FACULTY OF CHEMISTRY

SUBJECT CARD

Name of subject in Polish: Inżynieria bioreaktorów
Name of subject in English: Bioreactors engineering
Main field of study (if applicable): BIOTECHNOLOGY
Specialization (if applicable):
Profile: academic
Level and form of studies: 1st level (version A), 2nd level - supplementary semester (version B), 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		
Number of hours of total student workload (CNPS)	90		60		
Form of crediting	Exam		crediting with grade		
For group of courses mark (X) final course					
Number of ECTS points	3		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 LEARNING OUTCOMES

related to knowledge:

PEK_W01 – student has knowledge of the use of various types of biocatalysts and is able to describe the processes with their participation
PEK_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.
PEK_W03 – student knows the methods of enzyme immobilization and is able to describe the process with their participation mathematically
PEK_W04 – student has knowledge about membrane bioreactors.

related to skills:

PEK_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.
PEK_U02 – student is can determine the activity of biomolecules.
PEK_U03 – student has the ability to experimentally determine the kinetics of enzymatic reactions and microbiological changes and the parameters of different types of bioreactors.

related to social competences:

PEK_K01 – student is ready to critically evaluate his/her knowledge and received content

PEK_K02 – student is aware of the importance of theoretical and practical knowledge acquired and is ready to apply his general and engineering skills in practice.		
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 (version A, 1st level of studies)		
La1	The way of conducting and passing exercises. Anti-plagiarism policy. Distribution of residence time in a stirred tank reactor and a column reactor.	5
La2	Chemical reactor, periodic, continuous stirred and continuous column. Determination of the kinetic equation of the reaction. Verification of kinetics in continuous reactors.	5
La3 La4	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.	10
La5	Flow reactors: glucose isomerization in a packed bed column	5
La6	Batch microbiological reactor. Measurement of growth rate of microorganisms, growth curve. Development of a kinetic equation for the growth of microorganisms.	5
		30
Laboratory (version B, 2nd level of studies)		
La1 La2 La3	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
La4	Research on the kinetics of a chemical reaction in a batch reactor	4
La5 La6	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
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)	PEK_W01 - PEK_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 – VERSION A i B**)	PEK_U1 – PEK_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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