

FACULTY OF CHEMISTRY					
SUBJECT CARD					
Name of subject in Polish	Procesy Ciepłne				
Name of subject in English	Heat Transfer Processes				
Main field of study (if applicable):	Chemical Engineering and Processing				
Specialization (if applicable):..					
Profile:	academic				
Level and form of studies:	1st level, full-time				
Kind of subject:	obligatory				
Subject code					
Group of courses	NO				
	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30		30	30	
Number of hours of total student workload (CNPS)	90		60	60	
Form of crediting	Examination		crediting with grade	crediting with grade	
For group of courses mark (X) final course					
Number of ECTS points	3		2	2	
including number of ECTS points for practical (P) classes			2	2	
including number of ECTS points for direct teacher-student contact (BU) classes	1,3		1,4	1,5	
PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES					
1. Basic knowledge of mathematics 2. Knowledge of chemistry at the high school level 3. Knowledge of physics at the high school level					
SUBJECT OBJECTIVES					
C1. Acquirement of the basic knowledge about the steady and transient heat transfer by conduction, convection and radiation C2. Acquirement of the basic knowledge about the design and selection of heat exchangers C3. Learning how to perform basic calculations of heat transfer and heat exchangers C4. Obtaining basic skills of measurement of heat transfer					
SUBJECT LEARNING OUTCOMES					
relating to knowledge:					
The person who has passed this subject:					
PEK_W01 - has a basic knowledge of heat transfer by conduction,					
PEK_W02 - has a basic knowledge about heat transfer by convection,					
PEK_W02 - has a basic knowledge about heat transfer by radiation,					
PEK_W04 - has a basic knowledge about heat transfer coefficients,					
PEK_W05 - knows the basics of modeling of unsteady state heat transfer,					
PEK_W06 - has a knowledge of methods of heat exchangers designing.					
relating to skills:					
The person who has passed this subject:					
PEK_U01 - can perform calculations related to heat transfer by conduction, convection and radiation,					
PEK_U02 - can perform calculations related to the heat transfer coefficients,					
PEK_U03 - can design basic types of heat exchangers,					

PEK_U04 - can design and conduct experiments necessary to calculate the heat transfer.		
PROGRAMME CONTENT		
Lectures		Number of hours
Lec 1	Types of heat transfer	2
Lec 2	Heat transfer between two fluids separated by a solid wall	2
Lec 3	Thermal insulation	2
Lec 4	Unsteady state heat conduction	2
Lec 5	Heat transfer by convection - introduction	2
Lec 6	Heat transfer by convection - analysis	2
Lec 7	Analogy between momentum and heat transfer	2
Lec 8	Heat transfer by radiation	2
Lec 9	Heat exchangers - basics	2
Lec 10	Designing of heat exchangers	2
Lec 11	Unsteady heat transfer in liquids	2
Lec 12	Concentration of solutions of non-volatile substances	2
Lec 13	Selection of a heat exchanger	2
Lec 14	Modern thermal devices (solar collectors and heat pumps)	2
Lec 15	Computational Fluid Dynamics in the design process of heat devices	2
	Total hours	30
Laboratory		Number of hours
Lab 1	Introduction	3
Lab 2	Heat transfer in the air cooler	3
Lab 3	Heat transfer in the shell-and-tube heat exchanger	3
Lab 4	Unsteady heat transfer in solid 1	3
Lab 5	Heat transfer in the plate heat exchanger	3
Lab 6	Heating and cooling of liquids in conditions of natural convection	3
Lab 7	Heat transfer in the thin layer heat exchanger	3
Lab 8	Heat transfer in the double-pipe heat exchanger	3
Lab 9	Heat transfer during boiling	3
Lab 10	Unsteady heat transfer in solid 2	3
	Total hours	30
Project		Number of hours
Proj 1	Heat conduction in flat and annular walls	4
Proj 2	Thermal insulation	2
Proj 3	Heat transfer in conditions of natural convection	2
Proj 4	Heat transfer in conditions of forced convection	2
Proj 5	Heat transfer in conditions of boiling and condensation	2
Proj 6	Test	2
Proj 7	Heat transfer between two fluids separated by flat and annular walls	4
Proj 8	Heat transfer by radiation	2

Proj 9	Designing of the thermal insulation of pipelines	2
Proj10	Project of a heat exchanger	6
Proj 11	Test	2
	Total hours	30
TEACHING TOOLS USED		
N1. Lecture with multimedia presentation N2. Tasks solving N3. Project making N4. Carrying out experiments N5. Report making		
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
C (Lecture)	PEK_W01 – PEK_W06	Final Exam 3,0 if the student has obtained a minimum of 45% points 3,5 if the student has obtained a minimum of 60% points 4,0 if the student has obtained a minimum of 70% points 4,5 if the student has obtained a minimum of 80% points 5,0 if the student has obtained a minimum of 90% points
F2 (laboratory)	PEK_U02, PEK_U04	Test, report
F3 (laboratory)	PEK_U02, PEK_U04	Test, report
F4 (laboratory)	PEK_U01, PEK_U04	Test, report
F5 (laboratory)	PEK_U02, PEK_U04	Test, report
F6 (laboratory)	PEK_U02, PEK_U04	Test, report
F7 (laboratory)	PEK_U02, PEK_U04	Test, report
F8 (laboratory)	PEK_U02, PEK_U04	Test, report
F9 (laboratory)	PEK_U02, PEK_U04	Test, report
F10 (laboratory)	PEK_U01, PEK_U04	Test, report
$S(\text{laboratory}) = (F2 + F3 + F4 + F5 + F6 + F7 + F8 + F9 + F10) / 9$ $C(\text{laboratory}) =$ <ul style="list-style-type: none"> 3,0 if the student has obtained the S average in the range 3-3.3 3,5 if the student has obtained the S average in the range 3.4-3.7 4,0 if the student has obtained the S average in the range 3.8-4.3 4,5 if the student has obtained the S average in the range 4.4-4.7 5,0 if the student has obtained the S average in the range 4.8-5 		
F1 (project)	PEK_U01, PEK_U02	Test 1
F2 (project)	PEK_U02, PEK_U03	Test 2
$S(\text{project}) = (F1 + F2) / 2$ $C(\text{project}) =$ <ul style="list-style-type: none"> 3,0 if the student has obtained the S average in the range 3-3.3 3,5 if the student has obtained the S average in the range 3.4-3.7 4,0 if the student has obtained the S average in the range 3.8-4.3 4,5 if the student has obtained the S average in the range 4.4-4.7 5,0 if the student has obtained the S average in the range 4.8-5 		

PRIMARY AND SECONDARY LITERATURE**PRIMARY LITERATURE:**

- [1] A. Kmieć, Procesy cieplne i aparaty, Oficyna Wydawnicza Politechniki Wrocławskiej, Wrocław, 2005.
- [2] A. Skoczylas, Przenoszenie ciepła, Oficyna Wydawnicza Politechniki Wrocławskiej, Wrocław, 1999.
- [3] A. Kawala, M. Pająk, J. Szust, Zbiór zadań z podstawowych procesów inżynierii chemicznej. Część 2. Przenoszenie ciepła, Wydawnictwo Politechniki Wrocławskiej, Wrocław, 1987.
- [4] <http://www.iic.pwr.wroc.pl/index.php/dydaktyka/43-kierunkowe/procesy-cieplne>

SECONDARY LITERATURE:

- [1] T. Hobler, Ruch ciepła i wymienniki, Wydawnictwo Naukowo Techniczne, Warszawa, 1979.
- [2] R.H. Perry, Perry's Chemical Engineers' Handbook, McGraw-Hill, 1997.

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