Zał. Nr 1 do ZW 78/2023

PROGRAM OF STUDIES

FACULTY: **CHEMISTRY**
MAIN FIELD OF STUDY: **Chemical Engineering and Technology**
BRANCH OF SCIENCE: **engineering and technology**
DISCIPLINES: **D1 chemical engineering**
EDUCATION LEVEL: **second-level studies (4-semester)**
FORM OF STUDIES: **full-time studies**
PROFILE: **general academic**
LANGUAGE OF STUDY: **English**

Content:

Resolution no. … of the Senate of Wroclaw University of Science and Technology

In effect since **2024/2025**

Zał. Nr 2 do ZW 78/2023
Attachment no. 1. to the Program of Studies

ASSUMED LEARNING OUTCOMES

FACULTY: **CHEMISTRY**
MAIN FIELD OF STUDY: **CHEMICAL ENGINEERING AND TECHNOLOGY**
EDUCATION LEVEL: **second-level studies**
PROFILE: **general academic**

Location of the main-field-of study:

Branch of science: **ENGINEERING AND TECHNOLOGY**

Discipline: **CHEMICAL ENGINEERING**

Explanation of the markings:
Reference to PRK characteristics:
P7U – universal first-degree characteristics corresponding to education at the second-level studies - 7 PRK level
P7S – second degree characteristics corresponding to education at the second-level studies - 7 PRK level

after the underscore:
W – category "knowledge" (extension: G = depth and scope, K = context),
U – category "skills" (extension: W = use of knowledge, K = communication, O = work organization, U = learning),
K – category "social competences" (extension: K = critical assessment, O = responsibility, R = professional role),
INŻ – learning outcomes leading to obtaining engineering competences.

Symbols of main field of study learning outcomes at the second cycle of studies for the Chemical Engineering and Technology (ce)
before the underscore:
K – directional learning outcomes,
2 – second cycle of studies
A – general academic profile
ce – direction code,
after the underscore:
W – knowledge category, **U** – skills category, **K** – social competence category

Main field of study learning outcomes	Description of learning outcomes for the main-field-of study **CHEMICAL ENGINEERING AND TECHNOLOGY** After completion of studies, the graduate:	Reference to PRK characteristics		
		Universal first degree characteristics (U)	Second degree characteristics typical for qualifications obtained in higher education (S)	
			Characteristics for qualifications on 7 levels of PRK	Characteristics for qualifications on 6 and 7 levels of PRK, enabling acquiring engineering competences
KNOWLEDGE (W)				
K2Ace_W01	has in-depth knowledge of materials, apparatus and devices used in chemical processes on various scales	P7U_W	P7S_WG	P7S_WG_INŻ
K2Ace_W02	knows methods of estimating investment and operating costs of industrial installations	P7U_W	P7S_WG	P7S_WG_INŻ
K2Ace_W03	has extended mathematical knowledge and knows extensive tools for designing and optimizing chemical processes at various scales	P7U_W	P7S_WG	P7S_WG_INŻ
K2Ace_W04	has knowledge of creating and implementing an industrial project	P7U_W	P7S_WG	P7S_WG_INŻ
K2Ace_W05	has in-depth knowledge in the field of creation (design), process optimization and/or design and application of diagnostic/measuring devices	P7U_W	P7S_WG	P7S_WG_INŻ
K2Ace_W06	has in-depth knowledge of development trends and new achievements in the field of chemical engineering and technology; is able to assess the usefulness and possibility of using new achievements in the discipline of chemical engineering	P7U_W	P7S_WG	P7S_WG_INŻ
K2Ace_W07	knows the basic concepts of entrepreneurship and the functioning of an enterprise, including a chemical or biotechnological plant	P7U_W	P7S_WK	P7S_WK_INŻ
K2Ace_W08	has structured and theoretically based knowledge in the production of chemicals, polymers and specialized materials, understanding their role in the civilization development	P7U_W	P7S_WG	P7S_WG_INŻ
K2Ace_W09	knows and understands in-depth issues including sustainable processes in chemical engineering and technology, the role of green chemistry in the development of the chemical industry	P7U_W	P7S_WG	P7S_WG_INŻ
K2Ace_W10	understands the impact of chemical processes on the environment and knows in-depth environmental protection methods/techniques/ technologies in industry	P7U_W	P7S_WG	P7S_WG_INŻ

K2Ace_W11	understands the economic, legal and ethical conditions of professional activity in applied chemistry, engineering and technical technology, including technical safety and industrial threats	P7U_W	P7S_WK	P7S_WK_INŻ
SKILLS (U)				
K2Ace_U01	can use mathematical tools to analyze data	P7U_U	P7S_UW	
K2Ace_U02	is able to carry out chemical processes of various degrees of complexity (integration) on laboratory equipment and on a larger scale	P7U_U	P7S_UW	P7S_UW_INŻ
K2Ace_U03	is able to assess the efficiency and quality of products using appropriate physical, physicochemical and chemical methods, including advanced instrumental methods	P7U_U	P7S_UW	
K2Ace_U04	can use analytical methods and simulation programs to solve complex tasks in the field of chemical processes carried out on various scales	P7U_U	P7S_UW	P7S_UW_INŻ
K2Ace_U05	can design a system integrating various unit processes and justify the economics	P7U_U	P7S_UW	P7S_UW_INŻ
K2Ace_U06	can efficiently use modern IT tools for solving engineering tasks and problems; can use advanced computer software to model chemical processes or materials used in them	P7U_U	P7S_UW	P7S_UW_INŻ
K2Ace_U07	can propose and describe the process of synthesizing chemicals and/or materials, also using biocomponents	P7U_U	P7S_UW	P7S_UW_INŻ
K2Ace_U08	acquires, critically evaluates and creatively processes information from scientific literature, databases and other properly selected sources in the field of advanced chemical engineering and innovative chemical technologies	P7U_U	P7S_UW P7S_UU	
K2Ace_U09	uses acquired knowledge from related fields of science and scientific disciplines in formulating and solving complex and unusual problems in chemical engineering and technology	P7U_U	P7S_UW	P7S_UW_INŻ
K2Ace_U10	demonstrates the ability to work in a team, taking on various roles (including leading)	P7U_U	P7S_UK P7S_UO	
K2Ace_U11	is able to independently plan and implement continuous own education in the field of chemical engineering and related sciences; is able to pass on his knowledge to others	P7U_U	P7S_UU	
K2Ace_U12	can use a foreign language at level B2+ of the Common European Framework of Reference for Languages	P7U_U	P7S_UK	
K2Ace_U13	is able to plan and carry out laboratory and/or design work, analyze the obtained results and draw conclusions based on them	P7U_U	P7S_UU	
K2Ace_U14	can take part in a discussion - initiate it, present different opinions and justify them	P7U_U	P7S_UK	
SOCIAL COMPETENCES (K)				

K2Ace_K01	is ready to critically evaluate his knowledge and received content.	P7U_K	P7S_KK	
K2Ace_K02	understands the need for entrepreneurial thinking and action and is aware of the need to act in the public interest.	P7U_K	P7S_KO	
K2Ace_K03	understands the need to take initiatives, inspire and organize activities for the benefit of the socio-economic environment.	P7U_K	P7S_KO	
K2Ace_K04	is ready to cooperate responsibly in a group, performing role taking into account the needs of the team (and/or social needs)	P7U_K	P7S_KR	
K2Ace_K05	is ready to comply with the principles of professional ethics and respect the law, including copyright.	P7U_K	P7S_KR	
K2Ace_K06	recognizes the importance and understands the non-technical aspects and consequences of scientific and engineering activities, including their impact on the environment, as well as the associated responsibilities.	P7U_K	P7S_KK P7S_KO	
K2Ace_K07	is aware of the social role of a technical university graduate and the need to maintain the ethos of the engineering profession.	P7U_K	P7S_KR	
K2Ace_K08	is ready to recognize the importance of knowledge in solving problems in the field of study and related sciences; recognizes the need to seek expert opinion when difficulties arise in solving problems.	P7U_K	P7S_KK	

Zał. nr 3 do ZW 78/2023

Attachment no. 2. to the Program of Studies

DESCRIPTION OF THE PROGRAM OF STUDIES

Main field of study: CHEMICAL ENGINEERING AND TECHNOLOGY	**Profile:** general academic
Level of studies: 2nd level studies (4-semestralne magisterskie)	**Form of studies:** full-time

1. General description

1.1 Number of semesters: ***4***	*1.2 Total number of ECTS points necessary to complete studies at a given level:* ***120***
1.3 Total number of hours: ***1515***	*1.4 Prerequisites (particularly for second-level studies):* ***are specified in the regulation: "Conditions and mode of recruitment" at the Wrocław University of Science and Technology***
1.5 Upon completion of studies graduate obtains professional degree of: ***magister inżynier***	*1.6 Graduate profile, employability:* *A graduate of* ***Chemical Engineering and Technology*** *program should:*

	- have specialized engineering and technical knowledge, including a deep understanding of the principles of chemical engineering and technology, with elements of mathematics, physics and chemistry; *- have problem-solving skills, including the ability to analyze complex problems related to chemical processes and find innovative solutions;* *- possess laboratory and experimental skills, including proficiency in conducting experiments, using laboratory equipment and interpreting experimental data;* *-be safety conscious through good knowledge of chemical process safety procedures to minimize risks and hazards associated with working with chemicals and equipment.* *-be environmentally conscious, including understanding the impact of chemical processes on the environment and processes that minimize environmental damage.* *- have the ability to design and optimize chemical processes, taking into account factors such as efficiency, profitability and environmental impact;* *-Have the communication skills, both written and oral, necessary to communicate complex technical information to colleagues, customers and the general public.* *- have the ability to work in a team, necessary for chemical engineers who often work in multidisciplinary teams, also with the participation of specialists from various backgrounds.* *- demonstrate ethical conduct in their work, adhering to the highest standards of professionalism and integrity in their field.* *- have the ability to adapt and be open to continuous learning and improving their qualifications, especially important considering the*

[1]BU – number of ECTS points assigned to hours of classes requiring direct participation of academic teachers and other persons conducting classes
[2]Traditional – enter T, remote – enter Z
[3]Exam – enter E, crediting – enter Z. For the group of classes – after the letter E or Z - enter in brackets the final subject form (lec, cl, lab, pr, sem)
[4]University-wide subject /group of classes – enter O
[5]DN - number of ECTS points assigned to the classes related to the University's academic activity in the discipline/disciplines to which the main field of study is assigned
[6]Practical subject / group of classes – enter P. For the group of classes – in brackets enter the number of ECTS points assigned to practical courses
[7]KO – general education courses, PD – basic sciences courses, K – main field of study courses, S – specialization courses

	rapidly developing nature of this field, the development of new technologies and methods; *- understand the economic aspects of projects and have knowledge in project management.* *- be aware of global problems in the chemical industry in order to be able to meet the requirements of the changing and dynamically developing industry.* *A graduate of a master's degree in* ***Chemical Engineering and Technology*** *has a high chance of being employed as a process engineer, project manager, quality control specialist or technician. Employment opportunities are found in various sectors, including the petrochemical industry, pharmaceutical industry, environmental engineering, plants producing materials (e.g. polymer and carbon for various applications), as well as in quality control laboratories, in the fuel and energy industries. The graduate can also find employment in research and development units.* *A graduate completing studies in the field of* ***Chemical Engineering and Technology*** *should be prepared to plan and conduct scientific research, and thus undertake education at the Doctoral School.*

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[5]DN - number of ECTS points assigned to the classes related to the University's academic activity in the discipline/disciplines to which the main field of study is assigned
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1.7 Possibility of continuing studies: ***Eligibility to apply for admission to a doctoral school, non-degree postgraduate programmes***	*1.8 Indicate connection with University's mission and its development strategy:* *The mission and strategy of Wrocław University of Science and Technology were defined in the document entitled: "Strategy of Wrocław University of Science and Technology 2023-2030". The second-cycle study program in* ***Chemical Engineering and Technology*** *fits into the key areas of the strategy and the overarching strategic goals both in the area of education, scientific research and cooperation with the environment. It is also consistent with the mission of "creating and transmitting knowledge that responds to new challenges and opportunities emerging before society, economy and civilization.* *The study program is consistent with the strategic goals by: (1) developing creative skills in the nature of scientific work through an increased number of classes related to the completion of a diploma thesis, (2) a large share (over 50%) of active classes, such as laboratories, exercises, seminars and projects , (3) ensuring a balance between the general and specialized knowledge, (4) providing students with knowledge and skills covering the latest achievements in the field of innovative process and chemical engineering and chemical technologies, (5) developing social competences, with particular emphasis on the development of skills teamwork, (6) developing the ability to work using the project method.*

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[4]University-wide subject /group of classes – enter O
[5]DN - number of ECTS points assigned to the classes related to the University's academic activity in the discipline/disciplines to which the main field of study is assigned
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2. Detailed description

2.1 Total number of learning outcomes in the program of study: W (knowledge) =11, U (skills) = 14, K (competences) = 8

W + U + K = 33

2.2 For the main field of study assigned to more than one discipline - the number of learning outcomes assigned to the discipline:

D1 50 (major) (this number must be greater than half the total number of learning outcomes)

2.3 For the main field of study assigned to more than one discipline - percentage share of the number of ECTS points for each discipline:

D1 100% ECTS points

2.4a. For the general academic profile of the main field of study – the number of ECTS points assigned to the classes related to the University's academic activity in the discipline or disciplines to which the main field of study is assigned – DN (must be greater than 50% of the total number of ECTS points from 1.2

Specialization	Total number of ECTS points
Advanced chemical engineering (ACE)	**84**
Advanced chemical technology (ACT)	**90**

2.4b. For the practical profile of the main field of study - the number of ECTS points assigned to the classes shaping practical skills (must be greater than 50% of the total number of ECTS points from 1.2)

2.5 Concise analysis of compliance of the assumed learning outcomes with the needs of the labor market

The chemical industry is characterized by a large diversity of processes and technologies, raw material base and manufactured products. This means that the expectations of the chemical industry towards graduates of chemical engineering and technology fields may vary depending on the specific industrial sector, type of company and current trends. Nevertheless, there are certain general competencies and skills that are often expected from graduates of degrees such as **Chemical Engineering and Technology**. They are indirectly presented in this study program under the Graduate profile item. The preparation of graduates listed there reflects, among others, the following learning outcomes:

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[4]University-wide subject /group of classes – enter O
[5]DN - number of ECTS points assigned to the classes related to the University's academic activity in the discipline/disciplines to which the main field of study is assigned
[6]Practical subject / group of classes – enter P. For the group of classes – in brackets enter the number of ECTS points assigned to practical courses
[7]KO – general education courses, PD – basic sciences courses, K – main field of study courses, S – specialization courses

- has in-depth knowledge of development trends and new achievements in the field of chemical engineering and technology. Is able to assess the usefulness and possibility of using new achievements in the field of chemical engineering,
- has advanced knowledge in the production of chemicals, polymers and specialized materials, understanding their role in the development of civilization.
- can use analytical methods and simulation programs to solve complex tasks in the field of chemical processes carried out on various scales,
- can design a system integrating various unit processes and justify its economics,
- demonstrates the ability to work in a team, taking on various roles (including leading),
- is able to independently plan and implement continuous education in the field of chemical engineering and related sciences; is able to pass on his knowledge to others.

2.6 The total number of ECTS points that a student must obtain in classes requiring direct participation of academic teachers or other persons conducting classes and students (enter the sum of ECTS points for subjects/ groups of classes marked with the BU[1] code)

Specialization	**T**otal number of ECTS **p**oints **(BU)**
Advanced chemical engineering (ACE)	65,2
Advanced chemical technology (ACT)	65,6

2.7. Total number of ECTS points, which student has to obtain from basic sciences classes

	ACE	**ACT**
Number of ECTS points for obligatory subjects	4	4
Number of ECTS points for optional subjects	2	2
Total number of ECTS points	**6**	**6**

[1]BU – number of ECTS points assigned to hours of classes requiring direct participation of academic teachers and other persons conducting classes
[2]Traditional – enter T, remote – enter Z
[3]Exam – enter E, crediting – enter Z. For the group of classes – after the letter E or Z - enter in brackets the final subject form (lec, cl, lab, pr, sem)
[4]University-wide subject /group of classes – enter O
[5]DN - number of ECTS points assigned to the classes related to the University's academic activity in the discipline/disciplines to which the main field of study is assigned
[6]Practical subject / group of classes – enter P. For the group of classes – in brackets enter the number of ECTS points assigned to practical courses
[7]KO – general education courses, PD – basic sciences courses, K – main field of study courses, S – specialization courses

2.8. Total number of ECTS points, which student has to obtain from practical classes, including project and laboratory classes (enter total number of ECTS points for subjects/group of classes denoted with code P)

	ACE	**ACT**
Number of ECTS points for obligatory subjects	19	19
Number of ECTS points for optional subjects	61	65
Total number of ECTS points	**80**	**84**

2.9. Minimum number of ECTS points, which student has to obtain doing education blocks offered as part of University-wide classes or other main field of study (enter number of ECTS points for subjects/group of classes denoted with code O)

8 ECTS points

2.10. Total number of ECTS points, which student may obtain doing optional blocks (min. 30% of total number of ECTS points)

83ECTS points

3. Description of the process leading to learning outcomes acquisition:

Verification and assessment of learning outcomes with reference to subjects or groups of subjects throughout the entire education cycle is carried out in relation to the information contained in subject cards (syllabuses). As a rule, it is conducted through quizzes, tests and exams, during which the student is supposed to demonstrate an appropriate level of knowledge. Learning outcomes in the field of skills are verified during practical classes, as well as on the basis of reports, projects and final works.

The student acquires knowledge and skills by participating in theoretical and practical classes, which are largely based on the results of scientific research conducted by academic teachers - course supervisors and those conducting classes with students. The basis of education are laboratory, seminar and design subjects. Education in the field of study is conducted in accordance with the principle of increasing the complexity of theoretical and practical tasks faced by students. Modern teaching methods are implemented into teaching practice, thanks to which students' activity during classes increases. Theoretical subjects in the form of lectures and seminars are supplemented with design and laboratory classes, which include, among others: modeling and computer design, as well as conducting scientific research. The program is complemented by humanities subjects and foreign language courses. The course of study ends with a diploma examination checking the student's theoretical knowledge and the defense of a master's thesis.

[1]BU – number of ECTS points assigned to hours of classes requiring direct participation of academic teachers and other persons conducting classes
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4. List of education blocks:

4.1. List of obligatory blocks:

4.1.1 List of general education blocks

4.1.1.1 *Liberal-managerial subjects* block *(min. ..... ECTS points):*

No.	Subject group of classes code	Name of Subjectgroup of classes (denote group of courses with symbol **GK**)	Weekly number of hours					Learning effect symbol	Number of hours		Number of ECTS points			Form[2] of Subjectgroup of courses	Way[3] of crediting	Subjectgroup of classes			
			lec	cl	lab	pr	sem		ZZU	CNPS	Total	DN[5] classes	BU[1] classes			University-wide[4]	Concerning scientific activities[5]	Practical[6]	Type[7]
		Total																	

4.1.1.2 *Foreign languages* block *(min. ..... ECTS points):*

No.	Subject group of classes code	Name of Subjectgroup of classes (denote group of courses with symbol **GK**)	Weekly number of hours					Learning effect symbol	Number of hours		Number of ECTS points			Form[2] of Subjectgroup of courses	Way[3] of crediting	Subjectgroup of classes			
			lec	cl	lab	pr	sem		ZZU	CNPS	Total	DN[5] classes	BU[1] classes			University-wide[4]	Concerning scientific activities[5]	Practical[6]	Type[7]
		Total																	

4.1.1.3 *Sporting classes* block *(0 ECTS points):*

No.	Subject group of classescode	Name of Subjectgroup of classes (denote group of courses with symbol **GK**)	Weekly number of hours					Learning effect symbol	Number of hours		Number of ECTS points			Form[2] of Subjectgroup of courses	Way[3] of crediting	Subjectgroup of classes			
			lec	cl	lab	pr	sem		ZZU	CNPS	Total	DN[5] classes	BU[1] classes			University-wide[4]	Concerning scientific activities[5]	Practical[6]	Type[7]
		Total																	

[1]BU – number of ECTS points assigned to hours of classes requiring direct participation of academic teachers and other persons conducting classes
[2]Traditional – enter T, remote – enter Z
[3]Exam – enter E, crediting – enter Z. For the group of classes – after the letter E or Z - enter in brackets the final subject form (lec, cl, lab, pr, sem)
[4]University-wide subject /group of classes – enter O
[5]DN - number of ECTS points assigned to the classes related to the University's academic activity in the discipline/disciplines to which the main field of study is assigned
[6]Practical subject / group of classes – enter P. For the group of classes – in brackets enter the number of ECTS points assigned to practical courses
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4.1.1.4 *Information technologies* block *(min. .... ECTS points):*

No.	Subject group of classes code	Name of Subjectgroup of classes (denote group of courses with symbol **GK**)	Weekly number of hours					Learning effect symbol	Number of hours		Number of ECTS points			Form[2] of Subjectgroup of courses	Way[3] of crediting	Subjectgroup of classes			
			lec	cl	lab	pr	sem		ZZU	CNPS	Total	DN[5] classes	BU[1] classes			University-wide[4]	Concerning scientific activities[5]	Practical[6]	Type[7]
		Total																	

Altogether for general education blocks

Total number of hours					Total number of ZZU hours	Total number of CNPS hours	Total number of ECTS points	Total number of ECTS points for DN classes[5]	Number of ECTS points for BU classes[1]
lec	cl	lab	pr	sem					

[1]BU – number of ECTS points assigned to hours of classes requiring direct participation of academic teachers and other persons conducting classes
[2]Traditional – enter T, remote – enter Z
[3]Exam – enter E, crediting – enter Z. For the group of classes – after the letter E or Z - enter in brackets the final subject form (lec, cl, lab, pr, sem)
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[5]DN - number of ECTS points assigned to the classes related to the University's academic activity in the discipline/disciplines to which the main field of study is assigned
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[7]KO – general education courses, PD – basic sciences courses, K – main field of study courses, S – specialization courses

4.1.2 List of basic sciences blocks

4.1.2.1 *Mathematics* block

No.	Subject group of classes code	Name of Subjectgroup of classes (denote group of courses with symbol **GK**)	Weekly number of hours					Learning effect symbol	Number of hours		Number of ECTS points			Form[2] of Subjectgroup of courses	Way[3] of crediting	Subjectgroup of classes			
			lec	cl	lab	pr	sem		ZZU	CNPS	Total	DN[5] classes	BU[1] classes			University-wide[4]	Concerning scientific activities[5]	Practical[6]	Type[7]
		Total																	

4.1.2.2 *Physics* block

No.	Subject group of classes code	Name of Subjectgroup of classes (denote group of courses with symbol **GK**)	Weekly number of hours					Learning effect symbol	Number of hours		Number of ECTS points			Form[2] of Subjectgroup of courses	Way[3] of crediting	Subjectgroup of classes			
			lec	cl	lab	pr	sem		ZZU	CNPS	Total	DN[5] classes	BU[1] classes			University-wide[4]	Concerning scientific activities[5]	Practical[6]	Type[7]
		Total																	

[1]BU – number of ECTS points assigned to hours of classes requiring direct participation of academic teachers and other persons conducting classes
[2]Traditional – enter T, remote – enter Z
[3]Exam – enter E, crediting – enter Z. For the group of classes – after the letter E or Z - enter in brackets the final subject form (lec, cl, lab, pr, sem)
[4]University-wide subject /group of classes – enter O
[5]DN - number of ECTS points assigned to the classes related to the University's academic activity in the discipline/disciplines to which the main field of study is assigned
[6]Practical subject / group of classes – enter P. For the group of classes – in brackets enter the number of ECTS points assigned to practical courses
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4.1.2.3 *Chemistry* block

No.	Subject group of classes code	Name of Subjectgroup of classess (denote group of courses with symbol **GK**)	Weekly number of hours					Learning effect symbol	Number of hours		Number of ECTS points			Form[2] of Subjectgroup of courses	Way[3] of crediting	Subjectgroup of classes			
			lec	cl	lab	pr	sem		ZZU	CNPS	Total	DN[5] classes	BU[1] classes			University -wide[4]	Concerning scientific activities[5]	Practical[6]	Type[7]
1.	W03CET-SM2010W	Green Chemistry and Sustainable Technology	1					K2Ace_W08; K2Ace_W09; K2Ace_W10; K2Ace_K07	15	25	1	1	0,6	T/Z	**E**		DN		PD
2	W03CET-SM2010P	Green Chemistry and Sustainable Technology				2		K2Ace_U09, K2Ace_U10; K2Ace_U14; K2Ace_K04	30	75	3	3	1,5	T/Z	Z		DN	P	PD
		Total	**1**			**2**			**45**	**100**	**4**	**4**	**2,1**		**1**			**3**	

Altogether for basic sciences blocks:

	Total number of hours					Total number of ZZU hours	Total number of CNPS hours	Total number of ECTS points	Total number of ECTS points for DN classes[5]	Number of ECTS points for BU classes[1]
	w	ć	l	p	s					
ACE ACT	**1**			**2**		**45**	**100**	**4**	**4**	**2,1**

[1]BU – number of ECTS points assigned to hours of classes requiring direct participation of academic teachers and other persons conducting classes
[2]Traditional – enter T, remote – enter Z
[3]Exam – enter E, crediting – enter Z. For the group of classes – after the letter E or Z - enter in brackets the final subject form (lec, cl, lab, pr, sem)
[4]University-wide subject /group of classes – enter O
[5]DN - number of ECTS points assigned to the classes related to the University's academic activity in the discipline/disciplines to which the main field of study is assigned
[6]Practical subject / group of classes – enter P. For the group of classes – in brackets enter the number of ECTS points assigned to practical courses
[7]KO – general education courses, PD – basic sciences courses, K – main field of study courses, S – specialization courses

4.1.3 List of the main field of study blocks

4.1.3.1 *Obligatory main field of study* blocks

No.	Subject group of classes code	Name of Subject group of classes (denote group of courses with symbol **GK**)	Weekly number of hours					Learning effect symbol	Number of hours		Number of ECTS points			Form[2] of Subjectgroup of courses	Way[3] of crediting	Subjectgroup of classes			
			lec	cl	lab	pr	sem		ZZU	CNPS	Total	DN[5] classes	BU[1] classes			University-wide[4]	Concerning scientific activities[5]	Practical[6]	Type[7]
1	W03W03-SM2018L	Informatics for engineers			2			K2Ace_U01 K2Ace_U06	30	50	2		1,4	T	Z			P	K
2	W03W03-SM2007W	Biotechnology with introduction to industrial microbiology	2					K2Ace_W06 K2Ace_W07 K2Ace_W08	30	50	2	2	1,3	T/Z	Z		DN		K
3	W03W03-SM2019P	Biotechnology with introduction to industrial microbiology				1		K2Ace_U07 K2Ace_U11 K2Ace_U14	15	50	2	2	0,75	T/Z	Z		DN	P	K
4	W03W03-SM2025P	Basics of technical drawing				2		K2Ace_U04	30	50	2		1,5	T	Z			P	K
5	W03W03-SM2026W	Technical safety in industry	1					K2Ace_W11	15	25	1		0,65	T/Z	Z				K
6	W03W03-SM2026L	Technical safety in industry			1			K2Ace_U01 K2Ace_U04	15	25	1		0,7	T	Z			P	K
7	W03W03-SM2027W	Material recovery and recycling	2					K2Ace_W06 K2Ace_W09 K2Ace_W10	30	50	2	2	1,3	T/Z	Z		DN		K
8	W03W03-SM2028W	Fundamentals of chemical and process engineering	2					K2Ace_W01 K2Ace_W04	30	50	2		1,3	T/Z	**E**				K
9	W03W03-SM2028P	Fundamentals of chemical and process engineering				2		K2Ace_U04 K2Ace_U05 K2Ace_U06	30	50	2		1,5	T/Z	Z			P	K
10	W03W03-SM2029W	Bioreactors	2					K2Ace_W04	30	50	2	2	1,3	T/Z	**E**		DN		K
11	W03W03-SM2029L	Bioreactors			2			K2Ace_U02 K2Ace_U03 K2Ace_U13	30	50	2	2	1,4	T	Z		DN	P	K
12	W03W03-SM2003W	Introduction to materials science and engineering	2					K2Ace_W06 K2Ace_W10	30	50	2		1,3	T/Z	Z				K
13	W03W03-SM2030W	Fundamentals of chemical technology design	2					K2Ace_W04 K2Ace_W05	30	75	3		1,3	T/Z	**E**				K
14	W03W03-SM2030P	Fundamentals of chemical technology design				2		K2Ace_U04 K2Ace_U05	30	50	2		1,5	T/Z	Z			P	K

[1]BU – number of ECTS points assigned to hours of classes requiring direct participation of academic teachers and other persons conducting classes
[2]Traditional – enter T, remote – enter Z
[3]Exam – enter E, crediting – enter Z. For the group of classes – after the letter E or Z - enter in brackets the final subject form (lec, cl, lab, pr, sem)
[4]University-wide subject /group of classes – enter O
[5]DN - number of ECTS points assigned to the classes related to the University's academic activity in the discipline/disciplines to which the main field of study is assigned
[6]Practical subject / group of classes – enter P. For the group of classes – in brackets enter the number of ECTS points assigned to practical courses
[7]KO – general education courses, PD – basic sciences courses, K – main field of study courses, S – specialization courses

