

## Attachment no. 4. to the Program of Studies

FACULTY of Chemistry

**SUBJECT CARD****Name of subject in Polish** ..... Projekt bioprocessowy**Name of subject in English** ..... Bioprocess project.....**Main field of study (if applicable):** ...Biosciences**Specialization (if applicable):** .....**Profile:** academic**Level and form of studies:** 2nd level**Kind of subject:** optional**Subject code** W03BSS-SM2103W**Group of courses:** NO

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30				
Number of hours of total student workload (CNPS)	50				
Form of crediting (Examination / crediting with grade)	Crediting with grade including final exam				
For group of courses mark (X) final course					
Number of ECTS points	2				
including number of ECTS points for practical classes (P)					
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1,3				

\*delete as not necessary

**PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCIES**

1. Knowledge of mathematics and physics at a bachelor level in chemistry, chemical engineering, or related field.

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**SUBJECT OBJECTIVES**

C1 Familiarization with the bioreactor design

C2 Familiarization with basics of downstream process design

C3 Cognition of separation processes and operation of selected equipment and apparatus

**SUBJECT EDUCATIONAL EFFECTS**

relating to knowledge:

K2Abt\_W01 student has advanced knowledge of mathematics allowing for understanding, quantitative description and / or modeling of chemical and / or biotechnological processes.

K2Abt\_W03 student knows the principles of formulating hypotheses, building models and formulating theories in the context of the concept of biotechnology development.

K2Abt\_W07 student knows and understands the facts, objects and phenomena in the field of biotechnology and related sciences as well as their methods and theories explaining the complex relationships between them.

relating to skills:

K2Abt\_U06 student is able to process research results, critically analyze them and formulate conclusions.

K2Abt\_U14 student is able to plan and carry out a biotechnological process. The student is able to write programs or scripts solving numerical problems in the area of computational chemistry and engineering sciences.

relating to social competencies:

K2Abt\_K04 student recognizes the importance of knowledge in solving cognitive and practical problems. Is ready to use the knowledge and experience of experts in case of difficulties in solving a problem.

K2Abt\_K09 student is aware of the social role of a technical university graduate and the need to maintain the ethos of the engineering profession. The student is committed to providing the public with information and opinions regarding technological achievements.

### PROGRAMME CONTENT

Lecture		Number of hours
Lec 1	Bioprocess design and bioreactor as its essential part. Stoichiometry and rate of a chemical reaction. Mathematical models of ideal chemical reactors.	2
Lec 2	Performance of Continuous stirred tank reactor, Plug-flow reactor, and Batch reactor. Material and energy balances.	2
Lec 3	Active intermediates and nonelementary rate laws.	2
Lec 4	Searching for a mechanism. Chain reactions.	2
Lec 5	Enzymatic reaction fundamentals – Enzyme-Substrate Complex, Mechanisms, Michaelis-Menten Equation.	2
Lec 6	Enzymatic reaction fundamentals – Batch reactor design.	2
Lec 7	Inhibition of enzyme reactions: competitive, uncompetitive, mixed, and substrate inhibition.	2
Lec 8	Bioreactors and Biosynthesis – Cell growth. Rate laws and mass balances.	2
Lec 9	Continuous stirred tank bioreactor operation. Chemostats.	2
Lec 10	Microbial fermentation.	2
Lec 11	Substrate-limiting microbial fermentation. Bioreactor design.	2
Lec 12	Product-limiting microbial fermentation. Bioreactor design.	2
Lec 13	Downstream processing. Separation and purification – primary, intermediate, and final recovery stages.	2

Lec 14	Processes and equipment – High-pressure homogenization, Centrifugation, Extraction.	2
Lec 15	Processes and equipment – Membrane separation, Crystallization, Chromatography.	2
	Total hours	30

### TEACHING TOOLS USED

N1. Multimedia presentations  
N2. Polymath software  
N3. MATLAB software

### EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

<b>Evaluation</b> (F – forming during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F1	K2Abt_W01 K2Abt_W03	Homework H1
F2	K2Abt_W01 K2Abt_W07	Homework H2
F3	K2Abt_W03 K2Abt_W07	Homework H3
P Exam Grade = $0.7 \times P + 0.1 \times H1 + 0.1 \times H2 + 0.1 \times H3$		

### PRIMARY AND SECONDARY LITERATURE

#### **PRIMARY LITERATURE:**

- [1] Elements of Chemical Reaction Engineering, 6<sup>th</sup> Edition, H. Scott Fogler, Pearson (2020)
- [2] Essentials of Chemical Reaction Engineering, 2<sup>nd</sup> Edition, H. Scott Fogler, Pearson (2018)
- [3] S. Liu, Bioprocess Engineering 2nd Edition, Elsevier (2016)
- [4] Chemical Reaction Engineering, 3<sup>rd</sup> Edition, Octave Levenspiel, John Wiley & Sons (1999)

#### **SECONDARY LITERATURE:**

- [1] Chemical Reaction Engineering with MATLAB examples, Irena Zizovic, Script, Politechnika Wroclawska (2019)
- [2] Bioseparations Science and Engineering (2nd Edition) Authored by: Roger G. Harrison, Paul W. Todd, Scott R. Rudge and Demetri P. Petrides. Oxford University Press (2015)
- [3] S. Ricardo, S.K. Sudhir, Chemical and Bioprocess Engineering, Springer (2013)
- [4] Separation Process Principles, 2<sup>nd</sup> Edition, J.D. Seader, E.J. Henley, John Wiley & Sons (2006)

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

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