as heat sources. Methods of use. Thermal and operational parameters.	2
Lec9	Solar radiation as a low temperature heat source. Characteristic. Solar collectors. Ways of designing the installation of a low temperature heat sources using solar radiation.	2
Lec10	Air as the low temperature heat source. Characteristics and requirements for heat exchangers. Methods of heat exchangers designing.	2
Lec11	Waste heat as the low temperature heat source. Methods and ways to use. Operational and safety conditions.	2
Lec12	Usefulness assessment of low-temperature heat sources. Refrigerants and coolants. Special features, properties, classification, application possibilities.	2
Lec13	Heat pump in the heating and DHW system. Hydraulic installations and accumulation tanks.	2
Lec14	Heat pumps development trends. Ways of meeting energy needs with heat pumps in the context of climate change.	2
Lec15	Colloquium.	2

	Total hours	**30**

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. Selection of the compressor.	2
Pr3	Description of the necessary computer software.	2
Pr4	Calculation of the heat exchangers (air and water).	2
Pr5	Calculation of the heat exchangers (ground).	2
Pr6	Selection of additional components (e.g. throttling valves, heat exchangers etc.)	2
Pr7	Individual consultations.	2
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 e-tests. N4. Self-study – working on the individual project. N5. Self-study – study and preparation to the exam. N6. Consultation – improvement of knowledge

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming (during semester), C – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
P (lecture)	PEU_W01 – PEU_W02	Mark of the colloquium
P (project)	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.

SECONDARY LITERATURE:

[1] McQuay International, Geothermal heat pump - Design Manual
[2] RETScreen Int. Training Material, Ground Source Heat Pump Project Analysis - Textbook

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

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