								K2Ace_U06											
15	W03W03-SM2025W	Separation and purification of products	1					K2Ace_W01 K2Ace_W02	15	25	1	1	0,65	T/Z	Z		DN		K
16	W03W03-SM2025L	Separation and purification of products			2			K2Ace_U13	30	50	2	2	1,4	T	Z		DN	P	K
17	W03CET-SM2004W	Trends in Chemical Engineering and Technology	2					K2Ace_W01; K2Ace_W06; K2Ace_W08; K2Ace_W10; K2Ace_W11; K2Ace_K01; K2Ace_K06	30	50	2	2	1,2	T/Z	Z		DN		K
18	W03CET-SM2005C	Retrieval of Scientific and Technological Resources		1				K2Ace_W11; K2Ace_U08; K2Ace_K01; K2Ace_K08;	15	25	1		0,6	T/Z	Z			P	K
		Total	**16**	**1**	**7**	**7**			**465**	**825**	**33**	**15**	**21,05**		**3**			**16**	

Altogether (for main field of study blocks):

	Total number of hours					Total number of ZZU hours	Total number of CNPS hours	Total number of ECTS points	Total number of ECTS points for DN classes[5]	Number of ECTS points for BU classes[1]
	w	ć	l	p	s					
ACE ACT	**16**	**1**	**7**	**7**		**465**	**825**	**33**	**15**	**21,05**

[1]BU – number of ECTS points assigned to hours of classes requiring direct participation of academic teachers and other persons conducting classes
[2]Traditional – enter T, remote – enter Z
[3]Exam – enter E, crediting – enter Z. For the group of classes – after the letter E or Z - enter in brackets the final subject form (lec, cl, lab, pr, sem)
[4]University-wide subject /group of classes – enter O
[5]DN - number of ECTS points assigned to the classes related to the University's academic activity in the discipline/disciplines to which the main field of study is assigned
[6]Practical subject / group of classes – enter P. For the group of classes – in brackets enter the number of ECTS points assigned to practical courses
[7]KO – general education courses, PD – basic sciences courses, K – main field of study courses, S – specialization courses

4.2 List of optional blocks
4.2.1 List of general education blocks

4.2.1.1 Liberal-managerial subjects blocks *(min. 5 ECTS points):*

No.	Subject group of classes code	Name of Subject group of classes (denote group of courses with symbol **GK**)	Weekly number of hours					Learning effect symbol	Number of hours		Number of ECTS points			Form[2] of Subjectgroup of courses	Way[3] of crediting	Subjectgroup of classes			
			lec	cl	lab	pr	sem		ZZU	CNPS	Total	DN[5] classes	BU[1] classes			University-wide[4]	Concerning scientific activities[5]	Practical[6]	Type[7]
1	W03SM-1002BH	Managerial course I	1					K2Ace_K02; K2Ace_K03; K2Ace_K07	15	60	2		0,65	T/Z	Z	O			KO
2	W03SM-1001BH	Managerial course II	2					K2Ace_K02; K2Ace_K03; K2Ace_K07	30	90	3		1,3	T/Z	Z	O			KO
		Total	**3**						**45**	**150**	**5**		**1,95**						

4.2.1.2 ***Foreign languages*** **block** *(min. 3 ECTS points):*

No.	**Subject group of classes code**	Name of Subject group of classes (denote group of courses with symbol **GK**)	Weekly number of hours					Learning effect symbol	Number of hours		Number of ECTS points			Form[2] of Subjectgroup of courses	Way[3] of crediting	Subjectgroup of classes			
			lec	cl	lab	pr	sem		ZZU	CNPS	Total	DN[5] classes	BU[1] classes			University-wide[4]	Concerning scientific activities[5]	Practical[6]	Type[7]
1	SJO-SM0004	Foreign language I		1				K2Ace_U12; K2Ace_K01; K2Ace_K04	15	30	1		0,6	T/Z	Z	O		P	KO
2	SJO-SM0003	Foreign language II		3				K2Ace_U12; K2Ace_K01; K2Ace_K04	45	60	2		1,8	T/Z	Z	O		P	KO
		Total		**4**					**60**	**90**	**3**		**2,4**					**3**	

[1]BU – number of ECTS points assigned to hours of classes requiring direct participation of academic teachers and other persons conducting classes
[2]Traditional – enter T, remote – enter Z
[3]Exam – enter E, crediting – enter Z. For the group of classes – after the letter E or Z - enter in brackets the final subject form (lec, cl, lab, pr, sem)
[4]University-wide subject /group of classes – enter O
[5]DN - number of ECTS points assigned to the classes related to the University's academic activity in the discipline/disciplines to which the main field of study is assigned
[6]Practical subject / group of classes – enter P. For the group of classes – in brackets enter the number of ECTS points assigned to practical courses
[7]KO – general education courses, PD – basic sciences courses, K – main field of study courses, S – specialization courses

Altogether for general education blocks:

	Total number of hours					Total number of ZZU hours	Total number of CNPS hours	Total number of ECTS points	Total number of ECTS points for DN classes[5]	Number of ECTS points for BU classes[1]
	w	ć	l	p	s					
ACE ACT	**3**	**4**				**105**	**240**	**8**		**4,35**

[1]BU – number of ECTS points assigned to hours of classes requiring direct participation of academic teachers and other persons conducting classes
[2]Traditional – enter T, remote – enter Z
[3]Exam – enter E, crediting – enter Z. For the group of classes – after the letter E or Z - enter in brackets the final subject form (lec, cl, lab, pr, sem)
[4]University-wide subject /group of classes – enter O
[5]DN - number of ECTS points assigned to the classes related to the University's academic activity in the discipline/disciplines to which the main field of study is assigned
[6]Practical subject / group of classes – enter P. For the group of classes – in brackets enter the number of ECTS points assigned to practical courses
[7]KO – general education courses, PD – basic sciences courses, K – main field of study courses, S – specialization courses

4.2.2 List of basic sciences blocks

4.2.2.1 *Mathematics* block

No.	Subject group of classes code	Name of Subject group of classes (denote group of courses with symbol **GK**)	Weekly number of hours					Learning effect symbol	Number of hours		Number of ECTS points			Form[2] of Subjectgroup of courses	Way[3] of crediting	Subjectgroup of classes			
			lec	cl	lab	pr	sem		ZZU	CNPS	Total	DN[5] classes	BU[1] classes			University -wide[4]	Concerning scientific activities[5]	Practical[6]	Type[7]
1	**W03CET-SM20B1**	**Block: Mathematics for engineers**		**2**				K2Ace_U01 K2Ace_K01	**30**	**50**	**2**		**1,3**	**T/Z**	**Z**			**P**	**PD**
	W03CET-SM2101c	1. Planning experiments in Statistica		2					30	50	2		1,3						
	W03CET-SM2102c	2. Advanced analysis of experimental data		2					30	50	2		1,3						
		Total		**2**					**30**	**50**	**2**		**1,3**					**2**	

Altogether for basic sciences blocks:

	Total number of hours					Total number of ZZU hours	Total number of CNPS hours	Total number of ECTS points	Total number of ECTS points for DN classes[5]	Number of ECTS points for BU classes[1]
	lec	cl	lab	pr	sem					
ACE ACT		**2**				**30**	**50**	**2**		**1,3**

[1]BU – number of ECTS points assigned to hours of classes requiring direct participation of academic teachers and other persons conducting classes
[2]Traditional – enter T, remote – enter Z
[3]Exam – enter E, crediting – enter Z. For the group of classes – after the letter E or Z - enter in brackets the final subject form (lec, cl, lab, pr, sem)
[4]University-wide subject /group of classes – enter O
[5]DN - number of ECTS points assigned to the classes related to the University's academic activity in the discipline/disciplines to which the main field of study is assigned
[6]Practical subject / group of classes – enter P. For the group of classes – in brackets enter the number of ECTS points assigned to practical courses
[7]KO – general education courses, PD – basic sciences courses, K – main field of study courses, S – specialization courses

4.2.3 List of main-field of study blocks

4.2.3.1 ***Diploma profile*** **block** *(min. 29. ECTS points):*

No.	Subject group of classes code	Name of Subjectgroup of classes (denote group of courses with symbol **GK**)	Weekly number of hours					Learning effect symbol	Number of hours		Number of ECTS points			Form[2] of Subjectgroup of courses	Way[3] of crediting	Subjectgroup of classes			
			lec	cl	lab	pr	sem		ZZU	CNPS	Total	DN[5] classes	BU[1] classes			University-wide[4]	Concerning scientific activities[5]	Practical[6]	Type[7]
1	W03W03-SM2053S	Graduation proseminar					1	K2Ace_U08; K2Ace_U11; K2Ace_U14; K2Ace_K01; K2Ace_K07	15	25	1	1	0,7	T/Z	Z		DN	P	K
2	W03W03-SM2054D	Graduate laboratory I			4			K2Ace_U08; K2Ace_U09; K2Ace_K01; K2Ace_K05; K2Ace_K07	60	150	6	6	3	T	Z		DN	P	K
3	W03W03-SM2055D	Graduate laboratory II			14			K2Ace_U08; K2Ace_U09; K2Ace_U13; K2Ace_K01; K2Ace_K05; K2Ace_K07	210	500	20	20	9,5	T	Z		DN	P	K
4	W03W03-SM2056S	Graduation seminar					1	K2Ace_U11; K2Ace_U14; K2Ace_K01; K2Ace_K06; K2Ace_K07; K2Ace_K08	15	50	2	2	0,7	T/Z	Z		DN	P	K
		Total			**18**		**2**		**300**	**725**	**29**	**29**	**13,9**					**29**	

[1]BU – number of ECTS points assigned to hours of classes requiring direct participation of academic teachers and other persons conducting classes
[2]Traditional – enter T, remote – enter Z
[3]Exam – enter E, crediting – enter Z. For the group of classes – after the letter E or Z - enter in brackets the final subject form (lec, cl, lab, pr, sem)
[4]University-wide subject /group of classes – enter O
[5]DN - number of ECTS points assigned to the classes related to the University's academic activity in the discipline/disciplines to which the main field of study is assigned
[6]Practical subject / group of classes – enter P. For the group of classes – in brackets enter the number of ECTS points assigned to practical courses
[7]KO – general education courses, PD – basic sciences courses, K – main field of study courses, S – specialization courses

4.2.3.2 *Optional courses* block

No.	Subject group of classes code	Name of Subjectgroup of classes (denote group of courses with symbol **GK**)	Weekly number of hours					Learning effect symbol	Number of hours		Number of ECTS points			Form[2] of Subjectgroup of courses	Way[3] of crediting	Subjectgroup of classes			
			lec	cl	lab	pr	sem		ZZU	CNPS	Total	DN[5] classes	BU[1] classes			University-wide[4]	Concerning scientific activities[5]	Practical[6]	Type[7]
1	W03CET-SM20BW	Elective course*	2					K2Ace_W06; K2Ace_K01; K2Ace_K07	30	50	2		1,3	T/Z	Z				K
		Total	**2**						**30**	**50**	**2**		**1,3**						

Altogether for blocks:

	Total number of hours					Total number of ZZU hours	Total number of CNPS hours	Total number of ECTS points	Total number of ECTS points for DN classes[5]	Number of ECTS points for BU classes[1]
	lec	cl	lab	pr	sem					
ACE ACT	**2**		**18**		**2**	**330**	**775**	**31**	**29**	**15,2**

[1]BU – number of ECTS points assigned to hours of classes requiring direct participation of academic teachers and other persons conducting classes
[2]Traditional – enter T, remote – enter Z
[3]Exam – enter E, crediting – enter Z. For the group of classes – after the letter E or Z - enter in brackets the final subject form (lec, cl, lab, pr, sem)
[4]University-wide subject /group of classes – enter O
[5]DN - number of ECTS points assigned to the classes related to the University's academic activity in the discipline/disciplines to which the main field of study is assigned
[6]Practical subject / group of classes – enter P. For the group of classes – in brackets enter the number of ECTS points assigned to practical courses
[7]KO – general education courses, PD – basic sciences courses, K – main field of study courses, S – specialization courses

4.2.4 List of specialization blocks

4.2.4.1 *Specialization subjects* blocks

ACE Advanced Chemical Engineering *(min 42 ECTS)*

No.	Subject group of classes code	Name of Subjectgroup of courses (denote group of courses with symbol **GK**)	Weekly number of hours					Learning effect symbol	Number of hours		Number of ECTS points			Form[2] of Subjectgroup of courses	Way[3] of crediting	Subjectgroup of classes			
			lec	cl	lab	pr	sem		ZZU	CNPS	Total	DN[5] classes	BU[1] classes			University-wide[4]	Concerning scientific activities[5]	Practical[6]	Type[7]
1	W03CET-SM2001W	Chemical Process Equipment	1					K2Ace_W01; K2Ace_W03; K2Ace_K01; K2Ace_K06	15	50	2	2	0,6	T/Z	**E**		DN		S
2	W03CET-SM2001P	Chemical Process Equipment				4		K2Ace_U04; K2Ace_U05; K2Ace_U06; K2Ace_K01; K2Ace_K02;	60	100	4	4	2,4	T/Z	Z		DN	P	S
3	W03CET-SM2002W	Membrane Processes	1					K2Ace_W01; K2Ace_W08; K2Ace_K01; K2Ace_K06	15	50	2	2	0,6	T/Z	Z		DN		S
4	W03CET-SM2002L	Membrane Processes			3			K2Ace_U02; K2Ace_U03; K2Ace_U04; K2Ace_K01; K2Ace_K06;	45	75	3	3	1,8	T	Z		DN	P	S
5	W03CET-SM2002S	Membrane Processes					1	K2Ace_U08; K2Ace_U11; K2Ace_U14; K2Ace_K01; K2Ace_K06;	15	25	1	1	0,6	T/Z	Z		DN	P	S
6	W03CET-SM2003W	Heterogeneous Reactors	2					K2Ace_W01; K2Ace_W03;	30	75	3	3	1,2	T/Z	**E**		DN		S

[1]BU – number of ECTS points assigned to hours of classes requiring direct participation of academic teachers and other persons conducting classes
[2]Traditional – enter T, remote – enter Z
[3]Exam – enter E, crediting – enter Z. For the group of classes – after the letter E or Z - enter in brackets the final subject form (lec, cl, lab, pr, sem)
[4]University-wide subject /group of classes – enter O
[5]DN - number of ECTS points assigned to the classes related to the University's academic activity in the discipline/disciplines to which the main field of study is assigned
[6]Practical subject / group of classes – enter P. For the group of classes – in brackets enter the number of ECTS points assigned to practical courses
[7]KO – general education courses, PD – basic sciences courses, K – main field of study courses, S – specialization courses

								K2Ace_W08; K2Ace_U06; K2Ace_K01; K2Ace_K08;										
7	W03CET-SM2003P	Heterogeneous Reactors				3		K2Ace_U01; K2Ace_U04; K2Ace_U05; K2Ace_U06; K2Ace_K01; K2Ace_K08;	45	75	3	3	1,8	T/Z	Z		DN	P	S
8	W03CET-SM2006W	Chemical Process Project with CFD calculations	1					K2Ace_W04; K2Ace_W05; K2Ace_K02; K2Ace_K08	15	50	2	2	0,6	T/Z	Z		DN		S
9	W03CET-SM2006P	Chemical Process Project with CFD calculations				4		K2Ace_U04; K2Ace_U06; K2Ace_U09; K2Ace_K02; K2Ace_K04	60	100	4	4	2,4	T/Z	Z		DN	P	S
10	W03CET-SM2007W	Biocatalysis in food, brewery and pharmaceutical industry	1					K2Ace_W01; K2Ace_W06; K2Ace_W08; K2Ace_W10; K2Ace_K01; K2Ace_K03	15	50	2	2	0,6	T/Z	Z		DN		S
11	W03CET-SM2007L	Biocatalysis in food, brewery and pharmaceutical industry			3			K2Ace_U02; K2Ace_U03; K2Ace_U04; K2Ace_U07; K2Ace_K01; K2Ace_K06;	45	75	3	3	1,8	T	Z		DN	P	S
12	W03CET-SM2007S	Biocatalysis in food, brewery and pharmaceutical industry					1	K2Ace_U08; K2Ace_U11; K2Ace_U14; K2Ace_K01; K2Ace_K06;	15	25	1	1	0,6	T/Z	Z		DN	P	S

[1]BU – number of ECTS points assigned to hours of classes requiring direct participation of academic teachers and other persons conducting classes
[2]Traditional – enter T, remote – enter Z
[3]Exam – enter E, crediting – enter Z. For the group of classes – after the letter E or Z - enter in brackets the final subject form (lec, cl, lab, pr, sem)
[4]University-wide subject /group of classes – enter O
[5]DN - number of ECTS points assigned to the classes related to the University's academic activity in the discipline/disciplines to which the main field of study is assigned
[6]Practical subject / group of classes – enter P. For the group of classes – in brackets enter the number of ECTS points assigned to practical courses
[7]KO – general education courses, PD – basic sciences courses, K – main field of study courses, S – specialization courses

13	W03CET-SM2008W	Numerical applications in nanoengineering	1					K2Ace_W09; K2Ace_W08; K2Ace_K06;	15	25	1	1	0,6	T/Z	**E**		DN		S
14	W03CET-SM2008P	Numerical applications in nanoengineering				2		K2Ace_U02; K2Ace_U03; K2Ace_U04; K2Ace_U07; K2Ace_K01; K2Ace_K06;	30	50	2	2	1,2	T/Z	Z		DN	P	S
15	W03CET-SM2009W	Nanotechnology	1					K2Ace_W09; K2Ace_W06; K2Ace_W08; K2Ace_K06;	15	25	1	1	0,6	T/Z	Z		DN		S
16	W03CET-SM2009L	Nanotechnology			2			K2Ace_U02; K2Ace_U03; K2Ace_U07; K2Ace_K04; K2Ace_K06	30	50	2	2	1,2	T	Z		DN	P	S
17	W03CET-SM2011W	Chemical Process Optimization and Management	1					K2Ace_W02; K2Ace_W04; K2Ace_W07 K2Ace_W10; K2Ace_W11; K2Ace_K05; K2Ace_K07;	15	50	2		0,6	T/Z	Z				S
18	W03CET-SM2011P	Chemical Process Optimization and Management				4		K2Ace_U04; K2Ace_U05; K2Ace_U13; K2Ace_U07; K2Ace_K01; K2Ace_K02; K2Ace_K08	60	100	4		2	T/Z	Z			P	S
		Total	**9**		**8**	**17**	**2**		**540**	**1050**	**42**	**36**	**21,2**		**3**			**27**	

[1]BU – number of ECTS points assigned to hours of classes requiring direct participation of academic teachers and other persons conducting classes
[2]Traditional – enter T, remote – enter Z
[3]Exam – enter E, crediting – enter Z. For the group of classes – after the letter E or Z - enter in brackets the final subject form (lec, cl, lab, pr, sem)
[4]University-wide subject /group of classes – enter O
[5]DN - number of ECTS points assigned to the classes related to the University's academic activity in the discipline/disciplines to which the main field of study is assigned
[6]Practical subject / group of classes – enter P. For the group of classes – in brackets enter the number of ECTS points assigned to practical courses
[7]KO – general education courses, PD – basic sciences courses, K – main field of study courses, S – specialization courses

ACT Advanced Chemical Technology (min 42 ECTS)

No.	Subject group of classes code	Name of Subjectgroup of courses (denote group of courses with symbol **GK**)	Weekly number of hours					Learning effect symbol	Number of hours		Number of ECTS points			Form[2] of Subjectgroup of courses	Way[3] of crediting	Subjectgroup of classes			
			lec	cl	lab	pr	sem		ZZU	CNPS	Total	DN[5] classes	BU[1] classes			University-wide[4]	Concerning scientific activities[5]	Practical[6]	Type[7]
1.	W03CET-SM2012W	Advanced Chemical Technologies – Biorefinery technologies for chemicals and fuels	1					K2Ace_W01; K2Ace_W08; K2Ace_K01; K2Ace_K06	15	25	1	1	0,6	T/Z	**E**		DN		S
2.	W03CET-SM2012S	Advanced Chemical Technologies – Biorefinery technologies for chemicals and fuels					1	K2Ace_U02; K2Ace_U03; K2Ace_U04; K2Ace_U07; K2Ace_U14; K2Ace_K01; K2Ace_K06;	15	25	1	1	0,6	T/Z	Z		DN	P	S
3.	W03CET-SM2012L	Advanced Chemical Technologies – Biorefinery technologies for chemicals and fuels			3			K2Ace_U02; K2Ace_U03; K2Ace_U04; K2Ace_U07; K2Ace_K01; K2Ace_K06;	45	100	4	4	1,8	T	Z		DN	P	S
4.	W03CET-SM2013W	Surface Phenomena and Heterogenous Catalysis	2					K2Ace_W01; K2Ace_W08; K2Ace_K01; K2Ace_K06	30	50	2	2	1,2	T/Z	**E**		DN		S
5.	W03CET-SM2013S	Surface Phenomena and Heterogenous Catalysis					1	K2Ace_U08; K2Ace_U10; K2Ace_U11; K2Ace_U14; K2Ace_K01; K2Ace_K08;	15	25	1	1	0,6	T/Z	Z		DN	P	S
6.	W03CET-SM2013L	Surface Phenomena and Heterogenous Catalysis			2			K2Ace_U02; K2Ace_U03; K2Ace_U04;	30	75	3	3	1,2	T	Z		DN	P	S

[1]BU – number of ECTS points assigned to hours of classes requiring direct participation of academic teachers and other persons conducting classes
[2]Traditional – enter T, remote – enter Z
[3]Exam – enter E, crediting – enter Z. For the group of classes – after the letter E or Z - enter in brackets the final subject form (lec, cl, lab, pr, sem)
[4]University-wide subject /group of classes – enter O
[5]DN - number of ECTS points assigned to the classes related to the University's academic activity in the discipline/disciplines to which the main field of study is assigned
[6]Practical subject / group of classes – enter P. For the group of classes – in brackets enter the number of ECTS points assigned to practical courses
[7]KO – general education courses, PD – basic sciences courses, K – main field of study courses, S – specialization courses

								K2Ace_U07; K2Ace_K01; K2Ace_K06;											
7.	W03CET-SM2014W	Industrial Plant Design Principles	1					K2Ace_W03; K2Ace_W04; K2Ace_W05 K2Ace_W07; K2Ace_W11; K2Ace_K02; K2Ace_K06	15	25	1	1	0,6	T/Z	Z		DN		S
8.	W03CET-SM2014P	Industrial Plant Design Principles				2		K2Ace_U01; K2Ace_U04; K2Ace_U05; K2Ace_U06; K2Ace_U13; K2Ace_K01; K2Ace_K08;	30	50	2	2	1,5	T/Z	Z		DN	P	S
9.	W03CET-SM2015W	Environmental protection in chemical industry	1					K2Ace_W09; K2Ace_W10; K2Ace_W11 K2Ace_K06	15	25	1	1		T/Z	Z		DN		S
10.	W03CET-SM2015L	Environmental protection in chemical industry			2			K2Ace_U09; K2Ace_K06; K2Ace_K07	30	50	2	2	1,2	T	Z		DN	P	S
11.	W03CET-SM2016W	Advanced Chemical Technologies – Modern macromolecular engineering materials	2					K2Ace_W09; K2Ace_W08; K2Ace_K06;	30	50	2	2	1,2	T/Z	**E**		DN		S
12.	W03CET-SM2016L	Advanced Chemical Technologies – Modern macromolecular engineering materials			3			K2Ace_U02; K2Ace_U03; K2Ace_U04; K2Ace_U07; K2Ace_K01; K2Ace_K06;	45	100	4	4	1,8	T	Z		DN	P	S
13.	W03CET-SM2017W	Chemical sensors and biosensors – fundamentals and applications	1					K2Ace_W05; K2Ace_W08; K2Ace_K05; K2Ace_K06;	15	25	1	1	0,6	T/Z	Z		DN		S

[1]BU – number of ECTS points assigned to hours of classes requiring direct participation of academic teachers and other persons conducting classes
[2]Traditional – enter T, remote – enter Z
[3]Exam – enter E, crediting – enter Z. For the group of classes – after the letter E or Z - enter in brackets the final subject form (lec, cl, lab, pr, sem)
[4]University-wide subject /group of classes – enter O
[5]DN - number of ECTS points assigned to the classes related to the University's academic activity in the discipline/disciplines to which the main field of study is assigned
[6]Practical subject / group of classes – enter P. For the group of classes – in brackets enter the number of ECTS points assigned to practical courses
[7]KO – general education courses, PD – basic sciences courses, K – main field of study courses, S – specialization courses

14.	W03CET-SM2017L	Chemical sensors and biosensors – fundamentals and applications			2			K2Ace_U02; K2Ace_U03; K2Ace_U04; K2Ace_U07; K2Ace_K01; K2Ace_K06;	30	50	2	2	1,2	T	Z		DN	P	S
15.	W03CET-SM2018W	Chemical reactors and bioreactors	1					K2Ace_W09; K2Ace_W08; K2Ace_K06;	15	25	1	1	0,6	T/Z	**E**		DN		S
16.	W03CET-SM2018P	Chemical reactors and bioreactors				2		K2Ace_U02; K2Ace_U03; K2Ace_U04; K2Ace_U07; K2Ace_U13; K2Ace_K01; K2Ace_K06;	30	50	2	2	1,2	T	Z		DN	P	S
17.	W03CET-SM2019P	Scientific team project				4		K2Ace_U07; K2Ace_U10; K2Ace_U11; K2Ace_K02; K2Ace_K04; K2Ace_K05; K2Ace_K08	60	150	6	6	3,0	T	Z		DN	P	S
18.	W03CET-SM2020W	Advanced Chemical Technologies – Nanotechnologies and Energy	2					K2Ace_W09; K2Ace_W08; K2Ace_K06;	30	50	2	2	1,2	T/Z	**E**				
19.	W03CET-SM2020L	Advanced Chemical Technologies – Nanotechnologies and Energy			3			K2Ace_U02; K2Ace_U03; K2Ace_U04; K2Ace_U07; K2Ace_K01; K2Ace_K06;	45	100	4	4	1,5	T	Z			P	S
		Total	**11**	**0**	**15**	**8**	**2**		**540**	**1050**	**42**	**42**	**21,6**		**5**			**31**	

[1]BU – number of ECTS points assigned to hours of classes requiring direct participation of academic teachers and other persons conducting classes
[2]Traditional – enter T, remote – enter Z
[3]Exam – enter E, crediting – enter Z. For the group of classes – after the letter E or Z - enter in brackets the final subject form (lec, cl, lab, pr, sem)
[4]University-wide subject /group of classes – enter O
[5]DN - number of ECTS points assigned to the classes related to the University's academic activity in the discipline/disciplines to which the main field of study is assigned
[6]Practical subject / group of classes – enter P. For the group of classes – in brackets enter the number of ECTS points assigned to practical courses
[7]KO – general education courses, PD – basic sciences courses, K – main field of study courses, S – specialization courses

Altogether for specialization blocks:

	Total number of hours					Total number of ZZU hours	Total number of CNPS hours	Total number of ECTS points	Total number of ECTS points for DN classes[5]	Number of ECTS points for BU classes[1]
	lec	cl	lab	pr	sem					
ACE	**9**	**0**	**8**	**17**	**2**	**540**	**1050**	**42**	**36**	**21,2**
ACT	**11**	**0**	**15**	**8**	**2**	**540**	**1050**	**42**	**42**	**21,6**

[1]BU – number of ECTS points assigned to hours of classes requiring direct participation of academic teachers and other persons conducting classes
[2]Traditional – enter T, remote – enter Z
[3]Exam – enter E, crediting – enter Z. For the group of classes – after the letter E or Z - enter in brackets the final subject form (lec, cl, lab, pr, sem)
[4]University-wide subject /group of classes – enter O
[5]DN - number of ECTS points assigned to the classes related to the University's academic activity in the discipline/disciplines to which the main field of study is assigned
[6]Practical subject / group of classes – enter P. For the group of classes – in brackets enter the number of ECTS points assigned to practical courses
[7]KO – general education courses, PD – basic sciences courses, K – main field of study courses, S – specialization courses

4.3 Training block - concerning principles of training crediting – attachment no.

Not applicable

Opinion of the Advisory Faculty Council concerning the rules of crediting training block

Name of training			
Number of ECTS points	**Number of ECTS points for BU[1] classes**	**Training crediting mode**	**Code**

Training duration	Training objective

4.4 „Diploma dissertation" block

Type of diploma dissertation	~~Licencjat / inżynier~~ / magister / magister inżynier*	
Number of diploma dissertation semesters	**Number of ECTS points**	**Code**
3	**29**	W03W03-SM2053S W03W03-SM2054D W03W03-SM2055D W03W03-SM2056S
Character of diploma dissertation		
Thesis of the second cycle (master) should have traits of scientific, experimental or theoretical, with a primary or practical. Work should lead to new results of original research or technical and technological solutions, and its presentation in the form of written work should include the results and show the knowledge and skills of the author, including but not limited to:(1)The ability to formulate objectives and research questions; (2)Ability to use literature and other sources of knowledge ;(3)The ability to plan and carry out research and other activities to achieve its objectives and problems; (4)Ability to correctly interpret the results; (5)Ability to use precise and clear language and the proper matching of the images presented to illustrate the problem.		
Number of BU[1] ECTS points	**13,9**	

[1]BU – number of ECTS points assigned to hours of classes requiring direct participation of academic teachers and other persons conducting classes
[2]Traditional – enter T, remote – enter Z
[3]Exam – enter E, crediting – enter Z. For the group of classes – after the letter E or Z - enter in brackets the final subject form (lec, cl, lab, pr, sem)
[4]University-wide subject /group of classes – enter O
[5]DN - number of ECTS points assigned to the classes related to the University's academic activity in the discipline/disciplines to which the main field of study is assigned
[6]Practical subject / group of classes – enter P. For the group of classes – in brackets enter the number of ECTS points assigned to practical courses
[7]KO – general education courses, PD – basic sciences courses, K – main field of study courses, S – specialization courses

5. Ways of verifying assumed learning outcomes

Form of classes	Ways of verifying assumed learning outcomes
lecture	e.g. examination, progress/final test
class	e.g. progress/final test
laboratory	e.g. pretest, report from laboratory
project	e.g. project defence
seminar	e.g. participation in discussion, topic presentation, essay
diploma dissertation	prepared diploma dissertation

6. Range of diploma examination

Specialty ACE

1. Chemical reactors
2. Membrane Processes
3. Chemical nanoengineering
4. Processes in food, brewery and pharmaceutical industry
5. Design and optimization of chemical processes
6. Sustainable chemical technologies

[1]BU – number of ECTS points assigned to hours of classes requiring direct participation of academic teachers and other persons conducting classes
[2]Traditional – enter T, remote – enter Z
[3]Exam – enter E, crediting – enter Z. For the group of classes – after the letter E or Z - enter in brackets the final subject form (lec, cl, lab, pr, sem)
[4]University-wide subject /group of classes – enter O
[5]DN - number of ECTS points assigned to the classes related to the University's academic activity in the discipline/disciplines to which the main field of study is assigned
[6]Practical subject / group of classes – enter P. For the group of classes – in brackets enter the number of ECTS points assigned to practical courses
[7]KO – general education courses, PD – basic sciences courses, K – main field of study courses, S – specialization courses

Specialty ACT

1. Chemical reactors
2. Catalytic processes in the chemical industry
3. Technologies for producing nanomaterials
4. Biorefinery systems
5. Modern technologies for the production of polymers and composites
6. Sustainable chemical technologies

7. Requirements concerning deadlines for crediting subject/groups of subject for all courses in particular blocks

Each course should be passed in accordance with the study plan. If it is necessary to repeat a course, it should be completed in the next semester in which it is offered.

