Zał. nr 5 do ZW 78/2023

Attachment no. 4. to the Program of Studies

FACULTY of Chemistry

SUBJECT CARD

Name of subject in Polish …Reaktory heterogeniczne…….
Name of subject in English ……Heterogeneous reactors…….
Main field of study (if applicable): …Chemical engineering and technology…….
Specialization (if applicable): …Advanced chemical engineering and green technology…..
Profile: academic
Level and form of studies: 2nd level
Kind of subject: obligatory
Subject code W03CET-SM2003W, W03CET-SM2003P
Group of courses NO

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30			45	
Number of hours of total student workload (CNPS)	75			75	
Form of crediting (Examination / crediting with grade)	Exam			Crediting with grade	
For group of courses mark (X) final course					
Number of ECTS points	3			3	
including number of ECTS points for practical classes (P)				3	
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1,2			1,8	

*delete as not necessary

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Knowledge of mathematics, physics, and mass transfer phenomena at the bachelor's level (chemical engineering or related)
2. Knowledge of the basics of chemical reactor engineering

SUBJECT OBJECTIVES

C1 To familiarize students with the topic and design of heterogeneous chemical reactors (non-catalytic reactions)
C2 To introduce students to the topic of heterogeneous catalysis
C3 To familiarize students with the design of heterogeneous catalytic reactors
C4 To introduce students to the topic and design of high-pressure reactors

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01 – student knows the principles of designing chemical reactors for heterogeneous non-catalytic processes

PEU_W02 - student knows the principles of designing chemical reactors for heterogeneous catalytic processes

PEU_W03 - student knows the principles of design and operation of high-pressure reactors

relating to skills:

PEU_U01 – student is able to determine the limiting resistance of mass transfer in non-catalyzed heterogeneous processes and derive the process rate equation

PEU_U02– student is able to determine the limiting resistances to mass transfer in heterogeneous catalytic processes and derive the process rate equation

PEU_U03 – student can calculate the volume, reaction time or efficiency in heterogeneous reactors.

PROGRAMME CONTENT

Lecture		**Number of hours**
Lec 1	Optimal temperature regime	2
Lec 2	Ammonia production. Ammonia cracking to produce hydrogen	2
Lec 3	Heterogeneous reactions	1
Lec 4	Gas-liquid and liquid-liquid reaction systems	3
Lec 5	Gas-solid non-catalytic systems	3
Lec 6	Heterogeneous catalysis and catalytic kinetics	3
Lec 7	Heterogeneous catalytic reactor design	2
Lec 8	Catalyst deactivation and strategies for its testing	2
Lec 9	External diffusion effects in heterogeneous catalytic reactions	2
Lec 10	Diffusion and reaction in porous catalyst	3
Lec 11	Slurry reactors	1
Lec 12	Thermodynamics of high-pressure processes	2
Lec 13	Supercritical water – green processes and chemical reactor selection. Supercritical water oxidation	2
Lec 14	Hydrothermal gasification	2
	Total hours	30

Project		**Number of hours**
Proj 1	Multiple heterogeneous reactions – isothermal performance, process design	2
Proj 2	Multiple heterogeneous reactions – non-isothermal performance, process design	2
Proj 3	Packed bed reactor; pressure drop	2
Proj 4	Optimal temperature regime for catalytic reactor – exothermic reactions	5

Proj 5	Ammonia synthesis	3
Proj 6	Optimal temperature regime for catalytic reactor – endothermic reactions	3
Proj 7	Hydrogen production by ammonia cracking	2
Proj 8	Absorber design (chemisorption)	5
Proj 9	Gas-solid non-catalyzed system design	4
Proj10	Catalytic reactions – determination of the process rate and reactor design	5
Proj11	Catalytic deactivation. Reactor design.	2
Proj12	Catalytic reactor design – external diffusion effects	2
Proj13	Catalytic reactor design – diffusion in porous catalyst	2
Proj14	Catalytic membranę reactor design	2
Proj15	Thermodynamics of high-pressure processes	2
Proj16	Partial oxidation of p-xylene in supercritical water	2
	Total hours	**45**

TEACHING TOOLS USED

N1. Multimedia presentation
N2. Polymath and Matlab software
N3. MS Office (Excel)

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F (project)	PEU_U01 – U03	Grading based on the work on projects
P (lecture)	PEU_W01 -W03	Exam

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] S. Fogler, Elements of Chemical Reaction Engineering, 6th Edition, Pearson, 2020.

[2] S. Fogler, Essentials of Chemical Reaction Engineering, 2nd Edition, Pearson, 2018.

[3] O. Levenspiel: Chemical Reaction Engineering, 3rd edition, John Wiley & Sons, New Jersey, 1999.

[4] R. Smith, H. Inomata, C. Peters, Introduction to Supercritical Fluids, A Spreadsheet-based approach, Elsevier, 2013.

SECONDARY LITERATURE:

[1] I. Zizovic, Chemical Reaction Engineering with MATLAB examples, Irena Zizovic, Script, Politechnika Wrocławska, 2019.

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

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