

FACULTY OF MECHANICAL AND POWER ENGINEERING					
<b>SUBJECT CARD</b>					
<b>Name of subject in Polish:</b>	Czynniki i łańcuch chłodniczy				
<b>Name of subject in English:</b>	Refrigerants, coolants, and cold chain				
<b>Main field of study (if applicable):</b>	POWER ENGINEERING				
<b>Specialization (if applicable):</b>	Refrigeration and Cryogenics				
<b>Profile:</b>	academic				
<b>Level and form of studies:</b>	2nd level, full-time				
<b>Kind of subject:</b>	optional				
<b>Subject code:</b>	W09ENG-SM0073				
<b>Group of courses:</b>	NO				
	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30				
Number of hours of total student workload (CNPS)	60				
Form of crediting	crediting with grade				
For group of courses mark final course with (X)					
Number of ECTS points	2				
including number of ECTS points for practical (P) classes	0				
including number of ECTS points for direct teacher-student contact (BK) classes	1				

**PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES**

1. Fundamental knowledge of thermodynamics and fluid mechanics.

**SUBJECT OBJECTIVES**

C1 – Familiarize students with fundamental knowledge on refrigerants and coolants, including history of their development, classification, physical and chemical properties and application in different types of refrigeration systems.

C2 – Familiarize students with properties, behavior, and application of different types of refrigerants (natural, synthetic and mixtures), as well as with safety requirements (including flammability and toxicity) and also with ecological requirements and expectations related to refrigerants.

C3 – Familiarize students with the basic knowledge about refrigeration technologies used in the cold chain.

C4 – Familiarize students with the mathematical model for cooling and freezing processes.

**SUBJECT EDUCATIONAL EFFECTS**

relating to knowledge:

PEK\_W01 – Student is able to define and classify refrigerants and coolants and characterize their most important physical and chemical properties. Student possess general knowledge of ecological aspects related to refrigerants usage and is aware of the most important international regulations in this area.

PEK\_W02 – Can define synthetic, natural and zeotropic refrigerants, describe their most important properties and understand methodology of their numeration. He/she knows refrigerant safety categories of refrigerant application.

PEK\_W03 – Student is able to choose the right refrigeration technology depending on the individual requirements of the stored goods

PEK\_W04 – Student is able to calculate the needed cooling capacity depending of the individual requirements of the stored goods or processes.

### PROGRAM CONTENT

Lectures		Number of hours
Lec 1	Introduction to the lecture. The scope, rules of crediting and grading, literature. Basic definitions and classifications.	2
Lec 2	Ecological aspects of refrigerant application.	2
Lec 3	Legal aspects of refrigerant application.	2
Lec 4	Synthetic refrigerants. Zeotropic and azeotropic mixtures. R-numbering system.	2
Lec 5	Natural refrigerants.	2
Lec 6	Safety of refrigerant usage. Recovery, recycling, reclaim, disposal.	2
Lec 7	Selection of refrigerants for various applications.	2
Lec 8	Basic thermal processes and their effect on organic materials.	2
Lec 9	Cold chain and legal regulations regarding its continuity.	2
Lec 10	Cooling and storage of products.	2
Lec 11	Preparation of air for the individual needs of cooled goods and the basics of cooling theory. Heat balance of the cooling process.	2
Lec 12	Food freezing - mathematical model.	2
Lec 13	Freezing food by air and fluidization techniques. Heat balance of the freezing process.	2
Lec 14	Contact freezing and cryogenic freezing techniques.	2
Lec 15	Final test.	2
	Total hours	30

### TEACHING TOOLS USED

- N1. Lecture with presentation.  
 N2. Self-study – reading of supplementary materials.  
 N3. Self-study – study and preparation for the final test.  
 N4. Office hours.

### EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming (during semester), P – concluding (at semester end))	Learning outcomes number	Way of evaluating learning outcomes achievement
P	PEK_W01÷PEK_W04	Assessment takes the form of a written test containing questions based on the entire range of the lecture.

## PRIMARY AND SECONDARY LITERATURE

### **PRIMARY LITERATURE:**

- [1] 2017 ASHRAE Handbook - Fundamentals (SI Edition), © 2017 American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.
- [2] 2014 ASHRAE Handbook - Refrigeration (SI Edition), © 2014 American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.
- [3] Regulation (EU) No 517/2014 of the European Parliament and of the Council of 16 April 2014 on fluorinated greenhouse gases and repealing Regulation (EC) No 842/2006 Text with EEA relevance
- [4] Calm J.M., The next generation of refrigerants – Historical review, considerations, and outlook., International Journal of Refrigeration, Volume 31, Issue 7, November 2008, 1123-1133
- [5] Stoecker, W.F. and Jones, J.W. 1982. Refrigeration and Air Conditioning, NY, USA. McGraw Hill.
- [6] Mallett, C.P. 1993. Frozen Food Technology. Chapman and Hall, London, UK

### **SECONDARY LITERATURE:**

- [1] ISO 817:2014 Refrigerants — Designation and safety classification
- [2] EN 378-1: Refrigerating systems and heat pumps - Safety and environmental requirements - Part 1: Basic requirements, definitions, classification and selection criteria

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

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