***T/Z** Remote form of classes requires Dean's approved, but cannot exceed 75 % of ECTS points.
T/Z option is accepted only for lectures, exercises and seminars

[1]BU – number of ECTS points assigned to hours of classes requiring direct participation of academic teachers and other persons conducting classes
[2]Traditional – enter T, remote – enter Z
[3]Exam – enter E, crediting – enter Z. For the group of classes – after the letter E or Z - enter in brackets the final subject form (lec, cl, lab, pr, sem)
[4]University-wide subject /group of classes – enter O
[5]DN - number of ECTS points assigned to the classes related to the University's academic activity in the discipline/disciplines to which the main field of study is assigned
[6]Practical subject / group of classes – enter P. For the group of classes – in brackets enter the number of ECTS points assigned to practical courses
[7]KO – general education courses, PD – basic sciences courses, K – main field of study courses, S – specialization courses

8. Plan of studies (attachment no. 4)

Approved by faculty student government legislative body:

.....	.....
Date	name and surname, signature of student representative

.....	.....
Date	Dean’s signature

[1]BU – number of ECTS points assigned to hours of classes requiring direct participation of academic teachers and other persons conducting classes
[2]Traditional – enter T, remote – enter Z
[3]Exam – enter E, crediting – enter Z. For the group of classes – after the letter E or Z - enter in brackets the final subject form (lec, cl, lab, pr, sem)
[4]University-wide subject /group of classes – enter O
[5]DN - number of ECTS points assigned to the classes related to the University's academic activity in the discipline/disciplines to which the main field of study is assigned
[6]Practical subject / group of classes – enter P. For the group of classes – in brackets enter the number of ECTS points assigned to practical courses
[7]KO – general education courses, PD – basic sciences courses, K – main field of study courses, S – specialization courses

Zał. nr 4 do ZW 78/2023
Attachment no. 3 to Program of Studies

PLAN OF STUDIES

FACULTY: **Chemistry**

MAIN FIELD OF STUDY: **CHEMICAL ENGINEERING AND TECHNOLOGY**

EDUCATION LEVEL: **second-level studies (4-semester)**

FORM OF STUDIES: **full-time studies**

PROFILE: **general academic**

SPECIALIZATION: **Advanced Chemical Engineering**

LANGUAGE OF STUDY: **English**

In effect since **2024/2025**

Plan of studies structure (optionally)

1) in ECTS point layout

(space for scheme of plan)

2) in hourly layout

(space for scheme of plan)

[1]BU – number of ECTS points assigned to hours of classes requiring direct participation of academic teachers and other persons conducting classes
[2]Traditional – enter T, remote – enter Z
[3]Exam – enter E, crediting – enter Z. For the group of classes – after the letter E or Z - enter in brackets the final subject form (lec, cl, lab, pr, sem)
[4]University-wide subject /group of classes – enter O
[5]DN - number of ECTS points assigned to the classes related to the University's academic activity in the discipline/disciplines to which the main field of study is assigned
[6]Practical subject / group of classes – enter P. For the group of classes – in brackets enter the number of ECTS points assigned to practical courses
[7]KO – general education courses, PD – basic sciences courses, K – main field of study courses, S – specialization courses

2nd LEVEL STUDIES (MASTER LEVEL STUDIES) 4 sem 2024/2025

Field of study: Chemical Engineering and Technology

Specialization: Advanced Chemical Engineering

Sem.	I	II	III	IV
Godz.	28h/ 30ECTS/ 3E	25h / 30ECTS / 2E	26h / 30 ECTS / 2E	22h / 30 ECTS
28	Informatics for engineers 2l (2ECTS)			
27				
26	Biotechnology with introduction to industrial microbiology 2w+1p (2+2) ECTS		Chemical Process Project with CFD calculations 1w+4p (2+4 ECTS)	
25		Chemical Process Equipment **E** 1w+4p (2+4ECTS)		
24				
23	Basics of technical drawing 2p (2 ECTS)			
22				Chemical Process Optimization and Management 1w+4p (2+4 ECTS)
21	Technical safety in industry 1w +1l (1+1) ECTS		Biocatalysis in food, brewery and pharmaceutical industry 1w+3l +1s (2+3+1 ECTS)	
20		Membrane Processes 1w+3l+1s (2+3+1 ECTS)		
19	Material recovery and recycling 2w (2 ECTS)			
18				
17	Fundamentals of chemical and process engineering **E** 2w+2p (2+2) ECTS			Elective course 2w, 2 ECTS
16			Numerical applications in nanoengineering 1w+2p (1+2 ECTS) **E**	
15		Heterogeneous reactors **E** 2w+3p (3+3 ECTS)		Graduate laboratory II 14l (20 ECTS)
14				
13	Bioreactors **E** 2w+2l (2+2) ECTS		Nanotechnology 1w+2l (1+2 ECTS)	
12				
11				
10		Managerial course II 2w, 3 ECTS	Green Chemistry and Sustainable Technology 1w+2p, 4 ECTS **E**	
9	Introduction to materials science and engineering 2w (2 ECTS)			
8		Trends in Chemical Engineering and Technology, 2w 2 ECTS		
7	Fundamentals of chemical technology design 2w +2p **E** (3+2 ECTS)		Foreign language II 3c (2 ECTS)	
6		Retrieval of Scientific and Technological Resources, 1c 1ECTS		
5		Managerial course I 1w 2 ECTS		
4		Block: Mathematics for engineers 2c (2 ECTS)	Graduate laboratory I 4l (6 ECTS)	
3	Separation and purification of products 1w+2l (1+2) ECTS			
2		Graduation proseminar 1s (1 ECTS)		
1		Foreign language I 1c (1 ECTS)		Graduation seminar 1s (2 ECTS)
Sem.	I	II	III	IV

1. Set of obligatory and optional subjects and groups of classes in semestral arrangement

Semester 1

Obligatory subjects / groups of classes Number of ECTS points 30

No.	Subject / groups of classescode	Name of subject / groups of classes (denote group of courses with symbol **GK**)	Weekly number of hours					Learning effect symbol	Number of hours		Number of ECTS points			Form[2] of subject / groups of classes	Way[3] of crediting	Subject / groups of classes			
			lec	cl	lab	pr	sem		ZZU	CNPS	Total	DN[5] classes	BU[1] classes			University -wide[4]	Concerning scientific activities[5]	Practical[6]	Type[7]
1	W03W03-SM2018L	Informatics for engineers			2			K2Ace_U01 K2Ace_U06	30	50	2		1,4	T	Z			P	K
2	W03W03-SM2007W	Biotechnology with introduction to industrial microbiology	2					K2Ace_W06 K2Ace_W07 K2Ace_W08	30	50	2	2	1,3	T/Z	Z		DN		K
3	W03W03-SM2019P	Biotechnology with introduction to industrial microbiology				1		K2Ace_U07 K2Ace_U11 K2Ace_U14	15	50	2	2	0,75	T/Z	Z		DN	P	K
4	W03W03-SM2025P	Basics of technical drawing				2		K2Ace_U04	30	50	2		1,5	T	Z			P	K
5	W03W03-SM2026W	Technical safety in industry	1					K2Ace_W11	15	25	1		0,65	T/Z	Z				K
6	W03W03-SM2026L	Technical safety in industry			1			K2Ace_U01 K2Ace_U04	15	25	1		0,7	T	Z			P	K
7	W03W03-SM2027W	Material recovery and recycling	2					K2Ace_W06 K2Ace_W09 K2Ace_W10	30	50	2	2	1,3	T/Z	Z		DN		K
8	W03W03-SM2028W	Fundamentals of chemical and process engineering	2					K2Ace_W01 K2Ace_W04	30	50	2		1,3	T/Z	**E**				K
9	W03W03-SM2028P	Fundamentals of chemical and process engineering				2		K2Ace_U04 K2Ace_U05 K2Ace_U06	30	50	2		1,5	T/Z	Z			P	K
10	W03W03-SM2029W	Bioreactors	2					K2Ace_W04	30	50	2	2	1,3	T/Z	**E**		DN		K
11	W03W03-SM2029L	Bioreactors			2			K2Ace_U02 K2Ace_U03 K2Ace_U13	30	50	2	2	1,4	T	Z		DN	P	K
12	W03W03-SM2003W	Introduction to materials science and engineering	2					K2Ace_W06 K2Ace_W10	30	50	2		1,3	T/Z	Z				K

[1]BU – number of ECTS points assigned to hours of classes requiring direct participation of academic teachers and other persons conducting classes
[2]Traditional – enter T, remote – enter Z
[3]Exam – enter E, crediting – enter Z. For the group of classes – after the letter E or Z - enter in brackets the final subject form (lec, cl, lab, pr, sem)
[4]University-wide subject /group of classes – enter O
[5]DN - number of ECTS points assigned to the classes related to the University's academic activity in the discipline/disciplines to which the main field of study is assigned
[6]Practical subject / group of classes – enter P. For the group of classes – in brackets enter the number of ECTS points assigned to practical courses
[7]KO – general education courses, PD – basic sciences courses, K – main field of study courses, S – specialization courses

13	W03W03-SM2030W	Fundamentals of chemical technology design	2					K2Ace_W04 K2Ace_W05	30	75	3		1,3	T/Z	**E**				K
14	W03W03-SM2030P	Fundamentals of chemical technology design				2		K2Ace_U04 K2Ace_U05 K2Ace_U06	30	50	2		1,5	T/Z	Z			P	K
15	W03W03-SM2025W	Separation and purification of products	1					K2Ace_W01 K2Ace_W02	15	25	1	1	0,65	T/Z	Z		DN		K
16	W03W03-SM2025L	Separation and purification of products			2			K2Ace_U13	30	50	2	2	1,4	T	Z		DN	P	K
		Total	**14**		**7**	**7**			**420**	**750**	**30**	**13**	**19,25**		**3**			**15**	

Altogether in semester

Total number of hours					Total number of ZZU hours	Total number of CNPS hours	Total number of ECTS points	Total number of ECTS points for DN classes[5]	Number of ECTS points for BU classes[1]
lec	cl	lab	pr	sem					
14		**7**	**7**		**420**	**750**	**30**	**13**	**19,25**

[1]BU – number of ECTS points assigned to hours of classes requiring direct participation of academic teachers and other persons conducting classes
[2]Traditional – enter T, remote – enter Z
[3]Exam – enter E, crediting – enter Z. For the group of classes – after the letter E or Z - enter in brackets the final subject form (lec, cl, lab, pr, sem)
[4]University-wide subject /group of classes – enter O
[5]DN - number of ECTS points assigned to the classes related to the University's academic activity in the discipline/disciplines to which the main field of study is assigned
[6]Practical subject / group of classes – enter P. For the group of classes – in brackets enter the number of ECTS points assigned to practical courses
[7]KO – general education courses, PD – basic sciences courses, K – main field of study courses, S – specialization courses

Semester 2

Obligatory subjects / groups of classes Number of ECTS points 3

No.	Subject / groups of classescode	Name of subject / groups of classes (denote group of courses with symbol **GK**)	Weekly number of hours					Learning effect symbol	Number of hours		Number of ECTS points			Form[2] of subject / groups of classes	Way[3] of crediting	Subject / groups of classes			
			lec	cl	lab	pr	sem		ZZU	CNPS	Total	DN[5] classes	BU[1] classes			University -wide[4]	Concerning scientific activities[5]	Practical[6]	Type[7]
1	W03CET-SM2004W	Trends in Chemical Engineering and Technology	2					K2Ace_W01; K2Ace_W06; K2Ace_W08; K2Ace_W10; K2Ace_W11; K2Ace_K01; K2Ace_K06	30	50	2	2	1,2	T/Z	Z		DN		K
2	W03CET-SM2005C	Retrieval of Scientific and Technological Resources		1				K2Ace_W11; K2Ace_U08; K2Ace_K01; K2Ace_K08;	15	25	1		0,6	T/Z	Z			P	K
		Total	**2**	**1**	**0**	**0**	**0**		**45**	**75**	**3**	**2**	**1,8**					**1**	

[1]BU – number of ECTS points assigned to hours of classes requiring direct participation of academic teachers and other persons conducting classes
[2]Traditional – enter T, remote – enter Z
[3]Exam – enter E, crediting – enter Z. For the group of classes – after the letter E or Z - enter in brackets the final subject form (lec, cl, lab, pr, sem)
[4]University-wide subject /group of classes – enter O
[5]DN - number of ECTS points assigned to the classes related to the University's academic activity in the discipline/disciplines to which the main field of study is assigned
[6]Practical subject / group of classes – enter P. For the group of classes – in brackets enter the number of ECTS points assigned to practical courses
[7]KO – general education courses, PD – basic sciences courses, K – main field of study courses, S – specialization courses

Specialization subjects: ***Advanced Chemical Engineering*** **Number of ECTS points 18**

No.	Subject / groups of classescode	Name of subject / groups of classes (denote group of courses with symbol **GK**)	Weekly number of hours					Learning effect symbol	Number of hours		Number of ECTS points			Form[2] of subject / groups of classes	Way[3] of crediting	Subject / groups of classes			
			lec	cl	lab	pr	sem		ZZU	CNPS	Total	DN[5] classes	BU[1] classes			University -wide[4]	Concerning scientific activities[5]	Practical[6]	Type[7]
1	W03CET-SM2001W	Chemical Process Equipment	1					K2Ace_W01; K2Ace_W03; K2Ace_K01; K2Ace_K06	15	50	2	2	0,6	T/Z	**E**		DN		S
2	W03CET-SM2001P	Chemical Process Equipment				4		K2Ace_U04; K2Ace_U05; K2Ace_U06; K2Ace_K01; K2Ace_K02;	60	100	4	4	2,4	T/Z	Z		DN	P	S
3	W03CET-SM2002W	Membrane Processes	1					K2Ace_W01; K2Ace_W08; K2Ace_K01; K2Ace_K06	15	50	2	2	0,6	T/Z	Z		DN		S
4	W03CET-SM2002L	Membrane Processes			3			K2Ace_U02; K2Ace_U03; K2Ace_U04; K2Ace_K01; K2Ace_K06;	45	75	3	3	1,8	T	Z		DN	P	S
5	W03CET-SM2002S	Membrane Processes					1	K2Ace_U08; K2Ace_U11; K2Ace_U14; K2Ace_K01; K2Ace_K06;	15	25	1	1	0,6	T/Z	Z		DN	P	S
6	W03CET-SM2003W	Heterogeneous Reactors	2					K2Ace_W01; K2Ace_W03; K2Ace_W08; K2Ace_U06; K2Ace_K01; K2Ace_K08;	30	75	3	3	1,2	T/Z	**E**		DN		S

[1]BU – number of ECTS points assigned to hours of classes requiring direct participation of academic teachers and other persons conducting classes
[2]Traditional – enter T, remote – enter Z
[3]Exam – enter E, crediting – enter Z. For the group of classes – after the letter E or Z - enter in brackets the final subject form (lec, cl, lab, pr, sem)
[4]University-wide subject /group of classes – enter O
[5]DN - number of ECTS points assigned to the classes related to the University's academic activity in the discipline/disciplines to which the main field of study is assigned
[6]Practical subject / group of classes – enter P. For the group of classes – in brackets enter the number of ECTS points assigned to practical courses
[7]KO – general education courses, PD – basic sciences courses, K – main field of study courses, S – specialization courses

7	W03CET-SM2003P	Heterogeneous Reactors				3		K2Ace_U01; K2Ace_U04; K2Ace_U05; K2Ace_U06; K2Ace_K01; K2Ace_K08;	45	75	3	3	1,8	T/Z	Z		DN	P	S
		Total	**4**	**0**	**3**	**7**	**1**		**225**	**450**	**18**	**18**	**9**		**2**			**11**	

Optional subjects / groups of classes 9 ECTS points

No.	Subject / groups of classescode	Name of subject / groups of classes (denote group of courses with symbol **GK**)	Weekly number of hours					Learning effect symbol	Number of hours		Number of ECTS points			Form[2] of subject / groups of classes	Way[3] of crediting	Subject / groups of classes			
			lec	cl	lab	pr	sem		ZZU	CNPS	Total	DN[5] classes	BU[1] classes			University -wide[4]	Concerning scientific activities[5]	Practical[6]	Type[7]
1	W03W03-SM2053S	Graduation proseminar					1	K2Ace_U08; K2Ace_U11; K2Ace_U14; K2Ace_K01; K2Ace_K07	15	25	1	1	0,7	T/Z	Z		DN	P	K
2	W03SM-1002BH	Managerial course I	1					K2Ace_K02; K2Ace_K03; K2Ace_K07	15	60	2		0,65	T/Z	Z	O			KO
3	W03SM-1001BH	Managerial course II	2					K2Ace_K02; K2Ace_K03; K2Ace_K07	30	90	3		1,3	T/Z	Z	O			KO
4	SJO-SM0004	Foreign language I		1				K2Ace_U12; K2Ace_K01; K2Ace_K04	15	30	1		0,6	T/Z	Z	O		P	KO
5	**W03CET-SM20B1**	**Block: Mathematics for engineers**		**2**				K2Ace_U01 K2Ace_K01	**30**	**50**	**2**		**1,3**	**T/Z**	**Z**			**P**	**PD**
	W03CET-SM2101C	1. Planning experiments in Statistica		2					30	50	2		1,3						
	W03CET-SM2102C	2. Advanced analysis of experimental data		2					30	50	2		1,3						
		Total	**3**	**3**			**1**		**105**	**225**	**9**	**1**	**4,55**					**4**	

[1]BU – number of ECTS points assigned to hours of classes requiring direct participation of academic teachers and other persons conducting classes
[2]Traditional – enter T, remote – enter Z
[3]Exam – enter E, crediting – enter Z. For the group of classes – after the letter E or Z - enter in brackets the final subject form (lec, cl, lab, pr, sem)
[4]University-wide subject /group of classes – enter O
[5]DN - number of ECTS points assigned to the classes related to the University's academic activity in the discipline/disciplines to which the main field of study is assigned
[6]Practical subject / group of classes – enter P. For the group of classes – in brackets enter the number of ECTS points assigned to practical courses
[7]KO – general education courses, PD – basic sciences courses, K – main field of study courses, S – specialization courses

Altogether in semester

Total number of hours					Total number of ZZU hours	Total number of CNPS hours	Total number of ECTS points	Total number of ECTS points for DN classes[5]	Number of ECTS points for BU classes[1]
lec	cl	lab	pr	sem					
9	**4**	**3**	**7**	**2**	**375**	**750**	**30**	**21**	**15,35**

[1]BU – number of ECTS points assigned to hours of classes requiring direct participation of academic teachers and other persons conducting classes
[2]Traditional – enter T, remote – enter Z
[3]Exam – enter E, crediting – enter Z. For the group of classes – after the letter E or Z - enter in brackets the final subject form (lec, cl, lab, pr, sem)
[4]University-wide subject /group of classes – enter O
[5]DN - number of ECTS points assigned to the classes related to the University's academic activity in the discipline/disciplines to which the main field of study is assigned
[6]Practical subject / group of classes – enter P. For the group of classes – in brackets enter the number of ECTS points assigned to practical courses
[7]KO – general education courses, PD – basic sciences courses, K – main field of study courses, S – specialization courses

Semester 3

Obligatory subjects / groups of classes Number of ECTS points 4

No.	Subject / groups of classescode	Name of subject / groups of classes (denote group of courses with symbol **GK**)	Weekly number of hours					Learning effect symbol	Number of hours		Number of ECTS points			Form[2] of subject / groups of classes	Way[3] of crediting	Subject / groups of classes			
			lec	cl	lab	pr	sem		ZZU	CNPS	Total	DN[5] classes	BU[1] classes			University-wide[4]	Concerning scientific activities[5]	Practical[6]	Type[7]
1	W03CET-SM2010W	Green Chemistry and Sustainable Technology	1					K2Ace_W08; K2Ace_W09; K2Ace_W10; K2Ace_K07	15	25	1	1	0,6	T/Z	**E**		DN		PD
2	W03CET-SM2010P	Green Chemistry and Sustainable Technology				2		K2Ace_U09, K2Ace_U10; K2Ace_U14; K2Ace_K04	30	75	3	3	1,5	T/Z	Z		DN	P	PD
		Total	**1**			**2**			**45**	**100**	**4**	**4**	**2,1**		**1**			**3**	

[1]BU – number of ECTS points assigned to hours of classes requiring direct participation of academic teachers and other persons conducting classes
[2]Traditional – enter T, remote – enter Z
[3]Exam – enter E, crediting – enter Z. For the group of classes – after the letter E or Z - enter in brackets the final subject form (lec, cl, lab, pr, sem)
[4]University-wide subject /group of classes – enter O
[5]DN - number of ECTS points assigned to the classes related to the University's academic activity in the discipline/disciplines to which the main field of study is assigned
[6]Practical subject / group of classes – enter P. For the group of classes – in brackets enter the number of ECTS points assigned to practical courses
[7]KO – general education courses, PD – basic sciences courses, K – main field of study courses, S – specialization courses

Specialization subjects: ***Advanced Chemical Engineering*** **Number of ECTS points 18**

No.	Subject / groups of classescode	Name of subject / groups of classes (denote group of courses with symbol **GK**)	Weekly number of hours					Learning effect symbol	Number of hours		Number of ECTS points			Form[2] of subject / groups of classes	Way[3] of crediting	Subject / groups of classes			
			lec	cl	lab	pr	sem		ZZU	CNPS	Total	DN[5] classes	BU[1] classes			University-wide[4]	Concerning scientific activities[5]	Practical[6]	Type[7]
1	W03CET-SM2006W	Chemical Process Project with CFD calculations	1					K2Ace_W04; K2Ace_W05; K2Ace_K02; K2Ace_K08	15	50	2	2	0,6	T/Z	Z		DN		S
2	W03CET-SM2006P	Chemical Process Project with CFD calculations				4		K2Ace_U04; K2Ace_U06; K2Ace_U09; K2Ace_K02; K2Ace_K04	60	100	4	4	2,4	T/Z	Z		DN	P	S
3	W03CET-SM2007W	Biocatalysis in food, brewery and pharmaceutical industry	1					K2Ace_W01; K2Ace_W06; K2Ace_W08; K2Ace_W10; K2Ace_K01; K2Ace_K03	15	50	2	2	0,6	T/Z	Z		DN		S
4	W03CET-SM2007L	Biocatalysis in food, brewery and pharmaceutical industry			3			K2Ace_U02; K2Ace_U03; K2Ace_U04; K2Ace_U07; K2Ace_K01; K2Ace_K06;	45	75	3	3	1,8	T	Z		DN	P	S
5	W03CET-SM2007S	Biocatalysis in food, brewery and pharmaceutical industry					1	K2Ace_U08; K2Ace_U11; K2Ace_U14; K2Ace_K01; K2Ace_K06;	15	25	1	1	0,6	T/Z	Z		DN	P	S
6	W03CET-SM2008W	Numerical applications in nanoengineering	1					K2Ace_W09; K2Ace_W08; K2Ace_K06;	15	25	1	1	0,6	T/Z	**E**		DN		S

[1]BU – number of ECTS points assigned to hours of classes requiring direct participation of academic teachers and other persons conducting classes
[2]Traditional – enter T, remote – enter Z
[3]Exam – enter E, crediting – enter Z. For the group of classes – after the letter E or Z - enter in brackets the final subject form (lec, cl, lab, pr, sem)
[4]University-wide subject /group of classes – enter O
[5]DN - number of ECTS points assigned to the classes related to the University's academic activity in the discipline/disciplines to which the main field of study is assigned
[6]Practical subject / group of classes – enter P. For the group of classes – in brackets enter the number of ECTS points assigned to practical courses
[7]KO – general education courses, PD – basic sciences courses, K – main field of study courses, S – specialization courses

7	W03CET-SM2008P	Numerical applications in nanoengineering				2		K2Ace_U02; K2Ace_U03; K2Ace_U04; K2Ace_U07; K2Ace_K01; K2Ace_K06;	30	50	2	2	1,2	T/Z	Z		DN	P	S
8	W03CET-SM2009W	Nanotechnology	1					K2Ace_W09; K2Ace_W06; K2Ace_W08; K2Ace_K06;	15	25	1	1	0,6	T/Z	Z		DN		S
9	W03CET-SM2009L	Nanotechnology			2			K2Ace_U02; K2Ace_U03; K2Ace_U07; K2Ace_K04; K2Ace_K06	30	50	2	2	1,2	T	Z		DN	P	S
		Total	**4**		**5**	**6**	**1**		**240**	**450**	**18**	**18**	**9,6**		**1**			**12**	

[1]BU – number of ECTS points assigned to hours of classes requiring direct participation of academic teachers and other persons conducting classes
[2]Traditional – enter T, remote – enter Z
[3]Exam – enter E, crediting – enter Z. For the group of classes – after the letter E or Z - enter in brackets the final subject form (lec, cl, lab, pr, sem)
[4]University-wide subject /group of classes – enter O
[5]DN - number of ECTS points assigned to the classes related to the University's academic activity in the discipline/disciplines to which the main field of study is assigned
[6]Practical subject / group of classes – enter P. For the group of classes – in brackets enter the number of ECTS points assigned to practical courses
[7]KO – general education courses, PD – basic sciences courses, K – main field of study courses, S – specialization courses

Optional subjects / groups of classes 8 ECTS points

No.	Subject / groups of classescode	Name of subject / groups of classes (denote group of courses with symbol **GK**)	Weekly number of hours					Learning effect symbol	Number of hours		Number of ECTS points			Form[2] of subject / groups of classes	Way[3] of crediting	Subject / groups of classes			
			lec	cl	lab	pr	sem		ZZU	CNPS	Total	DN[5] classes	BU[1] classes			University -wide[4]	Concerning scientific activities[5]	Practical[6]	Type[7]
1	W03W03-SM2054D	Graduate laboratory I			4			K2Ace_U08; K2Ace_U09; K2Ace_K01; K2Ace_K05; K2Ace_K07	60	150	6	6	3	T	Z		DN	P	K
2	SJO-SM0003	Foreign language II		3				K2Ace_U12; K2Ace_K01; K2Ace_K04	45	60	2		1,8	T/Z	Z	O		P	KO
		Total		**3**	**4**				**105**	**210**	**8**	**6**	**4,8**					**8**	

