

FACULTY OF CHEMISTRY					
SUBJECT CARD					
Name of subject in Polish:	Bioreaktory				
Name of subject in English:	Bioreactors				
Main field of study (if applicable):	all fields of 2 nd level study				
Specialization (if applicable):					
Profile:	academic				
Level and form of studies:	2nd level - supplementary semester, full-time				
Kind of subject:	obligatory				
Subject code:	W03W03-SM2029W, W03W03-SM2029L				
Group of courses:	NO				
	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30		30		
Number of hours of total student workload (CNPS)	50		50		
Form of crediting	Exam		crediting with grade		
For group of courses mark (X) final course					
Number of ECTS points	2		2		
including number of ECTS points for practical (P) classes			2		
including number of ECTS points for direct teacher-student contact (BU) classes	1,3		1,4		
PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES					
1. Passed course - Basics of chemical engineering					
2. Basic knowledge of biochemistry, enzymology and microbiology					
SUBJECT OBJECTIVES					
C1. Learning how to balance microbiological changes					
C2. Learning the description of the kinetics of enzymatic reactions and microbiological changes					
C3. Presentation of the mathematical description of particular types of bioreactors					
C4. Obtaining knowledge about the properties and purpose of particular types of bioreactors					
C5. Learning methods for the selection of bioreactors					
SUBJECT EDUCATIONAL EFFECTS					
related to knowledge:					
PEU_W01 – student has knowledge of the use of various types of biocatalysts and is able to describe the processes with their participation					
PEU_W02 – student knows and understands the basics of construction and the essence of the operation of the equipment used to carry out enzymatic and microbiological processes in the laboratory and industrial scale.					
PEU_W03 – student knows the methods of enzyme immobilization and is able to describe the process with their participation mathematically					
PEU_W04 – student has knowledge about membrane bioreactors.					
related to skills:					
PEU_U01 – student is able to develop the results and is able to present them in the form of a written study or oral presentation, using terminology suitable for bioreactor engineering.					
PEU_U02 – student is can determine the activity of biomolecules.					
PEU_U03 – student has the ability to experimentally determine the kinetics of enzymatic reactions and microbiological changes and the parameters of different types of bioreactors.					
PROGRAMME CONTENT					

Lectures		Number of hours
Lec 1	Introduction to the issue of bioreactor engineering.	2
Lec 2	Kinetics of chemical reaction.	2
Lec 3	Methods of determining the parameters of the kinetic equation.	2
Lec 4	Kinetic equations in enzymatic catalysis. Substrate and product inhibition.	2
Lec 5	Kinetic equations for multi-substrate kinetics. Inactivation of enzymes.	2
Lec 6	Immobilization of enzymes.	2
Lec 7	Catalytic catalysis with mass transfer.	2
Lec 8	Kinetics of microbial growth. Construction of a stirred microbial bioreactor.	2
Lec 9	Mixing in a bioreactor.	2
Lec 10	Material balance of the bioreactor. Batch reactor.	2
Lec 11	Continuous reactor. Time of residence.	2
Lec 12	Biofilm.	2
Lec 13	Cascade of reactors.	2
Lec 14	Microbiological membrane reactor.	2
Lec 15	Reactor with a catalytic membrane.	2
		30
Laboratory (2nd level of studies)		
La1	The way of conducting and passing exercises. Anti-plagiarism policy. Microbiological reactor - study of the kinetics of yeast growth and determination of the parameters of the Monod equation.	10
La2		
La3		
La4	Research on the kinetics of a chemical reaction in a batch reactor	4
La5	Enzymatic processes in a batch reactor: determination of kinetic parameters. Laboratory combined with calculations of parameters of equations using linear and non-linear regression in a computer laboratory.	8
La6		
La7	Distribution of residence time in a stirred tank reactor and a column reactor.	4
La8	Flow reactors: glucose isomerization in a packed bed column	4
		30
TEACHING TOOLS USED		
N1. Lecture with multimedia presentation		
N2. Laboratory		
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 (lecture)	PEU_W01 - PEU_W04	Final exam (max. 10 points)
P(lecture) = F1 9.5 - 10 pkt. + bdb 9.0 – 9.4 pkt. bdb 8.0 – 8.9 pkt. + db 7.0 – 7.9 pkt. db 6.0 – 6.9 pkt. + dst 5.0 – 5.9 pkt. dst		
F1 – F6 (laboratory)	PEU_U1 – PEU_04	Points for each exercise – test + report (max. 5 points for each)
P (laboratory) = (F1+F2+F3+F4+F5+F6) P = 3.0 if sum in the range 60-67,9% 3.5 if sum in the range 68-75,9% 4.0 if sum in the range 76-83,9%		

4.5 if sum in the range 84-89,9%
5.0 if sum in the range 90-98%
5.5 if sum in the range >98%

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

- [1] S.Ledakowicz – Inżynieria biochemiczna, WNT, 2011
- [2] J. Bałdyga: Obliczenia w inżynierii bioreaktorów, Oficyna Wyd. Pol. Warszawskiej, 1996
- [3] E.Klimiuk, K.Lossow, M.Bulińska – Kinetyka reakcji i modelowanie reaktorów biochemicznych w procesach oczyszczania ścieków, ART, 1995
- [4] K.Szewczyk – Bilansowanie i kinetyka procesów biochemicznych, Wyd. PW, 1993

SECONDARY LITERATURE:

- [1] J.E. Bailey, D.F/ Ollis: Biochemical Engineering Fundamentals, McGraw-Hill, 1986
- [2] A. Trusek-Hołownia: Membrane Bioreactors - Models for Bioprocess Design, Desalination Publications, 2011

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

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