FACULTY CHEMISTRY

SUBJECT CARD

Name of subject in English: Heterogeneous processes in chemical, food and pharmaceutical industry
Main field of study (if applicable): Inżynieria chemiczna i procesowa
Specialization (if applicable): Advanced Chemical Engineering and Nanotechnology
Profile: academic
Level and form of studies: 2nd level, full-time
Kind of subject: obligatory
Subject code: ICC024036
Group of courses: NO

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	60	15	45	15	
Number of hours of total student workload (CNPS)	180	60	90	60	
Form of crediting	Exam	crediting with grade	crediting with grade	crediting with grade	
For group of courses mark (X) final course					
Number of ECTS points	6	2	3	2	
including number of ECTS points for practical (P) classes		2	3	2	
including number of ECTS points for direct teacher-student contact (BK) classes	2	0,5	1,5	0,5	

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Knowledge of mathematics and mass transfer phenomena on an engineering level
2. Knowledge of basics of chemical reactor engineering

SUBJECT OBJECTIVES

C1 To provide students with a general knowledge about heterogeneous processes in chemical, food and pharmaceutical industry
C2 To provide students with knowledge about heterogeneous chemical reactors
C3 To provide students with knowledge about heterogeneous catalysis
C4 To provide students with knowledge about bioreactors
C5 To provide students with a general knowledge about high-pressure processes in chemical, food and pharmaceutical industry
C6 To provide student with an ability to derive a mathematical model of the process and perform simulation calculations.

SUBJECT LEARNING OUTCOMES

related to knowledge:

PEK_W01student knows transport phenomena the processes of chemical engineering and environmental protection.
PEK_W02 student knows the basic apparatus and devices used in industrial installations.
PEK_W03 student knows the basics of designing unit operations.
PEK_W05 student knows about the applications of high-pressure processes.
PEK_W06 student has knowledge about heterogeneous reactors.
PEK_W10 student knows the basics and use of bioreactors.

related to skills:
PEK_U02 student is able to derive a mathematical model of the process and perform simulation calculations.
PEK_U03 student is able to carry out selected unit processes and perform design calculations for them.
PEK_U04 student is able to perform process optimization calculations.
PEK_U06 student is able to use transport phenomena in the design of processes.
PEK_U11 student is able to plan and carry out the process in heterogeneous reactors.
related to social competences:
PEK_K02 student can present the results of the work
PEK_K03 student is ready to act and think in an entrepreneurial way

PROGRAMME CONTENT

Lectures		**Number of hours**
Lec 1	Heterogeneous reactions	2
Lec 2	Gas-liquid and liquid-liquid reaction systems	3
Lec 3	Gas-solid non-catalytic systems	3
Lec 4	Heterogeneous catalysis and catalytic kinetics	3
Lec 5	Mass and heat transfer in heterogeneous catalysis, catalyst effectiveness	3
Lec 6	Analyses and design of heterogeneous reactors	8
Lec 7	Catalyst deactivation and strategies for its testing	3
Lec 8	High-pressure technology – thermodynamic and kinetic properties at high pressure	2
Lec 9	High-pressure industrial reaction units	2
Lec 10	Separation operation and equipment; supercritical fluid extraction	2
Lec 11	Supercritical fluid impregnation	2
Lec 12	Application of supercritical fluids in food and pharmaceutical industry	2
Lec 13	High pressure in renewable energy processes	2
Lec 14	High-pressure homogenization for production of emulsions	1
Lec 15	High-pressure food processing	2
Lec 16	Introduction to Nuclear Chemical Engineering	2
Lec 17	Enrichment of uranium and principles of isotopes separation. Nuclear fuel cycle and reprocessing.	3
Lec 18	Microbiological reactors - division, characteristics	2
Lec 19	Application of microbiological processes.	2
Lec 20	Biofilm.	2
Lec21	Immobilization of catalysts.	2
Lec22	Application of enzymatic catalysis.	2
Lec23	Membrane microbiological reactors	2
Lec24	Membrane enzyme reactors	2
Lec25	Biocatalysis in liquid-liquid systems	1

	Total hours	**60**
Classes		**Number of hours**
Proj 1	Optimal temperature regime in reactor performances	3
Proj 2	Gas-liquid and liquid-liquid reaction systems	3
Proj 3	Gas-solid non-catalytic systems	3
Proj 4	Catalytic reactor design I	3
Proj 5	Catalytic reactor design II	3
	Total hours	15
Laboratory		**Number of hours**
Proj 1	Supercritical fluid extraction and impregnation	5
Proj 2	Biodegradation of gaseous pollutants	10
Proj 3	Beer production	15
Proj 4	Immobilization of enzymes	5
Proj 5	Enzymatic catalysis in a mixer and column reactor	10
	Total hours	**45**
Project		**Number of hours**
Proj 1	Multiply heterogeneous reactions – isothermal performance, process design	3
Proj 2	Multiply heterogeneous reactions – non-isothermal performance, process design	3
Proj 3	Industrial catalytic process design for the net exothermic effect of reactions	3
Proj 4	Industrial catalytic process design for the net endothermic effect of reactions	3
Proj 5	Design of process in a catalytic membrane reactor	3
	Total hours	15

TEACHING TOOLS USED

N1. Multimedia presentation
N2. Computer / Excel, Polymath, Matlab
N3. Performing tasks in the laboratory
N4. Solving tasks

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
F1		
P	PEK_W01-W03, PEK_W05, PEK_W06, PEK_W10	Written exam

Evaluation (F – forming (during semester), P – concluding (at semester end)	Learning outcomes number	Way of evaluating learning outcomes achievement
F1	PEK_W01-W03, PEK_W06	Activity during classes (solving tasks using Polymath and Matlab)
P	PEK_W01-W03, PEK_W06	Written Exam (Computer laboratoty)
Evaluation (F – forming (during semester), P – concluding (at semester end)	Learning outcomes number	Way of evaluating learning outcomes achievement
F1	PEK_W03, PEK_W05, PEK_W06, PEK_W10	Short test Activity during classes Laboratory reports
P		
Evaluation (F – forming (during semester), P – concluding (at semester end)	Learning outcomes number	Way of evaluating learning outcomes achievement
F1	PEK_W01-W03, PEK_W06	Evaluation of each project performed
P		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] H. Scott Fogler: Elements of Chemical Reaction Engineering, Prentice Hall 3rd Ed., 2004
[2] James J. Carberry, Chemical and Catalytic Reaction Engineering, McGraw-Hill 1976
[3] O. Levenspiel: Chemical Reaction Engineering, 3rd edition, John Wiley & Sons, New Jersey, 1999
[4] High Pressure Process Technology: Fundamentals and Applications, A. Bertucco and G. Vetter (Editors), Elsevier 2001
[5] Bioreactors: Design, Operation and Novel Applications, C-F. Mandenius, Wiley-VCH Verlag. GmbH & Co. KGaA 2016

SECONDARY LITERATURE:

[1] Gas-Liquid-Solid Reactor Design, McGraw-Hill 1979
[2] Industrial High Pressure Applications, Rudolf Eggers (Editor), WILEY-VCH, 2012
[3]

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

Irena Žižović (irena.zizovic@pwr.edu.pl)

Anna Trusek (anna.trusek@pwr.edu.pl)