Altogether in semester

Total number of hours					Total number of ZZU hours	Total number of CNPS hours	Total number of ECTS points	Total number of ECTS points for DN classes[5]	Number of ECTS points for BU classes[1]
lec	cl	lab	pr	sem					
5	**3**	**9**	**8**	**1**	**390**	**760**	**30**	**28**	**16,5**

[1]BU – number of ECTS points assigned to hours of classes requiring direct participation of academic teachers and other persons conducting classes
[2]Traditional – enter T, remote – enter Z
[3]Exam – enter E, crediting – enter Z. For the group of classes – after the letter E or Z - enter in brackets the final subject form (lec, cl, lab, pr, sem)
[4]University-wide subject /group of classes – enter O
[5]DN - number of ECTS points assigned to the classes related to the University's academic activity in the discipline/disciplines to which the main field of study is assigned
[6]Practical subject / group of classes – enter P. For the group of classes – in brackets enter the number of ECTS points assigned to practical courses
[7]KO – general education courses, PD – basic sciences courses, K – main field of study courses, S – specialization courses

Semester 4

Specialization subjects: *Advanced Chemical Engineering* Number of ECTS points 6

No.	Subject / groups of classescode	Name of subject / groups of classes (denote group of courses with symbol **GK**)	Weekly number of hours					Learning effect symbol	Number of hours		Number of ECTS points			Form[2] of subject / groups of classes	Way[3] of crediting	Subject / groups of classes			
			lec	cl	lab	pr	sem		ZZU	CNPS	Total	DN[5] classes	BU[1] classes			University -wide[4]	Concerning scientific activities[5]	Practical[6]	Type[7]
1	W03CET-SM2011W	Chemical Process Optimization and Management	1					K2Ace_W02; K2Ace_W04; K2Ace_W07 K2Ace_W10; K2Ace_W11; K2Ace_K05; K2Ace_K07;	15	50	2		0,6	T/Z	Z				S
2	W03CET-SM2011P	Chemical Process Optimization and Management				4		K2Ace_U04; K2Ace_U05; K2Ace_U13; K2Ace_U07; K2Ace_K01; K2Ace_K02; K2Ace_K08	60	100	4		2	T/Z	Z			P	S
		Total	**1**			**4**			**75**	**150**	**6**		**2,6**		**1**			**4**	

[1]BU – number of ECTS points assigned to hours of classes requiring direct participation of academic teachers and other persons conducting classes
[2]Traditional – enter T, remote – enter Z
[3]Exam – enter E, crediting – enter Z. For the group of classes – after the letter E or Z - enter in brackets the final subject form (lec, cl, lab, pr, sem)
[4]University-wide subject /group of classes – enter O
[5]DN - number of ECTS points assigned to the classes related to the University's academic activity in the discipline/disciplines to which the main field of study is assigned
[6]Practical subject / group of classes – enter P. For the group of classes – in brackets enter the number of ECTS points assigned to practical courses
[7]KO – general education courses, PD – basic sciences courses, K – main field of study courses, S – specialization courses

Optional subjects / groups of classes 24 ECTS points

No.	Subject / groups of classescode	Name of subject / groups of classes (denote group of courses with symbol **GK**)	Weekly number of hours					Learning effect symbol	Number of hours		Number of ECTS points			Form[2] of subject / groups of classes	Way[3] of crediting	Subject / groups of classes			
			lec	cl	lab	pr	sem		ZZU	CNPS	Total	DN[5] classes	BU[1] classes			University -wide[4]	Concerning scientific activities[5]	Practical[6]	Type[7]
1	W03W03-SM2055D	Graduate laboratory II			14			K2Ace_U08; K2Ace_U09; K2Ace_U13; K2Ace_K01; K2Ace_K05; K2Ace_K07	210	500	20	20	9,5	T	Z		DN	P	K
2	W03W03-SM2056S	Graduation seminar					1	K2Ace_U11; K2Ace_U14; K2Ace_K01; K2Ace_K06; K2Ace_K07; K2Ace_K08	15	50	2	2	0,7	T/Z	Z		DN	P	K
3	W03CET-SM20BW	Elective course*	2					K2Ace_W06; K2Ace_K01; K2Ace_K07	30	50	2		1,3	T/Z	Z				K
		Total	**2**		**14**		**1**		**255**	**600**	**24**	**22**	**11,5**					**22**	

Altogether in semester

Total number of hours					Total number of ZZU hours	Total number of CNPS hours	Total number of ECTS points	Total number of ECTS points for DN classes[5]	Number of ECTS points for BU classes[1]
lec	cl	lab	pr	sem					
3		**14**	**4**	**1**	**330**	**750**	**30**	**22**	**14,1**

[1]BU – number of ECTS points assigned to hours of classes requiring direct participation of academic teachers and other persons conducting classes
[2]Traditional – enter T, remote – enter Z
[3]Exam – enter E, crediting – enter Z. For the group of classes – after the letter E or Z - enter in brackets the final subject form (lec, cl, lab, pr, sem)
[4]University-wide subject /group of classes – enter O
[5]DN - number of ECTS points assigned to the classes related to the University's academic activity in the discipline/disciplines to which the main field of study is assigned
[6]Practical subject / group of classes – enter P. For the group of classes – in brackets enter the number of ECTS points assigned to practical courses
[7]KO – general education courses, PD – basic sciences courses, K – main field of study courses, S – specialization courses

2. Set of examinations in semestral arrangement

Subject / groups of classescode	Names of subjects / groups of classesending with examination	Semester
W03W03-SM2028W	Fundamentals of chemical and process engineering	1
W03W03-SM2029W	Bioreactors	
W03W03-SM2030W	Fundamentals of chemical technology design	
W03CET-SM2001W	Chemical process equipment	2
W03CET-SM2003W	Heterogeneous reactors	
W03CET-SM2008W	Numerical applications in nanoengineering	3
W03CET-SM2010W	Green chemistry and sustainable technology	
W03W03-SM2022W	----------	4

3. Numbers of allowable deficit of ECTS points after particular semesters

Semester	Allowable deficit of ECTS points after semester
1	15
2	15
3	15
4	0

[1]BU – number of ECTS points assigned to hours of classes requiring direct participation of academic teachers and other persons conducting classes
[2]Traditional – enter T, remote – enter Z
[3]Exam – enter E, crediting – enter Z. For the group of classes – after the letter E or Z - enter in brackets the final subject form (lec, cl, lab, pr, sem)
[4]University-wide subject /group of classes – enter O
[5]DN - number of ECTS points assigned to the classes related to the University's academic activity in the discipline/disciplines to which the main field of study is assigned
[6]Practical subject / group of classes – enter P. For the group of classes – in brackets enter the number of ECTS points assigned to practical courses
[7]KO – general education courses, PD – basic sciences courses, K – main field of study courses, S – specialization courses

Opinion of student government legislative body

.....	.....
Date	Name and surname, signature of student representative

.....	.....
Date	Dean’s signature

[1]BU – number of ECTS points assigned to hours of classes requiring direct participation of academic teachers and other persons conducting classes
[2]Traditional – enter T, remote – enter Z
[3]Exam – enter E, crediting – enter Z. For the group of classes – after the letter E or Z - enter in brackets the final subject form (lec, cl, lab, pr, sem)
[4]University-wide subject /group of classes – enter O
[5]DN - number of ECTS points assigned to the classes related to the University's academic activity in the discipline/disciplines to which the main field of study is assigned
[6]Practical subject / group of classes – enter P. For the group of classes – in brackets enter the number of ECTS points assigned to practical courses
[7]KO – general education courses, PD – basic sciences courses, K – main field of study courses, S – specialization courses

Zał. nr 4 do ZW 78/2023
Attachment no. 3 to Program of Studies

PLAN OF STUDIES

FACULTY: **Chemistry**

MAIN FIELD OF STUDY: **CHEMICAL ENGINEERING AND TECHNOLOGY**

EDUCATION LEVEL: **second-level studies (4-semester)**

FORM OF STUDIES: **full-time studies**

PROFILE: **general academic**

SPECIALIZATION: **Advanced Chemical Technology**

LANGUAGE OF STUDY: **English**

In effect since **2024/2025**

Plan of studies structure (optionally)

1) in ECTS point layout

(space for scheme of plan)

2) in hourly layout

(space for scheme of plan)

[1]BU – number of ECTS points assigned to hours of classes requiring direct participation of academic teachers and other persons conducting classes
[2]Traditional – enter T, remote – enter Z
[3]Exam – enter E, crediting – enter Z. For the group of classes – after the letter E or Z - enter in brackets the final subject form (lec, cl, lab, pr, sem)
[4]University-wide subject /group of classes – enter O
[5]DN - number of ECTS points assigned to the classes related to the University's academic activity in the discipline/disciplines to which the main field of study is assigned
[6]Practical subject / group of classes – enter P. For the group of classes – in brackets enter the number of ECTS points assigned to practical courses
[7]KO – general education courses, PD – basic sciences courses, K – main field of study courses, S – specialization courses

2nd LEVEL STUDIES (MASTER LEVEL STUDIES) 4 sem **2024/2025**

Field of study: Chemical Engineering and Technology

Specialization: Advanced Chemical Technology

Sem.	I	II	III	IV
Godz.	**28h/ 30ECTS/ 3E**	**26h / 30ECTS / 2E**	**25h / 30 ECTS / 3E**	**22h / 30 ECTS / 1E**
28	Informatics for engineers 2l (2ECTS)			
27				
26	Biotechnology with introduction to industrial microbiology 2w+1p (2+2) ECTS	Advanced Chemical Technologies – Biorefinery technologies for chemicals and fuels 1w+1s+3l (6 ECTS) **E**		
25			Advanced Chemical Technologies – Modern macromolecular engineering materials **E** 2w + 3l (6 ECTS)	
24				
23	Basics of technical drawing 2p (2 ECTS)			
22				Advanced Chemical Technologies – Nanotechnologies and Energy **E** 5h (6 ECTS) 2w + 3l
21	Technical safety in industry 1w +1l (1+1) ECTS	Surface Phenomena and Heterogenous Catalysis 2w+1s+2l (6ECTS) **E**		
20			Chemical sensors and biosensors – fundamentals and applications 1w + 2l (3 ECTS)	
19	Material recovery and recycling 2w (2 ECTS)			
18				
17	Fundamentals of chemical and process engineering **E** 2w+2p (2+2) ECTS		Chemical reactors and bioreactors 1w+ 2p (3 ECTS) **E**	Elective course 2w, 2 ECTS
16		Industrial plants design principles 1w+2p 3ECTS		
15				Graduate laboratory II 14l (20 ECTS)
14			Scientific team project (elective) Module 1A: computational project Module 1B: laboratory project 4p (6ECTS)	
13	Bioreactors **E** 2w+2l (2+2) ECTS	Environmental protection in chemical industry 1w+2l (1+2 ECTS)		
12				
11				
10		Managerial course II 2w, 3 ECTS	Green Chemistry and Sustainable Technology, **E** 1w+2p, 4 ECTS	
9	Introduction to materials science and engineering 2w (2 ECTS)			
8		Trends in Chemical Engineering and Technology, 2w 2 ECTS		
7	Fundamentals of chemical technology design 2w +2p **E** (3+2 ECTS)		Foreign language II 3c (2 ECTS)	
6		Retrieval of Scientific and Technological Resources, 1c 1ECTS		
5		Managerial course I 1w 2 ECTS		
4		Block: Mathematics for engineers 2c (2 ECTS)	Graduate laboratory I 4l (6 ECTS)	
3	Separation and purification of products 1w+2l (1+2) ECTS			
2		Graduation proseminar 1s (1 ECTS)		
1		Foreign language I, 1c (1 ECTS)		Graduation seminar 1s (2 ECTS)
Sem.	**I**	**II**	**III**	**IV**

1. Set of obligatory and optional subjects and groups of classes in semestral arrangement

Semester 1

Obligatory subjects / groups of classes Number of ECTS points 30

No.	Subject / groups of classescode	Name of subject / groups of classes (denote group of courses with symbol **GK**)	Weekly number of hours					Learning effect symbol	Number of hours		Number of ECTS points			Form[2] of subject / groups of classes	Way[3] of crediting	Subject / groups of classes			
			lec	cl	lab	pr	sem		ZZU	CNPS	Total	DN[5] classes	BU[1] classes			University -wide[4]	Concerning scientific activities[5]	Practical[6]	Type[7]
1	W03W03-SM2018L	Informatics for engineers			2			K2Ace_U01 K2Ace_U06	30	50	2		1,4	T	Z			P	K
2	W03W03-SM2007W	Biotechnology with introduction to industrial microbiology	2					K2Ace_W06 K2Ace_W07 K2Ace_W08	30	50	2	2	1,3	T/Z	Z		DN		K
3	W03W03-SM2019P	Biotechnology with introduction to industrial microbiology				1		K2Ace_U07 K2Ace_U11 K2Ace_U14	15	50	2	2	0,75	T/Z	Z		DN	P	K
4	W03W03-SM2025P	Basics of technical drawing				2		K2Ace_U04	30	50	2		1,5	T	Z			P	K
5	W03W03-SM2026W	Technical safety in industry	1					K2Ace_W11	15	25	1		0,65	T/Z	Z				K
6	W03W03-SM2026L	Technical safety in industry			1			K2Ace_U01 K2Ace_U04	15	25	1		0,7	T	Z			P	K
7	W03W03-SM2027W	Material recovery and recycling	2					K2Ace_W06 K2Ace_W09 K2Ace_W10	30	50	2	2	1,3	T/Z	Z		DN		K
8	W03W03-SM2028W	Fundamentals of chemical and process engineering	2					K2Ace_W01 K2Ace_W04	30	50	2		1,3	T/Z	**E**				K
9	W03W03-SM2028P	Fundamentals of chemical and process engineering				2		K2Ace_U04 K2Ace_U05 K2Ace_U06	30	50	2		1,5	T/Z	Z			P	K
10	W03W03-SM2029W	Bioreactors	2					K2Ace_W04	30	50	2	2	1,3	T/Z	**E**		DN		K
11	W03W03-SM2029L	Bioreactors			2			K2Ace_U02 K2Ace_U03 K2Ace_U13	30	50	2	2	1,4	T	Z		DN	P	K
12	W03W03-SM2003W	Introduction to materials science and engineering	2					K2Ace_W06 K2Ace_W10	30	50	2		1,3	T/Z	Z				K

[1]BU – number of ECTS points assigned to hours of classes requiring direct participation of academic teachers and other persons conducting classes
[2]Traditional – enter T, remote – enter Z
[3]Exam – enter E, crediting – enter Z. For the group of classes – after the letter E or Z - enter in brackets the final subject form (lec, cl, lab, pr, sem)
[4]University-wide subject /group of classes – enter O
[5]DN - number of ECTS points assigned to the classes related to the University's academic activity in the discipline/disciplines to which the main field of study is assigned
[6]Practical subject / group of classes – enter P. For the group of classes – in brackets enter the number of ECTS points assigned to practical courses
[7]KO – general education courses, PD – basic sciences courses, K – main field of study courses, S – specialization courses

13	W03W03-SM2030W	Fundamentals of chemical technology design	2					K2Ace_W04 K2Ace_W05	30	75	3		1,3	T/Z	**E**				K
14	W03W03-SM2030P	Fundamentals of chemical technology design				2		K2Ace_U04 K2Ace_U05 K2Ace_U06	30	50	2		1,5	T/Z	Z			P	K
15	W03W03-SM2025W	Separation and purification of products	1					K2Ace_W01 K2Ace_W02	15	25	1	1	0,65	T/Z	Z		DN		K
16	W03W03-SM2025L	Separation and purification of products			2			K2Ace_U13	30	50	2	2	1,4	T	Z		DN	P	K
		Total	**14**		**7**	**7**			**420**	**750**	**30**	**13**	**19,25**		**3**			**15**	

Altogether in semester

Total number of hours					Total number of ZZU hours	Total number of CNPS hours	Total number of ECTS points	Total number of ECTS points for DN classes[5]	Number of ECTS points for BU classes[1]
lec	cl	lab	pr	sem					
14		**7**	**7**		**420**	**750**	**30**	**13**	**19,25**

[1]BU – number of ECTS points assigned to hours of classes requiring direct participation of academic teachers and other persons conducting classes
[2]Traditional – enter T, remote – enter Z
[3]Exam – enter E, crediting – enter Z. For the group of classes – after the letter E or Z - enter in brackets the final subject form (lec, cl, lab, pr, sem)
[4]University-wide subject /group of classes – enter O
[5]DN - number of ECTS points assigned to the classes related to the University's academic activity in the discipline/disciplines to which the main field of study is assigned
[6]Practical subject / group of classes – enter P. For the group of classes – in brackets enter the number of ECTS points assigned to practical courses
[7]KO – general education courses, PD – basic sciences courses, K – main field of study courses, S – specialization courses

Semester 2

Obligatory subjects / groups of classes Number of ECTS points 3

No.	Subject / groups of classescode	Name of subject / groups of classes (denote group of courses with symbol **GK**)	Weekly number of hours					Learning effect symbol	Number of hours		Number of ECTS points			Form[2] of subject / groups of classes	Way[3] of crediting	Subject / groups of classes			
			lec	cl	lab	pr	sem		ZZU	CNPS	Total	DN[5] classes	BU[1] classes			University -wide[4]	Concerning scientific activities[5]	Practical[6]	Type[7]
1	W03CET-SM2004W	Trends in Chemical Engineering and Technology	2					K2Ace_W01; K2Ace_W06; K2Ace_W08; K2Ace_W10; K2Ace_W11; K2Ace_K01; K2Ace_K06	30	50	2	2	1,2	T/Z	Z		DN		K
2	W03CET-SM2005C	Retrieval of Scientific and Technological Resources		1				K2Ace_W11; K2Ace_U08; K2Ace_K01; K2Ace_K08	15	25	1		0,6	T/Z	Z			P	K
		Total	**2**	**1**	**0**	**0**	**0**		**45**	**75**	**3**	**2**	**1,8**					**1**	

[1]BU – number of ECTS points assigned to hours of classes requiring direct participation of academic teachers and other persons conducting classes
[2]Traditional – enter T, remote – enter Z
[3]Exam – enter E, crediting – enter Z. For the group of classes – after the letter E or Z - enter in brackets the final subject form (lec, cl, lab, pr, sem)
[4]University-wide subject /group of classes – enter O
[5]DN - number of ECTS points assigned to the classes related to the University's academic activity in the discipline/disciplines to which the main field of study is assigned
[6]Practical subject / group of classes – enter P. For the group of classes – in brackets enter the number of ECTS points assigned to practical courses
[7]KO – general education courses, PD – basic sciences courses, K – main field of study courses, S – specialization courses

Specialization subjects: *Advanced Chemical Technology* **Number of ECTS points 18**

No.	Subject / groups of classescode	Name of subject / groups of classes (denote group of courses with symbol **GK**)	Weekly number of hours					Learning effect symbol	Number of hours		Number of ECTS points			Form[2] of subject / groups of classes	Way[3] of crediting	Subject / groups of classes			
			lec	cl	lab	pr	sem		ZZU	CNPS	Total	DN[5] classes	BU[1] classes			University -wide[4]	Concerning scientific activities[5]	Practical[6]	Type[7]
1	W03CET-SM2012W	Advanced Chemical Technologies – Biorefinery technologies for chemicals and fuels	1					K2Ace_W01; K2Ace_W08; K2Ace_K01; K2Ace_K06	15	25	1	1	0,6	T/Z	**E**		DN		S
2	W03CET-SM2012S	Advanced Chemical Technologies – Biorefinery technologies for chemicals and fuels					1	K2Ace_U02; K2Ace_U03; K2Ace_U04; K2Ace_U07; K2Ace_U14 K2Ace_K01; K2Ace_K06;	15	25	1	1	0,6	T/Z	Z		DN	P	S
3	W03CET-SM2012L	Advanced Chemical Technologies – Biorefinery technologies for chemicals and fuels			3			K2Ace_U02; K2Ace_U03; K2Ace_U04; K2Ace_U07; K2Ace_K01; K2Ace_K06;	45	100	4	4	1,8	T	Z		DN	P	S
4	W03CET-SM2013W	Surface Phenomena and Heterogenous Catalysis	2					K2Ace_W01; K2Ace_W08; K2Ace_K01; K2Ace_K06	30	50	2	2	1,2	T/Z	**E**		DN		S
5	W03CET-SM2013S	Surface Phenomena and Heterogenous Catalysis					1	K2Ace_U08; K2Ace_U10; K2Ace_U11; K2Ace_U14; K2Ace_K01; K2Ace_K08;	15	25	1	1	0,6	T/Z	Z		DN	P	S
6	W03CET-SM2013L	Surface Phenomena and Heterogenous Catalysis			2			K2Ace_U02; K2Ace_U03; K2Ace_U04; K2Ace_U07;	30	75	3	3	1,2	T	Z		DN	P	S

[1]BU – number of ECTS points assigned to hours of classes requiring direct participation of academic teachers and other persons conducting classes
[2]Traditional – enter T, remote – enter Z
[3]Exam – enter E, crediting – enter Z. For the group of classes – after the letter E or Z - enter in brackets the final subject form (lec, cl, lab, pr, sem)
[4]University-wide subject /group of classes – enter O
[5]DN - number of ECTS points assigned to the classes related to the University's academic activity in the discipline/disciplines to which the main field of study is assigned
[6]Practical subject / group of classes – enter P. For the group of classes – in brackets enter the number of ECTS points assigned to practical courses
[7]KO – general education courses, PD – basic sciences courses, K – main field of study courses, S – specialization courses

								K2Ace_K01; K2Ace_K06;											
7	W03CET-SM2014W	Industrial Plant Design Principles	1					K2Ace_W03; K2Ace_W04; K2Ace_W05 K2Ace_W07; K2Ace_W11; K2Ace_K02; K2Ace_K06	15	25	1	1	0,6	T/Z	Z		DN		S
8	W03CET-SM2014P	Industrial Plant Design Principles				2		K2Ace_U01; K2Ace_U04; K2Ace_U05; K2Ace_U06; K2Ace_U13; K2Ace_K01; K2Ace_K08;	30	50	2	2	1,5	T/Z	Z		DN	P	S
9	W03CET-SM2015W	Environmental protection in chemical industry	1					K2Ace_W09; K2Ace_W10; K2Ace_W11 K2Ace_K06	15	25	1	1		T/Z	Z		DN		S
10	W03CET-SM2015L	Environmental protection in chemical industry			2			K2Ace_U09; K2Ace_K06; K2Ace_K07	30	50	2	2	1,2	T	Z		DN	P	S
		Total	**5**	**0**	**7**	**2**	**2**	**0**	**240**	**450**	**18**	**18**	**9,3**		**2**			**13**	

[1]BU – number of ECTS points assigned to hours of classes requiring direct participation of academic teachers and other persons conducting classes
[2]Traditional – enter T, remote – enter Z
[3]Exam – enter E, crediting – enter Z. For the group of classes – after the letter E or Z - enter in brackets the final subject form (lec, cl, lab, pr, sem)
[4]University-wide subject /group of classes – enter O
[5]DN - number of ECTS points assigned to the classes related to the University's academic activity in the discipline/disciplines to which the main field of study is assigned
[6]Practical subject / group of classes – enter P. For the group of classes – in brackets enter the number of ECTS points assigned to practical courses
[7]KO – general education courses, PD – basic sciences courses, K – main field of study courses, S – specialization courses

Optional subjects / groups of classes 9 ECTS points

No.	Subject / groups of classescode	Name of subject / groups of classes (denote group of courses with symbol **GK**)	Weekly number of hours					Learning effect symbol	Number of hours		Number of ECTS points			Form[2] of subject / groups of classes	Way[3] of crediting	Subject / groups of classes			
			lec	cl	lab	pr	sem		ZZU	CNPS	Total	DN[5] classes	BU[1] classes			University -wide[4]	Concerning scientific activities[5]	Practical[6]	Type[7]
1	W03W03-SM2053S	Graduation proseminar					1	K2Ace_U08; K2Ace_U11; K2Ace_U14; K2Ace_K01; K2Ace_K07	15	25	1	1	0,7	T/Z	Z		DN	P	K
2	W03SM-1002BH	Managerial course I	1					K2Ace_K02; K2Ace_K03; K2Ace_K07	15	60	2		0,65	T/Z	Z	O			KO
3	W03SM-1001BH	Managerial course II	2					K2Ace_K02; K2Ace_K03; K2Ace_K07	30	90	3		1,3	T/Z	Z	O			KO
4	SJO-SM0004	Foreign language I		1				K2Ace_U12; K2Ace_K01; K2Ace_K04	15	30	1		0,6	T/Z	Z	O		P	KO
5	**W03CET-SM20B1**	**Block: Mathematics for engineers**		**2**				K2Ace_U01 K2Ace_K01	**30**	**50**	**2**		**1,3**	**T/Z**	**Z**			**P**	**PD**
	W03CET-SM2101C	1. Planning experiments in Statistica		2					30	50	2		1,3						
	W03CET-SM2102C	2. Advanced analysis of experimental data		2					30	50	2		1,3						
		Total	**3**	**3**			**1**		**105**	**225**	**9**	**1**	**4,55**					**4**	

Altogether in semester

Total number of hours					Total number of ZZU hours	Total number of CNPS hours	Total number of ECTS points	Total number of ECTS points for DN classes[5]	Number of ECTS points for BU classes[1]
lec	cl	lab	pr	sem					
10	**4**	**7**	**2**	**3**	**390**	**750**	**30**	**21**	**15,65**

[1]BU – number of ECTS points assigned to hours of classes requiring direct participation of academic teachers and other persons conducting classes
[2]Traditional – enter T, remote – enter Z
[3]Exam – enter E, crediting – enter Z. For the group of classes – after the letter E or Z - enter in brackets the final subject form (lec, cl, lab, pr, sem)
[4]University-wide subject /group of classes – enter O
[5]DN - number of ECTS points assigned to the classes related to the University's academic activity in the discipline/disciplines to which the main field of study is assigned
[6]Practical subject / group of classes – enter P. For the group of classes – in brackets enter the number of ECTS points assigned to practical courses
[7]KO – general education courses, PD – basic sciences courses, K – main field of study courses, S – specialization courses

Semester 3

Obligatory subjects / groups of classes Number of ECTS points 4

No.	Subject / groups of classescode	Name of subject / groups of classes (denote group of courses with symbol **GK**)	Weekly number of hours					Learning effect symbol	Number of hours		Number of ECTS points			Form[2] of subject / groups of classes	Way[3] of crediting	Subject / groups of classes			
			lec	cl	lab	pr	sem		ZZU	CNPS	Total	DN[5] classes	BU[1] classes			University-wide[4]	Concerning scientific activities[5]	Practical[6]	Type[7]
1	W03CET-SM2010W	Green Chemistry and Sustainable Technology	1					K2Ace_W08; K2Ace_W09; K2Ace_W10; K2Ace_K07	15	25	1	1	0,6	T/Z	**E**		DN		PD
2	W03CET-SM2010P	Green Chemistry and Sustainable Technology				2		K2Ace_U09, K2Ace_U10; K2Ace_U14; K2Ace_K04	30	75	3	3	1,5	T/Z	Z		DN	P	PD
		Total	**1**			**2**			**45**	**100**	**4**	**4**	**2,1**		**1**			**3**	

[1]BU – number of ECTS points assigned to hours of classes requiring direct participation of academic teachers and other persons conducting classes
[2]Traditional – enter T, remote – enter Z
[3]Exam – enter E, crediting – enter Z. For the group of classes – after the letter E or Z - enter in brackets the final subject form (lec, cl, lab, pr, sem)
[4]University-wide subject /group of classes – enter O
[5]DN - number of ECTS points assigned to the classes related to the University's academic activity in the discipline/disciplines to which the main field of study is assigned
[6]Practical subject / group of classes – enter P. For the group of classes – in brackets enter the number of ECTS points assigned to practical courses
[7]KO – general education courses, PD – basic sciences courses, K – main field of study courses, S – specialization courses

Specialization subjects: *Advanced Chemical Technology* **Number of ECTS points 18**

No.	Subject / groups of classescode	Name of subject / groups of classes (denote group of courses with symbol **GK**)	Weekly number of hours					Learning effect symbol	Number of hours		Number of ECTS points			Form[2] of subject / groups of classes	Way[3] of crediting	Subject / groups of classes			
			lec	cl	lab	pr	sem		ZZU	CNPS	Total	DN[5] classes	BU[1] classes			University -wide[4]	Concerning scientific activities[5]	Practical[6]	Type[7]
1	W03CET-SM2016W	Advanced Chemical Technologies – Modern macromolecular engineering materials	2					K2Ace_W09; K2Ace_W08; K2Ace_K06;	30	50	2	2	1,2	T/Z	**E**		DN		S
2	W03CET-SM2016L	Advanced Chemical Technologies – Modern macromolecular engineering materials			3			K2Ace_U02; K2Ace_U03; K2Ace_U04; K2Ace_U07; K2Ace_K01; K2Ace_K06;	45	100	4	4	1,8	T	Z		DN	P	S
3	W03CET-SM2017W	Chemical sensors and biosensors – fundamentals and applications	1					K2Ace_W05; K2Ace_W08; K2Ace_K05; K2Ace_K06;	15	25	1	1	0,6	T/Z	Z		DN		S
4	W03CET-SM2017L	Chemical sensors and biosensors – fundamentals and applications			2			K2Ace_U02; K2Ace_U03; K2Ace_U04; K2Ace_U07; K2Ace_K01; K2Ace_K06;	30	50	2	2	1,2	T	Z		DN	P	S
5	W03CET-SM2018W	Chemical reactors and bioreactors	1					K2Ace_W09; K2Ace_W08; K2Ace_K06;	15	25	1	1	0,6	T/Z	**E**		DN		S
6	W03CET-SM2018P	Chemical reactors and bioreactors				2		K2Ace_U02; K2Ace_U03; K2Ace_U04; K2Ace_U07; K2Ace_U13 K2Ace_K01; K2Ace_K06;	30	50	2	2	1,2	T	Z		DN	P	S
7	W03CET-SM2019P	Scientific team project				4		K2Ace_U07; K2Ace_U10;	60	150	6	6	3,0	T	Z		DN	P	S

[1]BU – number of ECTS points assigned to hours of classes requiring direct participation of academic teachers and other persons conducting classes
[2]Traditional – enter T, remote – enter Z
[3]Exam – enter E, crediting – enter Z. For the group of classes – after the letter E or Z - enter in brackets the final subject form (lec, cl, lab, pr, sem)
[4]University-wide subject /group of classes – enter O
[5]DN - number of ECTS points assigned to the classes related to the University's academic activity in the discipline/disciplines to which the main field of study is assigned
[6]Practical subject / group of classes – enter P. For the group of classes – in brackets enter the number of ECTS points assigned to practical courses
[7]KO – general education courses, PD – basic sciences courses, K – main field of study courses, S – specialization courses

								K2Ace_U11; K2Ace_K02; K2Ace_K04; K2Ace_K05; K2Ace_K08											
		Total	**4**	**0**	**5**	**6**	**0**		**225**	**450**	**18**	**18**	**9,6**		**2**			**14**	

Optional subjects / groups of classes 8 ECTS points

No.	Subject / groups of classescode	Name of subject / groups of classes (denote group of courses with symbol **GK**)	Weekly number of hours					Learning effect symbol	Number of hours		Number of ECTS points			Form[2] of subject / groups of classes	Way[3] of crediting	Subject / groups of classes			
			lec	cl	lab	pr	sem		ZZU	CNPS	Total	DN[5] classes	BU[1] classes			University -wide[4]	Concerning scientific activities[5]	Practical[6]	Type[7]
1	W03W03-SM2054D	Graduate laboratory I			4			K2Ace_U08; K2Ace_U09; K2Ace_K01; K2Ace_K05; K2Ace_K07	60	150	6	6	3	T	Z		DN	P	K
2	SJO-SM0003	Foreign language II		3				K2Ace_U12; K2Ace_K01; K2Ace_K04	45	60	2		1,8	T/Z	Z	O		P	KO
		Total		**3**	**4**				**105**	**210**	**8**	**6**	**4,8**					**8**	

Altogether in semester

Total number of hours					Total number of ZZU hours	Total number of CNPS hours	Total number of ECTS points	Total number of ECTS points for DN classes[5]	Number of ECTS points for BU classes[1]
lec	cl	lab	pr	sem					
5	**3**	**9**	**8**	**0**	**375**	**760**	**30**	**28**	**16,5**

[1]BU – number of ECTS points assigned to hours of classes requiring direct participation of academic teachers and other persons conducting classes
[2]Traditional – enter T, remote – enter Z
[3]Exam – enter E, crediting – enter Z. For the group of classes – after the letter E or Z - enter in brackets the final subject form (lec, cl, lab, pr, sem)
[4]University-wide subject /group of classes – enter O
[5]DN - number of ECTS points assigned to the classes related to the University's academic activity in the discipline/disciplines to which the main field of study is assigned
[6]Practical subject / group of classes – enter P. For the group of classes – in brackets enter the number of ECTS points assigned to practical courses
[7]KO – general education courses, PD – basic sciences courses, K – main field of study courses, S – specialization courses

Semester 4

Specialization subjects: *Advanced Chemical Technology* Number of ECTS points 6

No.	Subject / groups of classescode	Name of subject / groups of classes (denote group of courses with symbol **GK**)	Weekly number of hours					Learning effect symbol	Number of hours		Number of ECTS points			Form[2] of subject / groups of classes	Way[3] of crediting	Subject / groups of classes			
			lec	cl	lab	pr	sem		ZZU	CNPS	Total	DN[5] classes	BU[1] classes			University -wide[4]	Concerning scientific activities[5]	Practical[6]	Type[7]
1	W03CET-SM2020W	Advanced Chemical Technologies – Nanotechnologies and Energy	2					K2Ace_W09; K2Ace_W08; K2Ace_K06;	30	50	2	2	1,2	T/Z	**E**				S
2	W03CET-SM2020L	Advanced Chemical Technologies – Nanotechnologies and Energy			3			K2Ace_U02; K2Ace_U03; K2Ace_U04; K2Ace_U07; K2Ace_K01; K2Ace_K06;	45	100	4	4	1,5	T	Z			P	S
		Total	**2**		**3**				**75**	**150**	**6**	**6**	**2,7**		**1**			**4**	

[1]BU – number of ECTS points assigned to hours of classes requiring direct participation of academic teachers and other persons conducting classes
[2]Traditional – enter T, remote – enter Z
[3]Exam – enter E, crediting – enter Z. For the group of classes – after the letter E or Z - enter in brackets the final subject form (lec, cl, lab, pr, sem)
[4]University-wide subject /group of classes – enter O
[5]DN - number of ECTS points assigned to the classes related to the University's academic activity in the discipline/disciplines to which the main field of study is assigned
[6]Practical subject / group of classes – enter P. For the group of classes – in brackets enter the number of ECTS points assigned to practical courses
[7]KO – general education courses, PD – basic sciences courses, K – main field of study courses, S – specialization courses

Optional subjects / groups of classes 24 ECTS points

No.	Subject / groups of classescode	Name of subject / groups of classes (denote group of courses with symbol **GK**)	Weekly number of hours					Learning effect symbol	Number of hours		Number of ECTS points			Form[2] of subject / groups of classes	Way[3] of crediting	Subject / groups of classes			
			lec	cl	lab	pr	sem		ZZU	CNPS	Total	DN[5] classes	BU[1] classes			University -wide[4]	Concerning scientific activities[5]	Practical[6]	Type[7]
1	W03W03-SM2055D	Graduate laboratory II			14			K2Ace_U08; K2Ace_U09; K2Ace_U13; K2Ace_K01; K2Ace_K05; K2Ace_K07	210	500	20	20	9,5	T	Z		DN	P	K
2	W03W03-SM2056S	Graduation seminar					1	K2Ace_U11 K2Ace_U14; K2Ace_K01; K2Ace_K06; K2Ace_K07; K2Ace_K08	15	50	2	2	0,7	T/Z	Z		DN	P	K
3	W03CET-SM20BW	Elective course*	2					K2Ace_W06; K2Ace_K01; K2Ace_K07	30	50	2		1,3	T/Z	Z				K
		Total	**2**		**14**		**1**		**255**	**600**	**24**	**22**	**11,5**					**22**	

Altogether in semester

Total number of hours					Total number of ZZU hours	Total number of CNPS hours	Total number of ECTS points	Total number of ECTS points for DN classes[5]	Number of ECTS points for BU classes[1]
lec	cl	lab	pr	sem					
4		**17**		**1**	**330**	**750**	**30**	**28**	**14,2**

[1]BU – number of ECTS points assigned to hours of classes requiring direct participation of academic teachers and other persons conducting classes
[2]Traditional – enter T, remote – enter Z
[3]Exam – enter E, crediting – enter Z. For the group of classes – after the letter E or Z - enter in brackets the final subject form (lec, cl, lab, pr, sem)
[4]University-wide subject /group of classes – enter O
[5]DN - number of ECTS points assigned to the classes related to the University's academic activity in the discipline/disciplines to which the main field of study is assigned
[6]Practical subject / group of classes – enter P. For the group of classes – in brackets enter the number of ECTS points assigned to practical courses
[7]KO – general education courses, PD – basic sciences courses, K – main field of study courses, S – specialization courses

2. Set of examinations in semestral arrangement

Subject / groups of classescode	Names of subjects / groups of classesending with examination	Semester
W03W03-SM2028W	Fundamentals of chemical and process engineering	1
W03W03-SM2029W	Bioreactors	
W03W03-SM2030W	Fundamentals of chemical technology design	
W03CET-SM2012W	Advanced Chemical Technologies – Biorefinery technologies for chemicals and fuels	2
W03CET-SM2013W	Surface Phenomena and Heterogenous Catalysis	
W03CET-SM2016W	Advanced Chemical Technologies – Modern macromolecular engineering materials	3
W03CET-SM2018W	Chemical reactors and bioreactors	
W03CET-SM2010W	Green chemistry and sustainable technology	
W03CET-SM2020W	Advanced Chemical Technologies – Nanotechnologies and Energy	4

3. Numbers of allowable deficit of ECTS points after particular semesters

Semester	Allowable deficit of ECTS points after semester
1	15
2	15
3	15
4	0

[1]BU – number of ECTS points assigned to hours of classes requiring direct participation of academic teachers and other persons conducting classes
[2]Traditional – enter T, remote – enter Z
[3]Exam – enter E, crediting – enter Z. For the group of classes – after the letter E or Z - enter in brackets the final subject form (lec, cl, lab, pr, sem)
[4]University-wide subject /group of classes – enter O
[5]DN - number of ECTS points assigned to the classes related to the University's academic activity in the discipline/disciplines to which the main field of study is assigned
[6]Practical subject / group of classes – enter P. For the group of classes – in brackets enter the number of ECTS points assigned to practical courses
[7]KO – general education courses, PD – basic sciences courses, K – main field of study courses, S – specialization courses

Opinion of student government legislative body

.....	.....
Date	Name and surname, signature of student representative

.....	.....
Date	Dean’s signature

[1]BU – number of ECTS points assigned to hours of classes requiring direct participation of academic teachers and other persons conducting classes
[2]Traditional – enter T, remote – enter Z
[3]Exam – enter E, crediting – enter Z. For the group of classes – after the letter E or Z - enter in brackets the final subject form (lec, cl, lab, pr, sem)
[4]University-wide subject /group of classes – enter O
[5]DN - number of ECTS points assigned to the classes related to the University's academic activity in the discipline/disciplines to which the main field of study is assigned
[6]Practical subject / group of classes – enter P. For the group of classes – in brackets enter the number of ECTS points assigned to practical courses
[7]KO – general education courses, PD – basic sciences courses, K – main field of study courses, S – specialization courses

KARTY PRZEDMIOTÓW

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 **Zaawansowane technologie chemiczne – technologie biorafineryjne dla chemikaliów i paliw**

Name of subject in English : **Advanced Chemial Technologies – Biorafinery technologies for chemicals and fuels**

Main field of study (if applicable): Chemical Engineering and Technology

Specialization (if applicable): Advanced Chemical Technology

Profile: academic

Level and form of studies: 2nd level, full-time

Kind of subject: obligatory

Subject code W03CET-SM2012W, W03CET-SM2012L, W03CET-SM2012S

Group of courses: NO

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	15		45		15
Number of hours of total student workload (CNPS)	25		100		25
Form of crediting (Examination / crediting with grade)	exam		crediting with grade		crediting with grade
For group of courses mark (X) final course					
Number of ECTS points	1		4		1
including number of ECTS points for practical classes (P)			4		1
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	0,6		1,8		0,6

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

n/a

SUBJECT OBJECTIVES

C1 to familiarize students with biorefinery systems for the production of chemicals
C2 presentation of issues related to fuel production in biorefineries
C3 developing the student's skills in planning and conducting technological and biotechnological processes

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01 the student has advanced knowledge of modern biorefinery technologies focused on the production of chemicals and fuels

PEU_W02 the student knows the principles of sustainable development in relation to biorefineries

PEU_W03 the student knows the latest trends in the development of biorefinery systems

relating to skills:

PEU_U01student is able to plan and carry out biomass conversion processes towards biofuels

PEU_U02 the student is able to plan and carry out biomass conversion processes towards chemicals

PEU_U03 the student critically processes the information obtained in the field of processes and technologies used in biorefineries, is able to discuss

PEU_U04 the student demonstrates the ability to work in a team

relating to social competences:

PEU_K01 the student is ready to critically evaluate his knowledge

PEU_K02 is aware of the importance of technical and non-technical aspects related to the operation of a biorefinery, also in the context of environmental protection and sustainable development goals

PROGRAMME CONTENT

	Lecture	**Number of hours**
Wy1	Principles of a sustainable biorefinery. Biomass resources for use in biorefineries.	2
Wy2-Wy4	Biorefinery technologies for chemical production Biorefinery approach to the production of industrially important C4, C5 and C6 chemicals	5
Wy4-Wy6	Biorefinery technologies in the production of alternative fuels and energy. Biorefinery production of bioethanol and biomethanol. Oleorefineries. Biogas plants – production and applications of biogas.	5
Wy7	Biochemical and thermochemical microalgae	2
Wy8	Enzymes in biorefinery systems	1
	Total hours	**15**

	Laboratory	**Number of hours**
Lab 1	Occupational health and safety rules, discussion of the conditions for passing the exam	1
Lab 2	Production and characteristics of liquid biofuels	12
Lab 3	Microalgae – a modern raw material in biorefinery systems	8
Lab 4	Conversion of sugars and polysaccharides into chemicals	12
Lab 5	Production and characterization of fine chemicals	12
	Total hours	45

Seminar	**Number of hours**

Se1	Biorefineries in the concept of sustainable development	2
Se2	Levulinic acid – a modern chemical platform	2
Se3	Biofuels – bioethanol, biomethanol	2
Se4	Biofuels – biodiesel	2
Se5	Biodegradable polymers as environmentally friendly materials	2
Se6	Microalgae – a modern raw material in biorefinery systems	2
Se7	Bioactive phytochemicals. Preparation, characteristics and applications.	2
Se8	Summary discussions	1
	Total hours	15

TEACHING TOOLS USED

N1. Multimedia presentation
N2. Discussion
N3. Case study
N4. Laboratory instructions

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
F1=P (lecture)	PEU_W01-PEU_W03, PEU_K01	Exam result (50% of points required to pass) + 10% for activity (possibility of increasing the grade by 0.5)
F2=P (laboratory)	PEU_U01, PEU_U02, PEU_U04, PEU_K01	Grades from reports, evaluation of laboratory work, activity
F3=P (seminar)	PEU_U03, PEU_U04, PEU_K01, PEU_K02	Quality of presentation, assessment of individual and group work

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Biorefineries: Production of Fuels and Platform Chemicals, Wiley&Sons 2024, ISBN-13: 9781119724728
[2] Biorefinery: A Sustainable Approach for the Production of Biomaterials, Biochemicals and Biofuels, Springer 2023
[3] Biorefinery Integrated Sustainable Processes for Biomass Conversion to Biomaterials, Biofuels, and Fertilizers, Springer 2019

SECONDARY LITERATURE:

[1] Specialized literature provided by the teacher at the beginning of the class
[2] Laboratory instructions

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

Team of lecturers

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 Nowoczesne wielkocząsteczkowe materiały inżynierskie
Name of subject in English Modern macromolecular engineering materials
Main field of study (if applicable): Chemical Engineering and Technology
Specialization (if applicable): Advanced Chemical Technologies
Profile: academic
Level and form of studies: 2nd level studies, full-time
Kind of subject: obligatory
Subject code W03CET-SM2016W, W03CET-SM2016L
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		credit		
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. Basic knowledge of polymer chemistry and physical chemistry.

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SUBJECT OBJECTIVES

C1 to acquaint students with the current knowledge of advanced polymeric engineering materials
C2 to acquaint students with the properties, methods of production and areas of application of macromolecular compounds
C3 to familiarize students with 3D printing techniques, polymer processing and recycling methods.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

Student, who has completed the course:
PEU_W01has knowledge of the properties of polymeric engineering materials.
PEU_W02 knows the basic methods of obtaining polymeric engineering materials.
PEU_W03 has knowledge of the application areas of polymeric engineering materials.
PEU_W04 has a basic understanding of advanced macromolecular and composite engineering materials.

relating to skills:

Student, who has completed the course:
PEU_U01 is familiar with selected 3D printing techniques
PEU_U02 is able to select the appropriate processing method to obtain the desired product form
PEU_U03 is familiar with selected mechanical and chemical recycling methods for plastics.

PROGRAMME CONTENT		
Lecture		**Number of hours**
Lec 1	Polymeric engineering materials - introduction.	2
Lec 2	Processing of polymeric engineering materials.	2
Lec 3	Laser modification of polymers.	2
Lec 4	Biomedical elastomers.	2
Lec 5	Modern natural polymers.	2
Lec 6	3D printing techniques	2
Lec 7	Polymer fibers.	2
Lec 8	Photoactive polymer materials.	2
Lec 9	Polymer recycling.	2
Lec 10	Magnetic polymer composites.	2
Lec 11	Polymer nanostructures.	2
Lec 12	Polymeric materials with ion-exchange properties.	2
Lec 13	Polymeric sorbents.	2
Lec 14	Forecasts for the development of polymeric engineering materials.	2
Lec 15	Summary of lectures and credit colloquium.	2
	Total hours	**30**
Laboratory		**Number of hours**
Lab 1	Introduction, health and safety rules and organizational information	3
Lab 2	Object-oriented design and creating details for 3D printing.	3
Lab 3	Filament production and FDM 3D printing.	3
Lab 4	Application of photoinitiated polymerization in 3D printing.	3
Lab 5	Extrusion of multilayer foil.	3
Lab 6	Plastic recycling – chemical methods.	3
Lab 7	Plastic recycling – mechanical methods.	3
Lab 8	Polymer hydrogels.	3
Lab 9	Electrospinning of nanofibers.	3
Lab 10	Magnetic polimer composites.	3
Lab 11	Biomedical elastomers.	3
Lab 12	Polymeric porous materials.	3
Lab 13	Polymeric materials with ion-exchange properties.	3
Lab 14	Polymeric sorbents.	3
Lab 15	Making up for not completed exercises.	3
	Total hours	**45**

TEACHING TOOLS USED

N1. Multimedia presentation
N2. Problem lecture

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
F1	PEU_U01 – PEU_U03	Summary reports
F2	PEU_U01 – PEU_U03	Final test
P1 (lecture)	PEU_W01 – PEU_W04	Final test
P2 (laboratory)	grade = (F1 + F2) / 2	

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Elnashar, M., Biopolymers, 2019, IntechOpen.
[2] Han, C.D., Rheology and Processing of Polymeric Materials Volume 2: Polymer Processing, 2006, Oxford University Press
[3] Su W.-F., Principles of Polymer Design and Synthesis, 2013, Springer
[4] Niaounakis, M., Biopolymers: Processing and Products, 2015, Elsevier

SECONDARY LITERATURE:

[1] Ji, W. (Ed.), Smart Polymer Hydrogels: Synthesis, Properties and Applications - Volume I, 2023, MDPI

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

Konrad Szustakiewicz, Ph.D., prof. PWr, konrad.szustakiewicz@pwr.edu.pl

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:	**Zaawansowane Technologie Chemiczne – nanotechnologie i energia**
Name of subject in English:	**Advanced Chemical Technologies – Nanotechnologies and Energy**
Main field of study:	Chemical Engineering and Technology
Specialization (if applicable):	Advanced Chemical Technology
Profile:	academic
Level and form of studies:	2nd level, full-time
Kind of subject:	obligatory
Subject code:	W03CET-SM2020W, W03CET-SM2020L
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)	50		100		
Form of crediting (Examination / crediting with grade)	exam		crediting with grade		
For group of courses mark (X) final course					
Number of ECTS points	2		4		
including number of ECTS points for practical classes (P)			4		
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1,2		1,8		

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1.

SUBJECT OBJECTIVES

C1 advanced knowledge mastery by students in the field of nanotechnology, production of nanomaterials, their characterization and applications

C2 familiarizing students with issues related to the use of nanomaterials and nanotechnologies in modern systems of energy production, storage and conversion

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01 the student has advanced knowledge in the production of modern materials aimed at generating, storing and converting energy

PEU_W02 the student knows the latest trends in the development of nanotechnology

relating to skills:
PEU_U01student is able to plan and carry out nanomaterials production processes
PEU_U02 the student is able to characterize nanomaterials in terms of their suitability for the production and storage of energy and/or fuels
PEU_U03 the student critically processes the acquired information in the field of nanotechnology and nanomaterials
PEU_U04 the student demonstrates the ability to work in a team

relating to social competences:
PEU_K01 the student is ready to critically evaluate his knowledge
PEU_K02 is aware of the importance of technical and non-technical aspects related to the production and use of nanomaterials, also in the context of environmental protection and sustainable development goals

PROGRAMME CONTENT

Lecture		**Number of hours**
Lec 1	Nanomaterials: review of synthesis methods, classifications, characterization and applications	2
Lec 2	Fullerenes. Synthesis methods, structure, functionalization, properties and applications.	2
Lec 3	Nanofibers and carbon nanotubes. Synthesis methods, structure, functionalization, properties and applications	2
Lec 4	Graphene and graphene oxide. Synthesis methods, properties and potential applications.	2
Lec 5	Metal nanoparticles. Synthesis, characterization, applications.	2
Lec 6-7	Ceramic nanomaterials. Synthesis strategies, properties, applications and prospects.	4
Lec 8-9	Applications of nanotechnology. The role of nanoscience in the development of societies - Medical applications and health care. Introduction to energy applications.	4
Lec 10-12	Nanotechnology in solar cells: applications under development. Nanotechnologies and energy production, storage and conversion.	6
Lec 13	Electrocatalysts. Hydrogen production from water.	2
Lec 14	Nanomaterials in fuel production technologies	2
Lec 15	The future of nanotechnology – summary discussion	2
	Total hours	**30**

Laboratory		**Number of hours**
La1	Safety rules for work in the laboratory and rules for passing the course.	2
La2-La8	Synthesis and characterization of nanostructures and nanosystems	20
La9-La14	Applications of nanostructures and nanosystems	20
La15	Summary lab	3
	Total hours	45

TEACHING TOOLS USED

N1. Multimedia presentation N2. Discussion N3. Case study N4. Laboratory instructions

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
P (lecture)	PEU_W01-PEU_W02, PEU_K01 PEU_K02	Exam result (50% of points required to pass) + 10% for activity (possibility of increasing the grade by 0.5)
P (laboratory) P=0,7xF1+0,2xF2+0,1xF3	PEU_U01-PEU_U04, PEU_K01 PEU_K02	Grades from reports, evaluation of laboratory work, activity

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Nanomaterials for Sustainable Energy Applications, S. P. Kumar, CRC Press Inc. 2023
[2] Nanomaterials: An Introduction to Properties, Synthesis and Applications, E. Craig, Larsen and Keller Education 2019
[3] Nanostructures and Nanomaterials, W. Ying, C. Guozhong, World Scientific Publishing Company 2011

SECONDARY LITERATURE:

[1] Specialized literature provided by the teacher at the beginning of the class
[2] Laboratory instructions

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

Team of lecturers

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: Zaawanasowana analiza danych eksperymentalnych
Name of subject in English: Advanced analysis of experimental data
Main field of study (if applicable): Chemical Engineering and Technology
Specialization (if applicable): ……..
Profile: practical
Level and form of studies: 2nd level
Kind of subject: optional
Subject code W03CET-SM2102C
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**			
For group of courses mark (X) final course					
Number of ECTS points		**2**			
including number of ECTS points for practical classes (P)		2			
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)		**1,2**			

*delete as not necessary

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Knowledge of academic courses: mathematical analysis and linear algebra
2. Knowledge of the basics of statistics
3. Knowledge of Excell
4. Knowledge of the principles of presentation of results

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SUBJECT OBJECTIVES

C1. To indicate the principle of correct elaboration and presentation of research and experimental results
C2. To learn advanced statistical methods
C3. To learn the practical application of linear regression and correlation
C4. To learn the principles of using optimization plans in process optimization
C5. To acquire the ability to analyze normality of distribution and homogeneity of variance.
C6. To learn the practical application of correlation

C7. To learn the methods of analyzing the significance of statistical differences and their interpretation

SUBJECT EDUCATIONAL EFFECTS

Relating to knowledge:

PEU_W01 - The student defines the basic concepts of statistics
PEU_W02 - The student knows the principles, objectives and stages of results analysis
PEU_W03 - Student knows the statistical tests that allow to reject extreme results with large measurement error
PEU_W04 - Student knows the principles of using linear regression analysis
PEU_W05 - Student knows the principles of determining normality distribution, homogeneity of variance
PEU_W06 - Student knows methods of correlation determination
PEU_W07 - Student knows statistical tests that allow to determine statistically significant differences.

Relating to skills:

PEU_U01 - The student correctly interprets and presents the results
PEU_U02 - Student is able to reject erroneous results
PEU_U03 - The student is able to apply linear regression
PEU_U04 - The student is able to determine normality of the distribution of results and assess homogeneity
PEU_U05 - Student can determine the relationship between results by using correlation
PEU_U06 - Student can determine the presence of statistically significant differences
PEU_U07 - Student can select and apply appropriate statistical tests to assess the significance of statistical differences

Relating to social competences:

PEU_K01 - The student is aware of the need to analyze and process the results
PEU_K02 - The student is aware of the need to interpret the results and look for relationships between them

PROGRAMME CONTENT

	Classes	**Number of hours**
Cl 1	Introductory classes. Introduction to statistical processing of results. Significant digits. Measurement error. Graphical presentation of results.	3h
Cl 2	Rejection of extreme results.	3h
Cl 3	Linear regression.	3h
Cl 4	Determination of optimal parameters.	3h
Cl 5	Test 1	3h
Cl 6	Analysis of normality of distribution and homogeneity of variance.	3h
Cl 7	Correlations	3h
Cl 8	Statistically significant differences - comparison of two groups	3h
Cl 9	Statistically significant differences - comparison of more than two groups	3h
Cl 10	Test 2	3h

	Total hours	**30h**

TEACHING TOOLS USED

N1. Multimedia presentation
N2. Computer software - Excel and Statistica
N3. Case study
N4. Working with the results
N5. Problem-based lecture
N6. Own work

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
F1	PEU_W01-W04, PEU_U01-U03 PEU_K01-K02	Test 1
F2	PEU_W04-W07 PEU_U04-U07 PEU_K01-K02	Test 2

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Frost J.:Introduction to Statistics: An Intuitive Guide for Analyzing Data and Unlocking Discoveries, 2020
[2] Frost J.: Regression Analysis: An Intuitive Guide for Using and Interpreting Linear Models, 2020
[3] Carlberg C.: Statistical Analysis: Microsoft Excel, 2017
[4] de Smith M.: Statistical Analysis Handbook, 2018

SECONDARY LITERATURE:

[1] Cowan G.: Statistical Data Analysis (Oxford Science Publications), 1997
[2] www.statsoft.pl

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

Dr inż. Grzegorz Izydorczyk, grzegorz.izydorczyk@pwr.edu.pl

Zał. nr 5 do ZW 78/2023

Attachment no. 4. to the Program of Studies

FACULTY CHEMISTRY

SUBJECT CARD

Name of subject in Polish Biokataliza w przemyśle spożywczym, browarniczym i farmaceutycznym
Name of subject in English Biocatalysis in food, brewery and pharmaceutical industry
Main field of study (if applicable): Chemical Engineering and Technology
Specialization (if applicable): Advanced Chemical Engineering
Profile: academic
Level and form of studies: 2nd level
Kind of subject: obligatory
Subject code W03CET-SM2007W, W03CET-SM2007L, W03CET-SM2007S
Group of courses NO

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	15		45		15
Number of hours of total student workload (CNPS)	50		75		25
Form of crediting (Examination / crediting with grade)	exam		crediting with grade		crediting with grade
For group of courses mark (X) final course					
Number of ECTS points	**2**		3		1
including number of ECTS points for practical classes (P)			3		1
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	0,6		1,8		0,6

1w+3l +1s (2+3+1 ECTS).

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1.Fundamentals of physical chemistry
2 Fundamentals of chemical engineering

SUBJECT OBJECTIVES

C1 To become familiar with the concepts of industrial biotechnology.
C2 To become familiar with methods of obtaining and characterising bioproducts.
C3 To become familiar with the possible applications of enzyme and microorganism in food, brewery and pharmaceutical industry.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:
PEU_W01 Knows the concepts of industrial biotechnology.
PEU_W02 Has knowledge of methods of obtaining bioproducts.
PEU_W03 Has knowledge of techniques for biocatalysis in industry.
PEU_W04 Knows the applications of industrial biotechnology in various fields

relating to skills:
PEU_U01 Can select a method and synthesise a chosen bioporoduct.
PEU_U02 Can carry out investigations of bioproduct properties and their characterisation using specialised equipment
PEU_U03 Can analyse and process the obtained test results
PEU_U04 Can find in literature the information about bioprocesses and present them to another students.

relating to social competences:
PEU_K01 Is able to cooperate in a laboratory group
PEU_K02 Feels responsible for the results of the assigned task

PROGRAMME CONTENT

Lecture		**Number of hours**
Lec 1	Biocatalysis in food industry: dairy, bakery.	2
Lec 2	Production of protein and peptide preparations.	2
Lec 3	Organic acid production	2
Lec 4	fermented beverage industry	2
Lec 5	vaccine production	2
Lec 6	antibiotics production	2
Lec 7	production of enzyme preparations	
Lec 8	Written course credit	1
	Total hours	**15**

production of food supplements

Laboratory		**Number of hours**
La1	Analytical methods for monitoring biocatalytic processes	5
La2	Beer production – part 1	5
La3	Enzymatic catalysis - determination of reaction kinetic parameters	5
La4	Production of an immobilized biocatalyst of industrial importance	5
La5	Production of lactose-free milk	5
La6	Cold pasteurization of milk using catalase	5
La7	Hydrolysis of penicillin G in a stirred batch reactor	5
La8	Selection of the degree of conversion of D-glucose to D-fructose in a packed bed column (immobilized enzyme)	5
La9	Beer production – part 2	5
	Total hours	45

Seminar		**Number of hours**
Se1	Biocatalysis in food industry	6

Se2	Biocatalys in brewery and winery.	3
Se3	Biocatalysis in pharmaceutical industry.	6
	Total hours	15

TEACHING TOOLS USED
N1. Lecture with multimedia presentation N2. Laboratory instructions N3. Laboratory workstations N4. Students presentation.

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
P (lecture)	PEU_W01 PEU_W02 PEU_W03 PEU_W04	Credit test
F1 (laboratory) P=F1	PEU_U01 PEU_U02 PEU_U03 PEU_K01 PEU_K02	Laboratory exercise reports (arithmetic mean)
P (seminar)	PEU_U04	presentation
3.0 jeżeli 3.00 ≤ P < 3.25 3.5 jeżeli 3.25 ≤ P < 3.75 4.0 jeżeli 3.75 ≤ P < 4.25 4.5 jeżeli 4.25 ≤ P < 4.75 5.0 jeżeli 4.75 ≤ P		

PRIMARY AND SECONDARY LITERATURE
PRIMARY LITERATURE:
[1] V.Beschkov, D.Yankov, Downstream Processing in Biotechnology, De Gruyter 2021 [2] N.Dunford, Food and Industrial Bioproducts and Bioprocessing, Iowa State University Press 2020
SECONDARY LITERATURE:
[3] PDF presentation
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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 Optymalizacja i zarządzanie procesami chemicznymi
Name of subject in English Chemical Process Optimisation and Management
Main field of study (if applicable): Chemical Engineering and Technology
Specialization (if applicable): Advanced Chemical Engineering.
Profile: academic / practical*
Level and form of studies: 2nd level, full-time / part-time*
Kind of subject: obligatory
Subject code W03CET-SM2011W, W03CET-SM2011P
Group of courses NO

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	15			60	
Number of hours of total student workload (CNPS)	50			100	
Form of crediting (Examination / crediting with grade)	crediting with grade			crediting with grade	
For group of courses mark (X) final course					
Number of ECTS points	2			4	
including number of ECTS points for practical classes (P)				4	
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	0,6			2,4	

*delete as not necessary

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Basic knowledge of unit processes and equipment solutions in chemical engineering and technology.
2. Basic knowledge of chemical process design.
3. Basic knowledge and skills in the field of computer-aided design and optimization of chemical processes

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SUBJECT OBJECTIVES

C1. Obtaining basic knowledge about designing industrial installations and managing the manufacturing process
C2. To familiarize students with the concepts of production economics.
C3. Understanding and practical application of knowledge about modeling and optimization of chemical processes
C4. Understanding the principles of developing project documentation.
C5. Understanding the principles of integrated process design.
C6. Acquiring the ability to present work results.
C7. Acquiring the ability to use specialized computer software to design and optimize chemical processes

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01 – Has basic knowledge of designing industrial installations and managing the manufacturing process

PEU_W02 – Has the knowledge needed to develop an economic analysis of an industrial installation used to obtain a product with the required parameters.

PEU_W03 – Knows methods of optimizing unit processes and technological lines.

relating to skills:

PEU_U01 – Is able to prepare basic design documentation.

PEU_U02 – Is able to perform process optimization calculations.

PEU_U03 – Is able to select a sequence of unit operations for a technological process.

PEU_U04 – Is able to make an economic analysis of a chemical installation.

PEU_U05 – Is able to use selected computer programs to design and optimize industrial installations

PEU_U06 – Is able to present the goals and results of scientific work in the form of an oral presentation using modern information and communication techniques.

relating to social competences:

PEU_K01 – Is ready to act and think in an entrepreneurial way.

PEU_K02 – Is able to cooperate in a project group.

PEU_K03 – Is able to present the results of work.

PROGRAMME CONTENT

Lecture		**Number of hours**
Lec 1	Design basics	2
Lec 2	Mass and energy balances	2
Lec 3	Technical drawings	2
Lec 4	Technological diagrams and control and measurement equipment	2
Lec 5	Modeling and optimization	2
Lec 6	Cost estimates and management	2
Lec 7	Waste management	2
Lec 8	Test	1
	Total hours	**15**

Classes		**Number of hours**
Cl 1		
Cl 2		
Cl 3		
Cl 4		
..		
	Total hours	

Laboratory		**Number of hours**
Lab 1		
Lab 2		

Lab 3		
Lab 4		
Lab 5		
…		
	Total hours	

Project		**Number of hours**
Part I		
Pr1	Analysis of the selected technology and presentation of the process concept. Presentation of the schematic diagram and mass balance.	4
Pr2	Development of the process flow diagram and selection of control and measurement equipment	4
Pr3	Process modeling and optimization.	4
Pr4	Preparation of an executive or assembly drawing of one of the devices used (or its parts)	4
Pr5	Development of a spatial layout diagram,, installation view. Preparation of a piping and instrumentation diagram	4
Pr6	Preparation of cost estimate	4
Pr7	Preparation of a multimedia presentation. Presentation rules	4
Part II		
Pr8	SuperProdesigner introduction.	4
Pr9	Process timeline. Up-stream and down-stream processes	4
Pr10	Order and costs of processes.	4
Pr11	Membrane processes. Diffusion processes.	4
Pr12	Gantt graphs. Resources management. Economical analysis.	4
Pr13	Optimal process parameters. Optimalisation of construction.	4
Pr14	Bottlenecks. Environmental impact of designed proces.	4
Final part		
Pr15	Project defenses (part 1 and 2)	2+2
	Total hours	60

Seminar		**Number of hours**
Semin 1		
Semin 2		
Semin 3		
…		
	Total hours	

TEACHING TOOLS USED

N1. Lecture with multimedia presentation.
N2. Preparation and presentation of the project.
N3. Preparation of design documentation using computer program packages.
N4. Use of specialized software to create projects
N5. Consultations

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
F1(Lecture)	PEU_W01 - PEU_W03	Test
P1 = F1		P1 = F1
F2 (proj. Part I)	PEU_U01 - PEU_U06 PEU_K01 - PEU_K06	Completed project
F3 (proj. Part II)	PEU_U01 - PEU_U06 PEU_K01 - PEU_K06	The project made using specialized software
P2 = (F2+F3)/2		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] B. Sujak-Cyrul, Quality management systems: an introduction to the project of documenting and audit of quality management systems, Wrocław, Wrocław University of Technology; Łódź: PRINTPAP, 2011.
[2] S.E. Windsor, An introduction to green process management, Milwaukee, Wis.: ASQ Quality Press, cop. 2011.
[3] F.N. Fraser, Global engineering economics, Financial decision making for engineers, 4th Ed., Prentice Hall, Toronto, 2009.
[4] E. Heinzle, A.P. Biwer, C.L. Cooney - Development of Sustainable Bioprocesses: Modeling and Assessment, Viley 2006.
[5] L.T. Blank, A. Tarquin, Engineering Economy, 6th Ed., McGraw-Hill, Boston, 2005.
[6] R. Turton, R. C. Bailie, W. B. Whiting, J. A. Shaeiwitz, D. Bhattacharyya, Analysis, Synthesis and Design of Chemical Processes, 4th Edition, Prentice Hall, 2012.
[7] W.D. Seider, D.R. Lewin, J.D. Seader, S. Widagdo, R. Gani, K- Ming. Ng, Product and Process Design Principles: Synthesis, Analysis and Evaluation, 4th Edition, Wiley, 2016.

SECONDARY LITERATURE:

[1] Woodard & Curran, Inc., Industrial Waste Treatment Handbook, Elsevier, 2006.
[2] H.V. Mott, Environmental Process Analysis: Principles and Modeling, Wiley, 2013.
[3] R.G. Harrison, P. Todd, S.R. Rudge, D.P. Petrides - Bioseparations Science and Engineering, Oxford, 2002.
[4] SuperPro Designer user manual.

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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 Projektowanie procesów chemicznych z użyciem obliczeń CFD
Name of subject in English Chemical Process Project with CFD calculations
Main field of study (if applicable): Chemical Engineering and Technology
Specialization (if applicable): Advanced Chemical Engineering
Profile: academic ~~/ practical~~*
Level and form of studies: ~~1st/~~ 2nd level, ~~uniform magister studies~~*, full-time ~~/ part-time~~*
Kind of subject: obligatory ~~/ optional / university-wide~~*
Subject code W03CET-SM2006W, W03CET-SM2006P
Group of courses ~~YES~~ / NO*

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	15			60	
Number of hours of total student workload (CNPS)	50			100	
Form of crediting (Examination / crediting with grade)	crediting with grade			crediting with grade	
For group of courses mark (X) final course					
Number of ECTS points	2			4	
including number of ECTS points for practical classes (P)				4	
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	0.6			2,4	

*delete as not necessary

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Knowledge of mathematics at a level that allows to understand the transport equations in single- and multi-phase systems, with laminar and turbulent flow
2. Knowledge of the fundamentals of momentum, heat and mass transfer in chemical devices

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SUBJECT OBJECTIVES

C1. Acquainting students with the basics of CFD methods and their areas of application
C2. Acquire basic skills to perform CFD calculations of momentum, heat and mass transfer in laminar and turbulent flow, in single and multiphase, steady and transient systems, with the help of a selected software package
C3. Acquiring basic skills in the design and optimization of apparatus construction used in the chemical industry using CFD methods
C4. Familiarization with modern programs for simulation and design of chemical installations
C5. Teaching how to perform simulation calculations and design of chemical installations
C6. Teaching how to search and process calculation results

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:
PEU_W01 - knows the principles of building mathematical models of processes and solving them using CFD methods
relating to skills:

PEU_U01 - can build a mathematical model of the process and perform simulation calculations using specialized software
PEU_U02 - is able to perform design calculations of selected unit operations with the use of specialized software
relating to social competences:
PEU_K01 - can work in a group

PROGRAMME CONTENT

Lecture		Number of hours
Lec1	Familiarization with the basics of CFD methods, their advantages and disadvantages, area of application	1
Lec2	Presentation of the equations of momentum, heat and mass transport of a Newtonian fluid for laminar one phase flow.	1
Lec3	Definition of turbulence, different approaches to the description of turbulent flows	1
Lec4	Presentation of turbulence models	1
Lec5	Different ways of describing the boundary zone	1
Lec6	Presentation of numerical basics of methods for solving momentum, heat and mass transport equations (difference and finite element methods, control volume method)	1
Lec7	Interpolation Schemes and pressure calculation	1
Lec8	Description of boundary conditions	1
Lec9	Numerical mesh (different types and ways of generation)	1
Lec10	Methods for evaluating and improving the quality of the numerical mesh	1
Lec11	General classification of multiphase models	1
Lec12	VOF and Level Set models	1
Lec13	Euler-Euler and Euler-Lagrange models	1
Lec14	Selection of a multiphase model	1
Lec15	Selection of the right computer hardware for CFD calculations	1
	Total hours	**15**
Project		**Number of hours**
Pr1	Introduction. Flash simulation.	2
Pr2	Distillation process simulation	2
Pr3	Sensitivity analysis	2
Pr4	Design specification	2
Pr5	Physical property analysis	2
Pr6	Physical property estimation	2
Pr7	Detailed design of heat exchanger	2
Pr8	Test I	2
Pr9	Chemical reactor simulation	2
Pr10	Chemical plant optimization	2

Pr11	Design of distillation column	2
Pr12	Parameter regression	2
Pr13	Analysis of heat exchanger network	2
Pr14	Synthesis of heat exchanger network	2
Pr15	Test II	2
Pr16	Basic information about the CFD package user interface, navigating in the program, solving a simple laminar flow example in a pipe, creating simple geometry, generating a mesh, defining boundary conditions	2
Pr17	Simulation of a single-phase laminar flow in different chemical devices in 2D, 2D axisymmetric and 3D geometry, comparison of results	2
Pr18	Simulation of a single-phase turbulent flow in various chemical devices in 2D, 2D axisymmetric and 3D geometry, application of different turbulence models, comparison of results	2
Pr19	Simulation of the heat conduction in various chemical apparatuses	2
Pr10	Simulation of the heat conduction with convection and radiation in various chemical apparatuses	2
Pr21	Simulation of a flow with diffusion and chemical reaction	2
Pr22	Simulation of a one phase isothermal, unsteady flow	
Pr23	Simulation of a one phase transient flow with heat transfer	2
Pr24	Simulation of a multiphase flow with the use of VOF model	2
Pr125	Simulation of a gas-solid flow with the use of Euler-Euler model	2
Pr26	Simulation of a liquid-liquid flow with the use of Euler-Euler model	2
Pr27	Determination of particle trajectories in a multiphase flow using the Euler-Lagrange model	2
Pr28	Project of the optimalization of a jet pump by means of CFD methods	2
Pr29	Project of the optimalization of a heat exchanger by means of CFD methods	2
Pr30	Test III	2
	Total hours	**60**

TEACHING TOOLS USED
N1. Lecture with multimedia presentation N2. Computer simulation

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
P (lecture)	PEU_W01	Final examination
F1	PEU_U01 PEU_U02 PEU_U03	Test I
F2	PEU_U01 PEU_U02 PEU_U03	Test II
F3	PEU_U01	Test III
F4	PEU_U01 PEU_U02 PEU_U03 PEU_K01	Evaluation of the project

P = (F1 + F2 + F3+F4)/4 Each test and project must be passed with a positive grade.

3,0 if 3,00 ≤ P < 3,25

3,5 if 3,25 ≤ P < 3,75

4,0 if 3,75 ≤ P < 4,25

4,5 if 4,25 ≤ P < 4,75

5,0 if 4,75 ≤ P

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] [1] J. D. Anderson, Computational Fluid Dynamics: The Basics with Application, McGraw-Hill, New York 1995

[2] [2] R. Shefflan, Teach Yourself the Basics of AspenPlus, John Wiley & Sons, 2011

SECONDARY LITERATURE:

[1] Ansys Fluent Help

[2] Comsol Multiphysics Help

[3] R. Smith, Chemical Process Design and Integration, Wiley 2005 R. Turton et al., Analysis, Synthesis, and Design of Chemical Processes, Prentice Hall 2009

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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 Aparaty inżynierii chemicznej

Name of subject in English Chemical Processes Equipment

Main field of study (if applicable): Chemical Engineering and Technology

Specialization (if applicable): Advanced Chemical Engineering

Profile: academic / ~~practical~~*

Level and form of studies: ~~1st/~~ 2nd level~~, uniform magister studies~~*, full-time ~~/ part-time~~*

Kind of subject: obligatory ~~/ optional / university-wide~~*

Subject code W03CET-SM2001W, W03CET-SM2001P

Group of courses ~~YES /~~ NO*

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	15			60	
Number of hours of total student workload (CNPS)	50			100	
Form of crediting (Examination / crediting with grade)	E			crediting with grade	
For group of courses mark (X) final course					
Number of ECTS points	2			4	
including number of ECTS points for practical classes (P)				4	
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	0,6			2,4	

*delete as not necessary

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Fundamentals of physics and general chemistry.
2. Understanding of energy, power, heat and mass transfer concepts.
3. Understanding of thermodynamics rules.
4. Basics of calculus.
5. Knowledge of the international system of units (SI).
6. Knowledge of the principles of technical drawing.
7. The ability to use AutoCAD.

SUBJECT OBJECTIVES

C1 Acquaintance student with technological process, apparatus and equipment being part of chemical installation.

C2. Gaining by the student the basic knowledge on the work of the process equipment applied for material transportation, heat and mass transfer.

C4. Acquaintance students with the apparatus for measurement, and manual and automatic control, applied in chemical installations.

C5. Presentation of methods for searching for, processing and analyzing calculation results.

C6. Familiarization of the student with the principles of creating and reading technological schemes.

C7. The ability to use computer-aided design in the creation and modification of technological schemes.

C8. Introduction to modern software for the simulation and design of chemical plants.

C9. Acquainting with the construction of unit operations and chemical plant models.
C10. Teaching how to perform simulation and design calculations.
C11. Teaching the search and processing of obtained calculation results.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01 – knows what the technological process, production installation, and what role the different apparatus play in the process installation.
PEU_W02 – knows basic equipment applied in the chemical industry installation.
PEU_W03 – knows fundamentals of design of unit operations and selection of the apparatus and constructional materials.
PEU_W04 – knows the rules of the measurement and control equipment selection as well as safety rules applied for chemical installations.

relating to skills:

PEU_U01– Can create and read a technological scheme.
PEU_U02 – Can use the methods of computer aided design in the creation and modification of technological schemes.
PEU_U03 – Can perform sensitivity analyses, optimisation calculations and set design specifications.
PEU_U04 – Can build a mathematical process model and perform simulation calculations using professional software
PEU_U05 – Can perform design calculations of selected unit operations
PEU_U06 – Can determine the physicochemical properties of substances and phase equilibria

relating to social competences:

PEU_K01 – can discuss the problems of the work conditions and equipment selection for chemical technology installation.
PEU_K02 – can work in a team.
PEU_K03 – can appreciate the quality of an experimental result ;
PEU_K04 – can evaluate critically the veracity of statistical analysis of any data.

PROGRAMME CONTENT

Lecture		**Number of hours**
Lec1	Technological process. Unit processes and unit operations. Scheme of a technological system. Rules of the equipment selection. Equipment for raw materials, semi-products, products, and wastes storage.	2
Lec2	Means of transport for the materials. Friction losses during the process of fluids transportation in the pipelines.	2
Lec3	Equipment for grinding, mixing, sedimentation, filtration and spinning.	2
Lec4	Equipment for heat transfer.	2
Lec5	Equipment for evaporation and liquid solutions concentration.	2
Lec6	Equipment for absorption and distillation.	2
Lec8	Equipment for extraction and adsorption.	2
Lec9	Exam.	1
	Total hours	15

Project	**Number of hours**

Industrial plant engineering and design		
Pr1	Introduction into the environment of AutoCAD Plant 3D. Familiarization with the user interface. Creating and managing a project in AutoCAD Plant 3D. Files management. Familiarization with the different work spaces.	2
Pr2	Working with the specification editor and part catalog - AutoCAD Plant 3D Spec Editor.	2
Pr3-4	P&ID drawing - creating a design and a technological drawing in 2D. Inserting process equipment into the installation diagram. Pipelines. Adding fittings. Adding descriptions to the technological drawing.	4
Pr5-6	Industrial plant 3D Project - modeling of steel constructions	4
Pr7	Industrial plant 3D Project - addition and configuration of process equipment	2
Pr8-9	Industrial plant 3D Project - connecting equipment with pipelines, addition of fittings.	4
Pr10-11	Documentation - creating and printing 2D documentation in AutoCAD Plant 3D.	4
Pr12-13	Design data management and reporting in AutoCAD Plant 3D. Data exchange with other applications - AutoCAD, Inventor Professional, Excel.	4
Pr14	Preparation of final projects	2
Pr15	Presentation and submission of the final project documentation in AutoCAD Plant 3D.	2
	Sum of hours	**30**

Project		**Number of hours**
Calculation and optimisation of unit processes		
Pr1	Presentation of the principles for completing the course. Discussion of the use of simulation software in chemical and process engineering. Introduction to the Aspen Plus interface.	2
Pr2	Principles of proper selection of physical property models.	2
Pr3-4	Sensitivity analysis and design specifications.	4
Pr5-6	Analysis and estimation of physicochemical properties of pure components and mixtures.	4
Pr7	Test 1	2
Pr8	Basics of hydraulic calculations. Calculation of pressure drops in pipelines. Simulation of the operation of media displacement devices. The cavitation issue.	2
Pr9	Determination of properties of solid materials, including granular materials. Simulation of the separation of solid materials.	2
Pr10	Simulation of equilibrium distillation and rectification.	2
Pr11	Simulation of the extraction process.	2
Pr12	Types of chemical reactors. Simulation of the operation of chemical reactors.	2

Pr13	Elements of heat exchanger calculations - an introduction to Aspen Exchanger Design and Rating.	2
Pr14	Optimisation of the chemical installation	2
Pr15	Test 2	2
	Sum of hours	**30**

TEACHING TOOLS USED

N1. Lecture.
N2. Multimedia presentation.
N3. AspenPlus simulation and design software
N4. Aspen Exchanger Design and Rating program for simulation and design of heat exchangers
N5. Aspen Properties program for calculating physicochemical properties of fluids and phase equilibria
N6. Microsoft Excel program for calculation of basic unit processes
N7. Individual work in simulation software.
N8. Using Autodesk Plant 3D software, AutoCAD, Autodesk Inventor.
N9. Preparing the project.

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
P=F1 (Lecture)	PEU_W01 PEU_W02 PEU_W03 PEU_W04	Exam
P=F2 (Project)	PEU_U01 PEU_U02 PEU_K01- PEU_K04	Project preparation
P=F3 (Project)	PEU_U03 PEU_U04 PEU_U05 PEU_U06 PEU_K01- PEU_K04	Test 1 Test 2 Project preparation

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Green D.W. i Perry R.H., *Perry's Chemical Engineers' Handbook*. McGraw-Hill, 2008.
[2] Couper J., Penney W., Fair J. i Walas S.M., *Chemical engineering equipment – selection and design*. 3rd edition. Elsevier, 2012.
[3] Tickoo S., AutoCAD Plant 3D 2023 for Designers, ADCIM Technologies; 7th edition, 2022.
[4] Toghraei M., Piping and Instrumentation Diagram Development, Wiley-Aiche, 2019.
[5] R. Shefflan, Teach Yourself the Basics of AspenPlus, John Wiley & Sons, 2011.

SECONDARY LITERATURE:

[6] Tutorial Books, Introduction to AutoCAD Plant 3D 2019, Tutorial Books, 2018.

[7] R. Smith, *Chemical Process Design and Integration*, Wiley 2005.
[8] K. Al-Malah, Aspen Plus® Chemical Engineering Applications, Wiley, Hoboken, 2017.
[9] J. Haydary, Chemical Process Design and Simulation: Aspen Plus and Aspen Hysys Applications, Wiley, 2019.

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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 chemiczne i bioreaktory…….
Name of subject in English ……Chemical reactors and bioreactors…….
Main field of study (if applicable): …Chemical engineering and technology…….
Specialization (if applicable): …Advanced Chemical Technologies…..
Profile: academic
Level and form of studies: 2nd level
Kind of subject: obligatory
Subject code W03CET-SM2018W, W03CET-SM2018P
Group of courses NO

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	15			30	
Number of hours of total student workload (CNPS)	25			50	
Form of crediting (Examination / crediting with grade)	Exam			crediting with grade	
For group of courses mark (X) final course					
Number of ECTS points	1			2	
including number of ECTS points for practical classes (P)				2	
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	0,6			1,2	

*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 bioreactors

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 bioreactors

relating to skills:
PEU_U01 – student is able to determine the limiting resistance of the process in non-catalyzed heterogeneous processes and derive the process rate equation
PEU_U02– student is able to determine the limiting resistances in heterogeneous catalytic processes and derive the process rate equation
PEU_U03 – student can calculate the volume, reaction or residence time, or conversion in heterogeneous chemical reactors and bioreactors.

PROGRAMME CONTENT

Lecture		**Number of hours**
Lec 1	Optimal temperature regime	2
Lec 2	Heterogeneous reactions	1
Lec 3	Gas-liquid and liquid-liquid reaction systems	1
Lec 4	Gas-solid non-catalytic systems	1
Lec 5	Heterogeneous catalysis and catalytic kinetics	1
Lec 6	Heterogeneous catalytic reactor design	1
Lec 7	External diffusion effects in heterogeneous catalytic reactions	1
Lec 8	Diffusion and reaction in porous catalyst	1
Lec 9	Slurry reactors	1
Lec 10	Enzymatic reaction fundamentals – Enzyme-Substrate Complex, Mechanisms, Michaelis-Menten Equation. Batch reactor design.	1
Lec 11	Inhibition of enzyme reactions: competitive, uncompetitive, mixed, and substrate inhibition. Continuous stirred tank reactor.	1
Lec 12	Microbial fermentation.	1
Lec 13	Substrate-limiting microbial fermentation. Bioreactor design.	1
Lec 14	Product-limiting microbial fermentation. Bioreactor design.	1
	Total hours	15

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	4
Proj 5	Optimal temperature regime for catalytic reactor – endothermic reactions	2
Proj 6	Absorber design (chemisorption)	3
Proj 7	Gas-solid non-catalyzed system design	2
Proj 8	Catalytic reactions – determination of the process rate and reactor design	3

Proj 9	Catalytic reactor design – external diffusion effects	2
Proj10	Catalytic reactor design – diffusion in porous catalyst	2
Proj11	Enzymatic reactions – bioreactor design	3
Proj12	Microbial fermentation – bioreactor design	3
	Total hours	30

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	Exam
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.

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)

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

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 Sensory chemiczne i biosensory – podstawy i zastosowanie
Name of subject in English Chemical sensors and biosensors - fundamentals and applications
Main field of study (if applicable): Chemical Engineering and Technology
Specialization (if applicable): Advanced Chemical Technologies
Profile: academic
Level and form of studies: 2nd level, full-time
Kind of subject: obligatory
Subject code: W03CET-SM2017W, W03CET-SM2017L
Group of courses: NO

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	15		30		
Number of hours of total student workload (CNPS)	25		50		
Form of crediting (Examination / crediting with grade)	passing with a grade		passing with a grade		
For group of courses mark (X) final course					
Number of ECTS points	**1**		**2**		
including number of ECTS points for practical classes (P)	0		2		
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	0,6		1,2		

*delete as not necessary

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Knowledge in the field of inorganic, analytical, physical, organic chemistry, and physics.
2. Basic knowledge of instrumental analytical techniques.
3. Fundamental skills in analytical techniques

SUBJECT OBJECTIVES

C1. Familiarizing students with the mechanisms of operation of chemical and biosensors, as well as the detection methods used in sensing.
C2. Introducing students to the physicochemical fundamentals of the construction of chemical and biosensors.
C3. Providing students with an understanding of the potential applications of chemical and biosensors as analytical tools in medical diagnostics, bioanalytics, food analysis, and environmental protection.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01: Knows the definitions of a sensor and biosensor and has knowledge regarding the classification of sensors based on their operating principle and method of analyte detection.

PEU_W02: Understands the principles of operation (detection) of electrochemical, optical, mass, thermal, and piezoelectric sensors.

PEU_W03: Knows the receptor elements in a sensor device, understands their operation principles in various types of sensors and biosensors.

PEU_W04: Familiar with the analytical parameters of sensors and biosensors, and knows their application possibilities as analytical tools in various industries, environmental protection, and broad diagnostics.

relating to skills:

PEU_U01: Can safely conduct oneself during laboratory work.

PEU_U02: Can correctly carry out a planned experiment.

PEU_U03: Can apply instrumental techniques in designing and creating a simple analytical system.

PEU_U04: Can prepare a written report on a conducted experiment, analyze the obtained results, and draw valid conclusions.

relating to social competences:

PEU_K01: Can collaborate in a group during laboratory sessions.

PEU_K02: Is ready to effectively organize one's work, critically assess the knowledge possessed, and evaluate the progress of tasks being carried out.

PROGRAMME CONTENT

	Lecture	Number of hours
Lec 1	Definition of a sensor and a biosensor. General characteristics and structure of a sensor and a biosensor. Application of sensors. Types of chemical sensors. Classification of biosensors based on the classical operating principle. Discussion of course grading principles.	1
Lec 2	Fundamentals of chemical sensing - operational parameters of sensors: measurement range, detection limits, sensitivity, selectivity, result repeatability, response time, operational lifetime, and storage lifetime.	1
Lec 3-4	The classic classification of sensors based on the type of transducer.	2
Lec 5	Classification of biosensors based on the type of receptor (e.g., enzymes, antibodies, DNA) influencing the bioselectivity of the sensor, as well as the type of transducer affecting the sensitivity of the biosensor.	1
Lec 6-7	Fundamentals of analytical optical methods used in sensing: absorption of radiation, fluorescence, chemiluminescence, bioluminescence. Surface Plasmon Resonance (SPR). Piezoelectric phenomenon. Application of piezoelectric crystal as a mass sensor (quartz crystal microbalance). Sensors utilizing acoustic waves in piezoelectric crystals.	2
Lec 8	Biological materials used in the construction of biosensors: enzymes, tissues, cellular organelles (mitochondria, chloroplasts), microorganisms (bacteria, yeast, single-cell algae), higher organisms and their organs (e.g., insects), antibodies, nucleic acids (DNA), other biologically active compounds (e.g., hemoglobin). Indicator organisms as biosensors.	1
Lec 9	Methods of immobilizing biological material in biosensors: adsorption, cross-linking, entrapment in polymeric gels, covalent binding, microencapsulation.	1
Lec 10	Applications of sensors and biosensors in medicine, production control, analysis of food (including genetically modified food), control of biotechnological processes, environmental protection, defense, and scientific research.	1

Lec 11-12	Chip-based laboratory - LOC - Lab-on-a-chip, the concept of operation of an analytical microchip, application of LOC in chemical and biochemical analysis (medical diagnostics), use of devices in the food, cosmetic industry, and environmental protection.	2
Lec 13-14	Biomimetic sensor devices: artificial nose, artificial tongue, odor reproduction.	2
Lec 15	Prospects for the development of sensor devices: further miniaturization of devices and associated challenges, multifunctional devices, personalized diagnostics (POC, point-of-care).	1
	Total hours	15

~~Classes~~		**~~Number of hours~~**
Cl 1		
Cl 2		
Cl 3		
Cl 4		
..		
	~~Total hours~~	

Laboratory		**Number of hours**
Lab 1	Organizational activities - Occupational Health and Safety regulations, discussion of the course program, and conditions for course completion. Overview of basic electroanalytical techniques applied in sensing and biosensing (voltammetric techniques, including cyclic voltammetry - CV, pulse voltammetry - differential pulse voltammetry - DPV, chronoamperometry - CA; polarographic techniques; potentiometric techniques).	2
Lab 2	Potentiometry - direct potentiometric methods (standard addition method), application of ion-selective electrodes for determining the content of, among others, chloride, magnesium, potassium, and hydrogen ions in food products. Selectivity of ion-selective electrodes, limits of detection.	4
Lab 3	Voltammetric methods - characteristics of the working electrode (platinum, carbon, glass, and gold electrodes). Selection of the reference electrode. Preparation of electrodes for work, storage, cleaning, measurements, and selection depending on the depolarizer used.	4
Lab 4	Constant current voltammetry techniques in sensing - determination of N-acetyl-4-aminophenol (paracetamol) using cyclic voltammetry (CV) and differential pulse voltammetry (DPV).	4
Lab 5	Semiconductor structures in sensing - electrode modification. Electropolymerization of conjugated systems (e.g., aniline and its derivatives) using voltammetric and chronoamperometric methods. Characteristics of the obtained polymer film.	4
Lab 6	Biosensors. Investigation of the activity of enzymatic proteins used in biosensing using spectrophotometric methods. Determination of optimal working conditions for enzymes as native and immobilized proteins.	4
Lab 7	Biosensor for determining glucose levels. Characterization of the operation of enzymatic biosensors based on a glucometer - introduction to techniques of enzyme immobilization on the electrode surface, determination of glucose concentration in solutions and biological samples. Determination of detection limits, sensor selectivity (interferences).	4
Lab 8	Semiconductor nanostructures in sensing and biosensing - synthesis and surface modification of nanomaterials to prepare a matrix for constructing biosensors.	4

	Total hours	**30**
~~Project~~		**~~Number of hours~~**
Proj 1		
Proj 2		
Proj 3		
Proj 4		
…		
	~~Total hours~~	
~~Seminar~~		**~~Number of hours~~**
~~Semin 1~~		
~~Semin 2~~		
~~Semin 3~~		
~~…~~		
	~~Total hours~~	

TEACHING TOOLS USED
N1. Lecture with audiovisual aids. N2. Laboratory classes - conducting experiments. N3. Laboratory classes - preparation of a report.

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
P (lecture)	PEU_W01- PEU_W04	passing with a grade
F1 (laboratory)	PEU_U01 - PEU_U04	passing with a grade
F2 (laboratory)	PEU_U01 - PEU_U04, PEU_K01_K02	Assessment of the correctness of experiment execution and preparation of a report after completing laboratory classes
P (laboratory) = = 0,6 x F1 + 0,4 x F2;		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Florinel-Gabriel Bănică, *Chemical Sensors and Biosensors: Fundamentals and Applications*, John Wiley and Sons, Chichester, 2012

SECONDARY LITERATURE:

[2] R. F. Taylor, J. S. Schultz (red.), *Handbook of chemical and biological sensors*, IOP, Philadelphia, Bristol, 2003

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

Joanna Cabaj, joanna.cabaj@pwr.edu.pl

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 Ochrona środowiska w technologii chemicznej
Name of subject in English Environmental protection in chemical industry
Main field of study (if applicable): Chemical Engineering and Technology
Specialization (if applicable): Advanced Chemical Technology
Profile: academic
Level and form of studies: 2nd level, full-time
Kind of subject: obligatory
Subject code W03CET-SM2015W, W03CET-SM2015L
Group of courses NO

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	15		30		
Number of hours of total student workload (CNPS)					
Form of crediting (Examination / crediting with grade)	crediting with grade		crediting with grade		
For group of courses mark (X) final course					
Number of ECTS points	1		2		
including number of ECTS points for practical classes (P)			2		
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	0,6		1,2		

*delete as not necessary

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Basic environmental knowledge
2. Basics of chemical production
3. Knowledge of the basics of general chemistry

SUBJECT OBJECTIVES

C1 Familiarization students with the basic terminology used in environmental protection and shaping, sozology, environmental law.
C2 Familiarization students with the principles of environmental protection, systems of environmental management, principles of sustainable development, management of natural resources, including energy resources, and use of renewable resources.
C3 Familiarization students with the mechanisms and effects of human activities with particular emphasis on the impact of chemical industry activities on the natural environment.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01 Knows the basics of chemical production, basic terminology in the field of environmental protection and basic legal regulations in the field of environmental protection.

PEU_W02 Knows the industry-environment relationship and is able to determine the state of impact of the chemical industry on the environment. Knows the basics of conducting measurements in chemical production and for environmental monitoring purposes in legally regulated areas.

PEU_W03 Knows the structure of the chemical industry in Poland, the role of innovation and special economic zones; knows the basic problems and challenges of the chemical industry and environmental management systems.

PEU_W04 Knows energy raw materials, knows what are the prospective trends in the use of natural resources, renewable raw materials, as well as biomass in the chemical and energy industries. Knows what energy security is, knows the energy goals of the European Union and the principles of rational energy management in the chemical industry.

PEU_W05 Knows the types and uses of water in the chemical industry. Knows basic solutions in water and sewage management of chemical plants.

PEU_W06 Knows what impact the chemical industry has on air, water, and soil pollution. Knows methods of preventing air, water, and soil pollution as well as legal regulations in this area. Knows what remediation is and knows remediation techniques.

PEU_W07 Knows what are the sources of waste in the chemical industry. Knows waste classification and legal regulations in this area. Knows the methods of waste neutralization and utilization as well as the principles of green chemistry in waste disposal

relating to skills:

PEU_U01 Is able to determine the threats resulting from the use of chromium compounds in the tanning industry and characterize the methods of removing these compounds from industrial wastewater.

PEU_U02 Is able to characterize biosorption and bioaccumulation processes and determine the kinetics of the biosorption process.

PEU_U03 Is able to select the appropriate type of ionite for the removal of metal ions from post-plating wastewater and determine its ion-exchange capacity.

PEU_U04 Is able to carry out the desulfurization process of liquid products in laboratory conditions and compare the effectiveness of the applied methods.

PEU_U05 Is able to carry out the desulfurization process of gaseous products using absorption and adsorption methods.

PEU_U06 Is able to analyze the FT-IR spectrum.

PEU_U07 Has the ability to work individually and in a team.

PEU_U08 Has the ability to use acquired knowledge to creatively analyze and solve problems.

relating to social competences:

PEU_K01 Is aware of the threats to the environment associated with the functioning of the chemical industry.

PEU_K02 Is aware of the need for continuous search for new forms and methods of environmental protection and rational management of environmental resources.

PEU_K03 Is able to work in a team to solve a problem.

PEU_K04 Is aware of responsibility for own work, is open to exchange of ideas and new challenges.

PROGRAMME CONTENT		
Lecture		**Number of hours**
Lec 1	**Basics of chemical production:** chemical industry products; basic definitions related to environmental protection and management; environmental protection activities; natural resources and their rational use, renewable resources; basic environmental protection instruments, elements of environmental protection policy, methods of assessing the state of the environment.	2
Lec 2	**Industry-environment relationship, measurements:** impact of the chemical industry on the environment; effects of pro-environmental activities of the chemical industry; the role of industrial analytics; rules for conducting measurements in the chemical industry and environmental monitoring in legally regulated areas. Ecological disasters related to the functioning of the chemical industry.	2
Lec 3	**Structure of the chemical industry in Poland, environmental management systems:** production structure and employment in the chemical industry; role of foreign direct investments and special economic zones; environmental management systems; BAT; the role of research and innovation in the development of environmentally friendly industry.	2
Lec 4	**Energy management:** history and future of energy changes; electricity production in Poland and in the world; raw material base; renewable energy sources; energy problems and energy policy goals; electricity in the chemical industry; energy security and energy efficiency, rational energy management in the chemical industry.	2
Lec 5	**Water environment protection:** water supply, water used in the chemical industry - types, use, consumption and quality requirements; water treatment methods, filter selection; water pollution and protection; wastewater in the chemical industry; water and sewage management; legal regulations.	2
Lec 6	**Soil and atmosphere protection:** the impact of the chemical industry on atmosphere and soil pollution; characteristics of gaseous pollutants; methods of preventing atmospheric pollution; remediation.	2
Lec 7	**Waste management in the chemical industry:** definition of waste, types and legal classification of waste, sources of waste in the chemical industry; methods of waste utilization and neutralization; the problem of hazardous waste; waste-free methods; principles of "green chemistry" in waste disposal.	2
Lec 8	**Summary of the lecture and crediting with grade.**	1
	Total hours	**15**
Laboratory		**Number of hours**
Lab 1	Introduction. OSH training.	2
Lab 2	Removal of chromium ions from wastewater from the tanning industry. Part I - Reduction of Cr (VI) to Cr (III) using oxalic acid.	4
Lab 3	Removal of chromium ions from wastewater - Part II - Removal of Cr (III) from wastewater by biosorption.	4
Lab 4	Recovery of heavy metals from post-plating wastewater.	4
Lab 5	Desulphurization processes of gas raw materials.	4

Lab 6	Desulfurization processes of liquid raw materials	4
Lab 7	Determination of impurities in liquid and solid samples using the FTIR method.	4
Lab 8	Extra laboratory classes.	4
	Total hours	**30**

TEACHING TOOLS USED
N1. Lecture with multimedia presentation. N2. Debate and conversation. N3. Audiovisual communication. N4. Job at laboratory. Performing experiments. N5. Preparation of the report.

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
P (lecture)	PEU_W01-PEU_W07 PEU_U08 PEU_K01-PEU_K04	Final test 3,0 if 50% – 59% 3,5 if 60 – 69 % 4,0 if 70 – 79 % 4,5 if 80 – 89% 5,0 if 90 – 100 %
F1-F7 (laboratory)	PEU_U01- PEU_U08 PEU_K03-PEU_K04	Grade of the short tests and reports
P (laboratory) =(F1+F2+F3+F4+F5+F6+F7)/7		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Porteous A. Dictionary of Environmental Science and Technology, New York, 2008, Wiley
[2] S. E. Manahan, Environmental science and technology, CRC Taylor & Francis, Boca Raton, London, New York, 2007
[3] G.Manahan; Environmental science technology and chemistry, CRC Press 2000
[4] Polish and European legal regulations regarding environmental protection
[5] Waste tire pyrolysis and desulfurization of tire pyrolytic oil (TPO) – A review, M. Mello, H. Rutto, T. Soedigeng, Journal of the Air & Waste Management Association, Volume 73, 2023 - Issue 3
[6] Summary of research progress on industrial flue gas desulfurization technology, X. Li et al. Separation and Purification Technology, Volume 281, 2022.
[7] Removal of Hydrogen Sulfide From Various Industrial Gases: A Review of The Most Promising Adsorbing Materials, A.G. Georgiadis et al. Catalysts 2020, 10(5), 521

SECONDARY LITERATURE:

[1] Comprehensive Renewable Energy, 2nd edition The Impact on the Environment in the Production of Photovoltaic Systems: With a Focus on Metal Recovery Ewa Klugmann-Radziemska, Elsevier 2020
[2] G. W. vanLoon, S.J. Duffy, Environmental chemistry. A global perspective, Oxford University Press, 2005
[3] Scientific and technical journals

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)	
Lecture	**Małgorzata Mironiuk** malgorzata.mironiuk@pwr.edu.pl
Laboratory	**Rafał Łużny** rafal.luzny@pwr.edu.pl

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: **Zielona chemia i zrównoważone technologie**
Name of subject in English: **Green Chemistry and Sustainable Technology**
Main field of study (if applicable): Chemical Engineering and Technology
Specialization (if applicable): Advanced Chemical Technology
Profile: academic
Level and form of studies: 2nd level, full-time
Kind of subject: obligatory
Subject code: W03CET-SM2010W, W03CET-SM2010P
Group of courses: NO

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	15			30	
Number of hours of total student workload (CNPS)	25			75	
Form of crediting (Examination / crediting with grade)	exam			crediting with grade	
For group of courses mark (X) final course					
Number of ECTS points	2			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)	0,6			1,2	

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1.

SUBJECT OBJECTIVES

C1 students' understanding of advanced issues in the field of green chemistry and chemical technologies in relation to sustainable development goals
C2 deepening students' skills in group work and strengthening their need for constant improvement

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:
a student completing a course
PEU_W01 has in-depth knowledge of the principles of green chemistry

PEU_W02 has advanced knowledge of the sustainable development of the chemical industry, as well as techniques, processes and technologies supporting the achievement of sustainable development goals

relating to skills:
a student completing a course
PEU_U01 is able to work using a case study
PEU_U02 is able to plan activities, work in a group, collect and analyze data, develop a project in the form of a compact document,
PEU_U03 is able to organize a discussion, present the results of one's work, and defend the presented theses

relating to social competences:
a student completing a course
PEU_K01 is aware of the importance of knowledge in a context beyond technical and engineering aspects
PEU_K02 is ready to use the experience and knowledge of specialists
PEU_K03 is aware of the role of an engineer in the modern world, including the need to inform society about the most important aspects of sustainable development

PROGRAMME CONTENT

Lecture		**Number of hours**
Lec 1	Green Chemistry – principles, concepts	2
Lec 2	Green Chemistry – green catalysis, green solvents, green processing	2
Lec 3	Green Chemistry – safety, waste management	2
Lec 4	Introduction to sustainable development (SD) – concepts, principles, definitions, models	2
Lec 5	A role of sustainability in biotechnology and chemical industry – the pollution prevention in chemical industry, the design and modeling of the sustainable manufacturing and industrial processes, conservation and management of resources	2
Lec 6	Sustainable development in chemistry and chemical technology – case studies	2
Lec 7	Environmental sustainability, Zero emission concept, Cleaner Production concept	2
Lec 8	The challenges for green chemistry and sustainable chemical technologies	1
	Total hours	**15**

Project		**Number of hours**
Pr1	Learning with the project method – introduction. Selection and discussion of group and individual project topics.	2
Pr2-Pr7	Working on a project. Collecting data, discussing assumptions for team and individual projects. Consultations. Brainstorm.	12
Pr8	Presentations of assumptions for team and individual projects – discussion.	2
Pr9-Pr14	Working on a project. Development of team and individual projects. Preparation of final reports	12
Pr5	Presentations of team and individual projects – summary discussion.	2

	Total hours	**30**

TEACHING TOOLS USED
N1. Multimedia presentation N2. Discussion N3. Consultations

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
P=0,1xF1+0,9xF2	PEU_W01-PEU_W02 PEU_K01, PEU_K03	F1-Engagement rating in discussions (10%); F2-Exam (90%)
P=0,4xF1+0,3xF2+0,3xF3	PEU_U01-PEU_U03 PEU_K01-PEU_K03	Assessment of: F1-quality of presentation, involvement in group work, participation in discussions (40%); F2-Group project evaluation (30%); F3-Assessment of the individual project (30%)

PRIMARY AND SECONDARY LITERATURE
PRIMARY LITERATURE: [1] Vincenzo Piemonte, Marcello De Falco, Angelo Basile, Sustainable Development in Chemical Engineering: Innovative Technologies, Wiley 2013, ISBN: 978-1-119-95352-4 [2] Sustainable Industrial Processes, ed. By F. Cavani, G. Centi, S. Perathoner and F. Trifiro, Wiley-VCH 2009 **SECONDARY LITERATURE:** [1] Current scientific publications [2] Current UN, EU, USEPA reports on the SDGs

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)
Dr hab. inż. Piotr Rutkowski, prof. uczelni, piotr.ruktowski@pwr.edu.pl

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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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 Projektowanie instalacji przemysłowych
Name of subject in English Industrial plants design principles
Main field of study (if applicable): Chemical Engineering and Technology
Specialization (if applicable): Advanced Chemical Technologies
Profile: academic
Level and form of studies: 2nd level, full-time
Kind of subject: obligatory
Subject code W03CET-SM2014W, W03CET-SM2014P
Group of courses NO

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	15			30	
Number of hours of total student workload (CNPS)	30			60	
Form of crediting (Examination / crediting with grade)	Crediting with grade			Crediting with grade	
For group of courses mark (X) final course					
Number of ECTS points	**1**			**2**	
including number of ECTS points for practical classes (P)				2	
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	0.6			1,2	

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Knowledge of unit operations in chemical and process engineering.
2. Basics of process design.
3. Knowledge of process equipment.

SUBJECT OBJECTIVES

C1 Providing the students with industrial plant design tasks and feasibility analysis of the new plant, rules of the integrated project elaboration.
C2 Providing the students with basic knowledge of raw materials and energy supply systems, requirements concerning raw materials and products quality, optimization and intensification of integrated process.
C3 Providing the students with the rules of production process course elaboration, including the rules of elaboration of schematic diagram and a technological-apparatus scheme of the integrated process.
C4 Providing the students with the rules of process equipment selection, apparatus constructions, constructional materials, methods of selection of control-measuring apparatuses and regulation equipment of the plant under design.
C5 Presentation of investment costs estimation and calculation of production costs of the designed integrated process.
C6 Making project of the of an integrated process.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:
PEU_W01 – knows basics of unit operations design,
PEU_W02 – knows process intensification rules,
PEU_W03 – has thorough knowledge as far as concerning the apparatus and equipment used in industrial plants.

relating to skills:
PEU_U01 – can make design calculations of selected unit operations in integrated processes,
PEU_U02 – can integrate the processes,
PEU_U03 – can select the sequence of unit operations for technological process in the plant (integrated processes) designs.

relating to social competences:
PEU_K01 – can cooperate in design group,
PEU_K02 – can present the work results.

PROGRAMME CONTENT

	Lecture	**Number of hours**
Lec 1	Integration of unit operations. Industrial plant. Industrial plant design principles. Feasibility analysis of the new plant.	2
Lec 2	Process integration rules. Technological – economic assumptions. Elaboration rules of the process project of industrial plant. Optimization of process solutions.	2
Lec 3	Examples of integrated processes application. Process data. Raw materials and the products, energy, waste. Parameters of unit operations. Integrated process course.	2
Lec 4	Principles balancing rules. Process equipment, industrial plant, constructional materials.	2
Lec 5	Control and regulation of designed integrated process – industrial plant.	2
Lec 6	Technological – apparatus scheme of integrated processes. Spatial distribution of apparatus and equipment in industrial plant.	2
Lec 7	Investment costs and calculation of project cost.	2
Lec 8	Analysis of advantages resulting from process integration – examples of real process solutions.	1
	Total hours	**15**

	Project	**Number of hours**
Proj 1	Feasibility analysis of a new (exemplary) investment.	2
Proj 2	Elaboration of chemical and technological concept of the design task – an exemplary industrial plant.	2
Proj 3, Proj 4	Selection of individual parameters of unit operations for specified design task – integrated proces – according to elaborated schematic diagram of the designed integrated process.	4
Proj 5 – Proj 7	Calculation of material and energy balances, calculation of indicators of raw material and energy consumption in integrated process. Calculating of the product/products composition, waste composition and elaboration of their storage/utilization method.	6
Proj 8 – Proj 10	Selection and/or design of process apparatuses, equipment selection, selection of constructional materials for integrated process.	6
Proj 11	Elaboration of measurement, control and regulation system of integrated process. Selection of control and measurement equipment. Selection of automatic control systems.	2
Proj 12, Proj 13	Elaboration of technological-apparatus scheme of the integrated process. Spatial distribution of apparatuses and equipment.	4
Proj 14, Proj 15	Estimated investment costs and production costs.	4
	Total hours	**30**

TEACHING TOOLS USED

N1. Lecture with multimedia presentation.
N2. Integrated project of the given task – elements of individual and group work.
N3. Design consultations.

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
P1	PEU_W01 – PEU_W03	Crediting with grade.
P2	PEU_U01 – PEU_U03, PEU_K01-PEU_K02	Crediting with grade. Project evaluation.

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] R. Koch, A. Kozioł: *Dyfuzyjno–cieplny rozdział substancji*, WNT Warszawa, 1994.
[2] R. Koch, A. Noworyta: *Procesy mechaniczne w inżynierii chemicznej*, WNT Warszawa, 1995.
[3] A. Burghardt, G. Bartelmus: *Inżynieria reaktorów chemicznych*, PWN Warszawa, 2001.
[4] S. Kucharski, J. Głowiński: *Podstawy obliczeń projektowych w inżynierii chemicznej*, OWPWr, Wrocław, 2000.
[5] D.W. Green, R.H. Perry (red.): *Perry's chemical engineers' handbook*, 8th ed., McGraw–Hill, 2007

SECONDARY LITERATURE:

[1] W.D. Seider: *Process design principles*, J.W.&S., 1999.
[2] U. Bröckel, W. Meier, G. Wagner (red.): *Product design and engineering.* Vol.1*: Basics and technologies,* Vol. 2: *Raw materials, additives and application*, Wiley, 2007.

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

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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 Procesy membranowe
Name of subject in English Membrane processes
Main field of study (if applicable): Chemical Engineering and Technology
Specialization (if applicable): Advanced Chemical Engineering
Profile: academic
Level and form of studies: 2nd level
Kind of subject: obligatory
Subject code W03CET-SM2002W, W03CET-SM2002L, W03CET-SM2002S
Group of courses NO

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	15		45		15
Number of hours of total student workload (CNPS)	50		75		25
Form of crediting (Examination / crediting with grade)	crediting with grade		crediting with grade		crediting with grade
For group of courses mark (X) final course					
Number of ECTS points	2		3		1
including number of ECTS points for practical classes (P)			3		1
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	0,6		1,8		0,6

1w+3l +1s (2+3+1 ECTS).

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1.Fundamentals of organic chemistry
2 Fundamentals of chemical engineering

SUBJECT OBJECTIVES

C1 To become familiar with the construction and characteristics of membranes.
C2 To become familiar with the types of membrane processes and their application.
C3 To become familiar with measurement methods during a membrane process.

SUBJECT EDUCATIONAL EFFECTS

In terms of knowledge:
PEU_W01 The student knows the chemical and physical structure of membranes.
PEU_W02 The student knows what membrane processes are and when to use them.

From the scope of skills:
PEU_U01 The student is able to carry out a process on a membrane plant and determine its membrane performance and selectivity.

PEU_U02 The student knows how to prepare documentation for a membrane process.
PEU_U03 The student is able to find examples of applications of membrane processes in the literature and prepare a presentation on them.

In terms of social competence:
PEU_K01 The student is able to engage in discussion and critically evaluate his/her own work and that of others in the course.

PROGRAMME CONTENT

	Lecture	**Number of hours**
Lec 1	Introduction to clean technologies.	2
Lec 2	Circular economy. Application of membrane processes in waste fractionation.	2
Lec 3	Membrane construction and structure of membrane modules.	2
Lec 4	Pressurised membrane processes.	3
Lec 5	Diffusion membrane processes.	3
Lec 6	Membrane electro-processes. Liquid membranes.	2
Lec 7	Written course credit	1
	Total hours	**15**

	Laboratory	**Number of hours**
La1	Microfiltration of bacterial and yeast cells.	5
La2	Ultrafiltration process.	5
La3	Protein hydrolysis coupled to nanofiltration.	15
La4	Pervaporation of beer.	5
La5	Dialysis.	5
La6	Membrane extraction.	5
La7	Reverse osmosis	5
	Total hours	**45**

	Seminar	**Number of hours**
Se1	Introduction to the class - application of membrane processes.	1

Se2	Micro- and ultrafiltration processes.	2
Se3	Nanofiltration and reverse osmosis.	2
Se4	Membrane extraction and distillation.	2
Se5	Pervaporation and dialysis.	2
Se6	Vapour and gas separation.	2
Se7	Liquid membranes. Membrane fabrication.	2
Se8	Electrodialysis, electrodiffusion.	2
	Total hours	**15**

TEACHING TOOLS USED
N1. Lecture with multimedia presentation N2. Laboratory. N3. Students presentations. N4. Consultations.

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
P (lecture)	PEU_W01 PEU_W02 PEU_W03 PEU_W04	Credit test
F1 (laboratory) P=F1	PEU_U01 PEU_U02 PEU_U03 PEU_K01 PEU_K02	Laboratory exercise reports (arithmetic mean)
P (seminar)	PEU_U04	presentation
3.0 if $3.00 \leq P < 3.25$ 3.5 if $3.25 \leq P < 3.75$ 4.0 if $3.75 \leq P < 4.25$ 4.5 if $4.25 \leq P < 4.75$ 5.0 if $4.75 \leq P$		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

LITERATURA PODSTAWOWA:

[1] Membrane processes, Robert Rautenbach, 1989.

[2] Membrane Modification: Technology and Applications – Nidal Hilal, Mohammed Khayet, Chris Wright, 2012.

[3]

SECONDARY LITERATURE:

[4] Multimedia presentation materials.

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

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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 Nanotechnologia
Name of subject in English Nanotechnology
Main field of study (if applicable): Chemical Engineering and Technology
Specialization (if applicable): Advanced Chemical Engineering
Profile: academic
Level and form of studies: 2nd level
Kind of subject: obligatory
Subject code W03CET-SM2009W, W03CET-SM2009L
Group of courses NO

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	15		30		
Number of hours of total student workload (CNPS)	25		50		
Form of crediting (Examination / crediting with grade)	crediting with grade		crediting with grade		
For group of courses mark (X) final course					
Number of ECTS points	**1**		2		
including number of ECTS points for practical classes (P)			2		
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	0.6		1.2		

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1.Fundamentals of physical chemistry
2 Fundamentals of biotechnology
3 Fundamentals of materials engineering

SUBJECT OBJECTIVES

C1 To become familiar with the concepts of nanotechnology.
C2 To become familiar with methods of obtaining and characterising nanomaterials.
C3 To become familiar with the possible applications of nanoengineering and nanomaterials in various fields.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:
PEU_W01 Knows the concepts of nanotechnology
PEU_W02 Has knowledge of methods of obtaining nanomaterials
PEU_W03 Has knowledge of characterisation techniques for nanomaterials
PEU_W04 Knows the applications of nanotechnology and nanomaterials in various fields

relating to skills:
PEU_U01 Can select a method and synthesise a chosen nanomaterial
PEU_U02 Can carry out investigations of nanomaterial properties and their characterisation using specialised equipment
PEU_U03 Can analyse and process the obtained test results

relating to social competences:
PEU_K01 Is able to cooperate in a laboratory group
PEU_K02 Feels responsible for the results of the assigned task

PROGRAMME CONTENT

	Lecture	**Number of hours**
Lec 1	Organising lesson. Credit requirements. Introduction -History of the development of nanotechnology and its applications in various fields. Properties of nanomaterials and how they differ from macroscale materials. New trends in nanotechnology.	2
Lec 2	Nanoemulsions - manufacturing methods, characterisation and stability testing and applications.	2
Lec 3	Metallic nanoparticles with the example of bionanosilver - preparation, properties and practical applications.	2
Lec 4	Synthesis of metal oxide-based nanomaterials and their potential applications	2
Lec 5	Definition of drug carriers. Mechanisms of release.	2
Lec 6	Externally applied drug carriers - construction, use.	2
Lec 7	Carriers in targeted therapy - construction, application.	2
Lec 8	Written course credit.	1
	Total hours	**15**

	Laboratory	**Number of hours**
Lab 1	Preparation, characterisation and stability testing of nanoemulsions.	5
Lab 2	Bioinspired synthesis and characterisation of silver nanoparticles.	5
Lab 3	Green synthesis of zinc oxide nanocrystals and their characterisation.	5
Lab 4	Preparation of encapsulator drug carriers.	5
Lab 5	Preparation of core-shell drug carriers.	5
Lab 6	Printing of carriers on a bio-printer. Control of drug release.	5
	Total hours	**15**

TEACHING TOOLS USED

N1. Lecture with multimedia presentation
N2. Laboratory instructions
N3. Laboratory workstations

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
P (lecture)	PEU_W01 PEU_W02 PEU_W03 PEU_W04	Credit test
F1 (laboratory) P=F1	PEU_U01 PEU_U02 PEU_U03 PEU_K01 PEU_K02	Laboratory exercise reports (arithmetic mean)
3.0 jeżeli 3.00 ≤ P < 3.25 3.5 jeżeli 3.25 ≤ P < 3.75 4.0 jeżeli 3.75 ≤ P < 4.25 4.5 jeżeli 4.25 ≤ P < 4.75 5.0 jeżeli 4.75 ≤ P		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] S.M. Jafari, D.J. McClements „Nanoemulsions: Formulation, Applications, and Characterization", Academic Press, 2018

[2] V.A. Basiuk, E.V. Basiuk "Green Processes for Nanotechnology: From Inorganic to Bioinspired Nanomaterials", Springer, 2015

[3] M. Rai, C. Posten "Green biosynthesis of nanoparticles: mechanisms and applications", CBA International, 2013

[4] A.D.Sezer "Application of Nanotechnology in Drug Delivery" https://www.intechopen.com/books/application-of-nanotechnology-in-drug-delivery

[5] J.L.Arias "Nanotechnology and Drug Delivery" https://www.taylorfrancis.com/books/e/9780429073533

SECONDARY LITERATURE:

[1] M. Naito, T. Yokoyoma, K. Hosokawa, K. Nogi "Nanoparticle technology handbook", Elsevier B.V., 2018

[2] H. Sarma, S.J. Joshi, R. Prasad, J. Jampilek „Biobased Nanotechnology for Green Applications", Springer, 2022

[3] Inamuddin, A.M. Asiri "Applications of nanotechnology for green synthesis", Springer, 2020

[4] D.L. Feldheim, C.A. Foss "Metal nanoparticles: synthesis, characterization, and applications", Marcel Dekker, Inc., 2002

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

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Izabela Polowczyk, izabela.polowczyk@pwr.edu.pl

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 … Numeryczne zastosowania w nano-inżynierii
Name of subject in English …… Numerical applications in nano-engineering
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-SM2008W, W03CET-SM2008P
Group of courses NO

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	15		30		
Number of hours of total student workload (CNPS)	25		50		
Form of crediting (Examination / crediting with grade)	Exam		Crediting with grade		
For group of courses mark (X) final course					
Number of ECTS points	1		2		
including number of ECTS points for practical classes (P)			2		
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	0.6		1,2		

*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. Understanding of numerical algorithms
3. Basic understanding of chemical thermodynamics

SUBJECT OBJECTIVES

C1 To familiarize students with the current state of nano-type research
C2 To understand future applications in nano-materials
C3 To familiarize students with specific properties in the nano-scale
C4 To introduce students to the modeling methodology of nano-porous materials

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01 – student understands the notion of nano-engineering and its role in future technologies
PEU_W02 - student knows the current trends of nano-technology developments
PEU_W03 - student knows how to model numerically the properties of nano-objects

relating to skills:
PEU_U01 – student is able to find and understand the literature related to nanotechnology
PEU_U02– student is able to discuss the current trends in nanotechnology
PEU_U03 – student can design a numerical modeling analyze of nano-materials

PROGRAMME CONTENT

Lecture		**Number of hours**
Lec 1	Characteristics of the nano-scale properties.	2
Lec 2	Numerical projects: basic notions and definitions	2
Lec 3	Numerical projects in nano-materials.	2
Lec 4	Surface and deformations in nanoscale. Nanoporous materials.	2
Lec 5	Industrial applications of nanoporous materials	2
Lec 6	Characteristics of nanoporous materials: adsorption	2
Lec 7	Microscopic models of nanoporous materials and adsorption	2
Lec 8	Interpretation of simulations of adsorption and diffusion in nanoprorous materials	1
	Total hours	15

Project		**Number of hours**
Proj 1	Definitions of models for simulations, basic Linux notions	4
Proj 2	Setting-up and optimalization of the input data	6
Proj 3	Examples of the Monte Carlo simulation methods	4
Proj 4	Simulation of adsorption in porous systems	6
Proj 5	Analysis of the simulation results: the role of adsorption energy	4
Proj 6	Transport in nanaopores	6
Proj 7	Adsorption in nanoporous systems	3
	Total hours	**30**

TEACHING TOOLS USED

N1. Multimedia presentation
N2. Discussions and exercises
N3. Consultations

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming during semester), P –	Learning outcomes code	Way of evaluating learning outcomes achievement

concluding (at semester end)		
F (project)	PEU_U01 – U03	Grading based on the work on projects
P (lecture)	PEU_W01 -W03	Exam

PRIMARY AND SECONDARY LITERATURE

LITERATURA PODSTAWOWA:

[1] Akhlesh Lakhtakia, Nanometer structures: Theory, modeling and simulation, SPIE Press 2004

LITERATURA UZUPEŁNIAJĄCA:

Internet.

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

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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 Planowanie eksperymentów w Statistica
Name of subject in English Planning experiments in Statistica
Main field of study (if applicable): Chemical Engineering and Technology
Specialization (if applicable): ……..
Profile: academic
Level and form of studies: 2nd level, full-time
Kind of subject: optional
Subject code W03CET-SM2101C
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			
For group of courses mark (X) final course					
Number of ECTS points		2			
including number of ECTS points for practical classes (P)		2			
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)		1,2			

*delete as not necessary

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Basics of probability theory: the concept of probability and its properties, independence of random events
2. Basic knowledge of mathematical analysis and linear algebra

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SUBJECT OBJECTIVES

C1 Getting to know the Statistica environment
C2 Learning about selected experiment planning techniques.
C3 Acquiring the ability to select an appropriate statistical test to analyze the results
C4 Acquiring the ability to use linear and non-linear regression in the analysis of results
C5 Acquiring the ability to use the selected Statistica package in planning the experiment and analyzing the results

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:
Person who passed the subject:
PEU_W01 – Has knowledge in the field of statistics
PEU_W02 – Has knowledge in planning research using experimental methods used in biotechnology
relating to skills:
Person who passed the subject:
PEU_U01 – Can operate Statistica software
PEU_U02 – Is able to create an experiment diagram with a work schedule
PEU_U03 – Is able to perform basic statistical analyzes and correctly interprets the obtained results
relating to social competences:
Person who passed the subject:
PEU_K01 – Is ready to critically evaluate their knowledge
PEU_K02 – Is aware of the importance of acquired theoretical and practical knowledge and is ready to apply general and engineering skills in practice
PEU_K03 – Has the ability to work in a team of several people

PROGRAMME CONTENT

	Classes	**Number of hours**
C1	Introduction to Statistica. Sample, types of data, data presentation	2
C2	Variable distributions (normal, normality test, binomial distribution, Poisson)	2
C3	Correlations, Anova	2
C4	Sets of variables, group analysis	2
C5	Data management. Worksheet formulas and multivariable transformation. Importing from Excel. Data preparation (cleaning and flirting)	2
C6	Characteristics of the purpose and object of research	2
C7	Optimal research plans. Selection based on the specific purpose and object of research	2
C8	Complete plans.	2
C9	Two-value complete or fractional plans. Bivalent elimination plans	2
C10	Plans with three-valued input quantities. Plans in which some factors are bivalent and some are trivalent	2
C11	Compositional master plans	2
C12	Statistical analysis of results 1	2
C13	Statistical analysis of results 2	2
C14	Practical use of results	2
C15	Collquium	2
	Total hours	**30**

TEACHING TOOLS USED

N1. Multimedia presentation.
N2. Lab.
N3. Description of results using computer graphics programs.
N4. Consultations.

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
F1	PEU_W01-W02	Colloquium
F2	PEU_U01-U03 PEU_K01-K03	Preparation of a computational project
P = (F1+F2)/2		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Joaquim P. Marques de Sá., Applied Statistics Using SPSS, STATISTICA, MATLAB and R, Springer Berlin, Heidelberg, 2007
[2] Lindsey, J.K., Introduction to Applied Statistics. Oxford University Press,2003

SECONDARY LITERATURE:

[1] Statistica: przewodnik. StatSoft, Kraków, 2011
[2] T. Greber, Statystyczne sterowanie procesami - doskonalenie jakości z pakietem STATISTICA, Kraków, 2000
[3] B. Kacprzyński, Planowanie eksperymentów : podstawy matematyczne, Wydawnictwa Naukowo-Techniczne, 1974

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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: Praca dyplomowa I
Name of subject in English: Graduate laboratory I
Main field of study (if applicable):
Specialization (if applicable):
Profile: academic
Level and form of studies: 2nd level, full-time
Kind of subject: obligatory
Subject code W03W03-SM1054D, W03W03-SM2054D
Group of courses NO

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)			60		
Number of hours of total student workload (CNPS)			150		
Form of crediting (Examination / crediting with grade)			crediting with grade		
For group of courses mark (X) final course					
Number of ECTS points			6		
including number of ECTS points for practical classes (P)			6		
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)			3		

*delete as not necessary

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1.
2.

SUBJECT OBJECTIVES

C1 Developing the ability to select and analyze sources of knowledge, including scientific literature
C2 Developing the ability to create a written study on the topic of the diploma thesis
C3 Expanding the skills of planning and conducting scientific work

SUBJECT EDUCATIONAL EFFECTS

In relation to knowledge:

PEU_W01 – knows the types of sources of scientific and professional knowledge,
PEU_W02 – has in-depth knowledge of the topic of the diploma thesis

In relation to skills:

PEU_U01 – is able to collect information useful for learning about a specific issue and preparing for the completion of a diploma thesis
PEU_U02 – is able to critically analyze the collected information in a form written on a selected scientific or practical issue.
PEU_U03 – (optional) is able to plan and carry out experiments/design work as well as develop the results and draw conclusions from their achievements and plan further work

In relation to social competences:

PEU_K01 – is ready to critically evaluate knowledge obtained from various sources
PEU_K02 – is ready to comply with the principles of professional ethics and respect copyrights

PROGRAMME CONTENT

	Laboratory	**Number of hours**
Lab 1-Lab15	Individual student work on a selected topic according to the schedule agreed with the diploma thesis supervisor	60
	Total hours	60

TEACHING TOOLS USED

N1. consultations

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
P	PEU_W01 – PEU_W02 PEU_U01 –PEU_U03 PEU_K01 – PEU_K02	assessment of student work based on progress in completing the diploma thesis

PRIMARY AND SECONDARY LITERATURE

Scientific and professional literature indicated by the course tutor and/or found by the student.

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

Supervisors of individual diploma thesis topics
Subject card preparation:
Piotr Rutkowski, piotr.rutkowski@pwr.edu.pl

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: Praca dyplomowa II
Name of subject in English: Graduate laboratory II
Main field of study (if applicable):
Specialization (if applicable):
Profile: academic
Level and form of studies: 2nd level, full-time
Kind of subject: obligatory
Subject code W03W03-SM1055D, W03W03-SM2055D
Group of courses NO

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)			210		
Number of hours of total student workload (CNPS)			500		
Form of crediting (Examination / crediting with grade)			crediting with grade		
For group of courses mark (X) final course					
Number of ECTS points			20		
including number of ECTS points for practical classes (P)			20		
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)			9,5		

*delete as not necessary

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1.

SUBJECT OBJECTIVES

C1 implementation of a research project
C2 written preparation of the diploma thesis

SUBJECT EDUCATIONAL EFFECTS

In relation to knowledge:
PEU_W01 – knows the types of sources of scientific and professional knowledge
PEU_W02 – has advanced knowledge of the topic of the diploma thesis

In relation to skills:
PEU_U01– is able to carry out experiments / develop a project in accordance with the developed work plan

PEU_U02 – is able to compare information obtained from sources of knowledge with the results of research, verify the results of own research, draw conclusions and plan further work
PEU_U03 – is able to develop the results of his/her work on a selected topic and present them in the form of a diploma thesis

In relation to social competences:
PEU_K01 – is ready to critically evaluate the obtained results of research work on a selected topic
PEU_K02 – is ready to comply with the principles of professional ethics and respect copyrights

PROGRAMME CONTENT

	Laboratory	**Number of hours**
Lab 1-Lab15	Individual student work on a selected topic according to the schedule agreed with the diploma thesis supervisor	210
	Total hours	210

TEACHING TOOLS USED

N1. consultations

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
P	PEU_W01 – PEU_W02 PEU_U01 – PEU_U03 PEU_K01 – PEU_K02	assessment of student work based on progress in completing the diploma thesis

PRIMARY AND SECONDARY LITERATURE

Scientific and professional literature indicated by the course tutor and/or found by the student.

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

Supervisors of individual diploma thesis topics
Subject card preparation:
Piotr Rutkowski, piotr.rutkowski@pwr.edu.pl

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: Proseminarium
Name of subject in English: Graduation proseminar
Main field of study (if applicable):
Specialization (if applicable):
Profile: academic
Level and form of studies: 2nd level, full-time
Kind of subject: obligatory
Subject code W03W03-SM1053S, W03W03-SM2053S
Group of courses NO

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)					15
Number of hours of total student workload (CNPS)					25
Form of crediting (Examination / crediting with grade)					crediting with grade
For group of courses mark (X) final course					
Number of ECTS points					1
including number of ECTS points for practical classes (P)					1
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)					0,7

*delete as not necessary

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1.
2.
3.

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SUBJECT OBJECTIVES

C1
C2

SUBJECT EDUCATIONAL EFFECTS

In relation to knowledge:
PEU_W01 – has knowledge of research topics related to the studied field of study conducted in organizational units of the Faculty of Chemistry

In relation to skills:

PEU_U01 – can take an active part in discussions on scientific topics

In relation to social competences:
PEU_K01 – is aware of the need to improve their competences in the field of research within the field of study

PROGRAMME CONTENT

	Seminar	**Number of hours**
Semin 1-15	Discussion of the topics of diploma theses by employees of the Faculty's units conducting research related to the field of study; Presentation of research and analytical laboratories in the Faculty's units; Discussion of the rules for selecting the topics of diploma theses and the rules for implementing/passing the "Diploma Thesis" courses	15
	Total hours	15

TEACHING TOOLS USED

N1. Presentation
N2. Discussion
N3. Consultations

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
P	PEU_W01 PEU_U01 PEU_K01	Attendance at classes, participation in discussions - assessed by the people conducting the classes

PRIMARY AND SECONDARY LITERATURE

N/A

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

Chairman of the study program committee

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: Przedmiot kierunkowy wybieralny
Name of subject in English: Elective course
Main field of study (if applicable):
Specialization (if applicable):
Profile: academic
Level and form of studies: 2nd level, full-time
Kind of subject: elective
Subject code …….
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)	25				
Form of crediting (Examination / crediting with grade)	Zaliczenie na ocenę				
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 COMPETENCES

1.
2.
3.

SUBJECT OBJECTIVES

C1 Familiarizing the student with advanced issues in the field of chemical sciences (including biotechnology) and/or materials engineering and/or chemical engineering (including chemical technology)

SUBJECT EDUCATIONAL EFFECTS

In relation to knowledge:
PEU_W01 – Knows and is able to describe the basic phenomena and processes occurring in the life cycle of devices, objects and technical systems.

PEU_W02 – has in-depth knowledge of development trends and new achievements in the field of chemical engineering and technology and related sciences

In relation to social competences:

PEU_K01 – is ready to critically evaluate the knowledge acquired and the content received

PEU_K02 – is aware of the role of a technical university graduate and the need to maintain the ethos of the engineering profession

PROGRAMME CONTENT

	Lecture	**Number of hours**
Lec 1-Lec 15	To familiarize students with advanced concepts, theories describing phenomena, operations and processes occurring in living and inanimate systems, as well as with the latest trends in chemical sciences, chemical engineering and related sciences. Issues presented in an elective subject, depending on the field studied, may include, among others: - adsorbents in environmental protection and industry - alternative and renewable energy sources, renewable raw materials in industry, recycling technologies - technical security - medical and pharmaceutical chemistry - chemistry of coordination compounds - chemistry of fragrance compounds - physical chemistry of chemical processes and products - chemistry, engineering and technology of materials (polymer, carbon, ceramic, metallic) and composites - technologies of dispersed systems - catalysts and catalysis in industry - instrumental methods in chemistry - physicochemical description of simple and complex systems - from the borderline of biology and medicine, describing the biological and biochemical basis of the functioning of organisms, including chemical and biochemical processes at the cellular and molecular level - industrial aspects of biotechnology - recycling of precious metals - issues of technological process and quality management, principles of investing and operating chemical technologies - modern chemical technologies - biotechnology development trends - basics of spectroscopic methods, - bioelectrochemical systems - issues related to sustainable development - characteristics of the biotechnology and chemical industry in Poland and in the world	30
	Total hours	30

TEACHING TOOLS USED

N1. Presentation

N2. Discussion

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
P	PEU_W01- PEU_W02 PEU_K01- PEU_K02	Writing test (to pass minimum 50% of points)

PRIMARY AND SECONDARY LITERATURE
[1] Literature is provided during the first classes by the teachers of the elective subject
SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)
Chairman of study program committee

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:	Pozyskiwanie danych naukowo technicznych
Name of subject in English:	Retrieval of Scientific and Technological Resources
Main field of study (if applicable):	Chemical engineering and Technology
Specialization (if applicable):	
Profile:	practical
Level and form of studies:	2nd level
Kind of subject:	obligatory
Subject code:	W03CET-SM2005C
Group of courses:	NO

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)		15			
Number of hours of total student workload (CNPS)		25			
Form of crediting (Examination / crediting with grade)		Crediting with grade			
For group of courses mark (X) final course					
Number of ECTS points		1			
including number of ECTS points for practical classes (P)		1			
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)		0,6			

*delete as not necessary

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Basic computer skills

SUBJECT OBJECTIVES

C1 Familiarization with technical standards and data
C2 Familiarization with scientific databases (Scopus, Web of Science, Google Scholar)
C3 Familiarization with specific databases (Reaxys, Chemspider, PDB, Mycobank)
C4 Familiarization with patent information, principles of patenting and patent protection

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:
PEU_W01 Be able to search for information in scientific databases and retrieve scientific articles
PEU_W02 Be able to find patent information
relating to skills:
PEU_U01 Be able to write a patent application

PEU_U02 Be able to prepare a report on the current state of knowledge in a given field of science relating to social competences: PEU_K01 Is able to work in a group PEU_K02 Is aware of the importance of acquired theoretical and practical knowledge PEU_K03 Is able to present the results of his/her work

PROGRAMME CONTENT		
Project		**Number of hours**
Cw1	Introduction to the class, discussion of the essence of scientific and technical information	1
Cw2	Resources of library, standardization and patent databases	2
Cw3	Working with databases (Web of Science, Scopus, Google Scholar)	2
Cw4	Working with specialized databases (PDB, Mycobank, Chemspider, Reaxys)	2
Cw5	Structure and methodology of creating patent applications	2
Cw6	Formulating the topic and scope of the project	2
Cw7	Partial evaluation of projects	2
Cw8	Project presentation	2
	Total hours	15

TEACHING TOOLS USED
N1. Presentation N2. Group work N3. Consultation

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
F1 Project	PEU_W01 PEU_W02 PEU_U01 PEU_U02 PEU_K01 PEU_K02 PEU_K03	-attendance during the course -project
P = F1= 10 pkt. 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

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] H. Kara *Research and Evaluation for Busy Students and Practitioners: A Time-Saving Guide*
[2] C. Manning, P. Raghavan, H. Schutze *An Introduction to Information Retrieval*
[3] D. Lewandowski *Web Search Engine Research* (Library and Information Science, 4)

SECONDARY LITERATURE:

[1] A.Szewc *Informacja naukowo-techniczna*

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

Mateusz Jackowski, mateusz.jackowski@pwr.edu.pl

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: Zespołowy projekt badawczy
Name of subject in English: **Scientific team project**
Main field of study (if applicable): Chemical Engineering and Technology
Specialization (if applicable): Advanced Chemical Technology
Profile: academic
Level and form of studies: 2nd level, full-time
Kind of subject: obligatory
Subject code: **W03CET-SM2019P**
Group of courses: NO

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)				60	
Number of hours of total student workload (CNPS)				150	
Form of crediting (Examination / crediting with grade)				crediting with grade	
For group of courses mark (X) final course					
Number of ECTS points				6	
including number of ECTS points for practical classes (P)				6	
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)				3	

*delete as not necessary

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

n/a

SUBJECT OBJECTIVES

C1 preparation of research project
C2 deepening teamwork skills

SUBJECT EDUCATIONAL EFFECTS

In relation to skills:
PEU_U01 – is able to plan, carry out experiments / develop a project together with a team in accordance with the developed work plan
PEU_U02 – can initiate a discussion and actively participate in it
PEU_U03 – is able to develop the results of his/her work on a selected topic and present them in the form of a presentation
In relation to social competences:
PEU_K01 – is ready to critically evaluate the obtained results of research work PEU_K02 – is ready to comply with the principles of professional ethics and respect copyrights

PROGRAMME CONTENT		
Laboratory		**Number of hours**
Pr1	Discussion of the principles of project implementation and conditions for passing the course. Basics of PBL (project-based learning).	4
Pr2-7	Organization of group work. Division of roles and tasks. Development of the project's goal and assumptions, development of a work schedule. Collecting data for the project. Laboratory work (computer laboratory, technology laboratory, chemical laboratory) on a selected topic according to the schedule agreed with the project supervisor - stage I.	26
Pr8	Presentation of progress on the project	2
Pr9-14	Laboratory work (computer laboratory, technology laboratory, chemical laboratory) on a selected topic according to the schedule agreed with the project supervisor - stage II. Preparation of the report.	26
Pr15	Presentation (defense) of the project.	2
	Total hours	60

TEACHING TOOLS USED
N1. Consultations N2. Multimedia presentation N3. Discussion

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
P	PEU_U01 – PEU_U03 PEU_K01	assessment of the student's individual work during the project implementation assessment of group work evaluation of the report and presentation (project defense)

PRIMARY AND SECONDARY LITERATURE
Scientific and professional literature indicated by the course tutor and/or found by the student.
SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)
Supervisor of specialization

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: Seminarium dyplomowe
Name of subject in English: Graduation seminar
Main field of study (if applicable):
Specialization (if applicable):
Profile: academic
Level and form of studies: 2nd level, full-time
Kind of subject: obligatory
Subject code: **W03W03-SM1056S, W03W03-SM2056S**
Group of courses: NO

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)					15
Number of hours of total student workload (CNPS)					50
Form of crediting (Examination / crediting with grade)					crediting with grade
For group of courses mark (X) final course					
Number of ECTS points					2
including number of ECTS points for practical classes (P)					2
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)					0,7

*delete as not necessary

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

n/a

SUBJECT OBJECTIVES

C1 development of students' social competences in presenting the results of their diploma thesis, initiating discussions and actively participating in them

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:
PEU_W01 – has in-depth knowledge of the topic of the diploma thesis
relating to skills:

PEU_U01 – is able to collect and verify information necessary to learn about the selected research topic
PEU_U02 – is able to draw conclusions from the results of one's own research in relation to literature sources
PEU_U03 – is able to publicly present the results of his research and defend them during public discussion
PEU_U04 – is able to transfer knowledge to others
relating to social competences:
PEU_K01 – is aware of the importance of knowledge, including its critical analysis
PEU_K02 – is ready to deepen knowledge and skills, and, if necessary, use the help of experts

PROGRAMME CONTENT		
Seminar		**Number of hours**
Se 1	Discussion of the diploma process in the field of study	1
Se 2 – Se 15	Presenting a multimedia presentation and participating in the discussion	14
	Total hours	15

TEACHING TOOLS USED
N1. Presentation N2. Discussion N3. Consultations

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
P	PEU_W01 PEU_U01 –PEU_U04 PEU_K01 – PEU_K02	assessment based on the presentation and activity in discussions

PRIMARY AND SECONDARY LITERATURE
N/A
SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)
Chairman of the program committee for the relevant field of study Card preparation: Piotr Rutkowski, piotr.rutkowski@pwr.edu.pl

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 Zjawiska powierzchniowe i kataliza heterogeniczna

Name of subject in English: Surface Phenomena and Heterogenous Catalysis

Main field of study (if applicable): Chemical Engineering and Technology
Specialization (if applicable): Advanced Chemical Technologies
Profile: academic
Level and form of studies: 2nd level, full-time
Kind of subject: obligatory
Subject code W03CET-SM2013W, W03CET-SM2013L, W03CET-SM2013S
Group of courses NO

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30		30		15
Number of hours of total student workload (CNPS)	75		50		25
Form of crediting (Examination / crediting with grade)	Examination		Crediting with grade		Crediting with grade
For group of courses mark (X) final course					
Number of ECTS points	3		2		1
including number of ECTS points for practical classes (P)			2		
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1,2		1,2		0,6

*delete as not necessary

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Knowledge of English language (B2 level).
2. The knowledge of organic and inorganic chemistry.
3. The knowledge of physical chemistry.

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SUBJECT OBJECTIVES

C1. To fmilalise the student with basic concept of heterogeneous catalysis.
C2. To familiarise the student with phenomena occurring on catalyst surface.
C3. To train the student in different methods of catalyst preparation, ways of its physicochemical characterization and determination of its performance.
C4. To bring the student up to date with the catalytic processes applied in the chemical, fuel and energy industry.
C5. To familiarise the student with the state-of-the-art catalytic processes for environmental protection.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01 The student knows the fundamental definitions used in heterogeneous catalysis.
PEU_W02 The student understands the surface phenomena occurring on the catalyst during

reaction.
PEU_W03 The student understands the mechanisms of catalytic reaction.
PEU_W04 The student knows the methods of catalysts preparation and their characterization.
PEU_W05 The student knows the main problems occurring during catalytic processes linked to catalyst deactivation.
PEU_W06 The student can describe popular types of catalysts and reactions used in different branches of chemical industry.
PEU_W07 The student can describe basic catalytic processes used in different branches of chemical industry (i.e., for production of chemicals, fuels, energy and in automotive sector).

relating to skills:
PEU_U01 The student can synthesize solid catalyst on the grounds of literature data.
PEU_U02 The student is able to carry out the catalytic test of specific reaction, calculate the conversions, selectivities and yields of reaction products.
PEU_U03 The student can determine the chemical composition of catalyst and describe its structure features on the basis of results of its characterisation.
PEU_U04 The student is able to prepare a multimedia presentation, perform in public, and share the knowledge with the group.
PEU_U05 The student can work with research data provided through journals, books, and patents.
PEU_U06 The student can determine the role of the active sites required for the individual reaction.
PEU_U07 The student is able to select research methods regarding the characteristics of a given group of heterogeneous catalysts and determining their activity.

relating to social competences:
PEU_K01 The student is aware of the need for continuous training.
PEU_K02 The student develops the ability to behave properly in their learning and working environment, and beyond those.
PEU_K03 The student is able to work with others and develops their leadership skills.
PEU_K04 The student is aware of the non-technical effects associated with chemical processes.

PROGRAMME CONTENT

Lecture		**Number of hours**
Lec 1	Catalysis and catalyst - introduction. The significance of catalysis in everyday life. Catalysis in industry. Description of types of catalysis. Definitions of conversion, selectivity, activity, yield, turnover frequency. Thermodynamics and kinetics of catalytic reaction. Activation energy, equilibrium constant, rate constant, reaction order.	4
Lec 2	Reaction steps in heterogeneous catalysis. active sites, reaction mechanism (Eley-Rideal, Langmuir-Hinshelwood).	2
Lec 3	Adsorption process. Types of adsorption. Energy of adsorption. The significance of surface structure of the catalyst for adsorption process.	2
Lec 4	Crystallographic structure of metals and metal oxides. Classification of crystal imperfections and their impact on catalyst activity.	2
Lec 5	Active sites. Crystallography of active sites, geometrical factor, saturation of active sites. The acid-base character of catalyst surface. Electronic properties of active sites. Bifunctional catalysts.	2

Lec 6	Preparation of solid catalysts. Description of sol-gel method, impregnation, precipitation and co-precipitation. Supported catalyst.	4
Lec 7	Characterization of solid catalyst. Surface structure and chemical composition of catalysts - description of methods and procedures of solid catalysts characterization.	2
Lec 8	Catalyst deactivation. Poisoning, formation of deposits, thermal degradation. Prevention of catalyst deactivation. Catalyst regeneration.	2
Lec 9	Catalysis for the production of chemicals.	2
Lec 10	Catalysis for the production of fuels.	4
Lec 11	Catalysis in environmental protection. Desulfurization, reduction of NOx, methane reforming, VOC's oxidation.	4
	Total hours	30

Classes		**Number of hours**
Cl 1		
Cl 2		
Cl 3		
Cl 4		
..		
	Total hours	

Laboratory		**Number of hours**
Lab 1	Introduction.	2
Lab 2	Preparation of supported catalysts via wetness incipient impregnation method.	4
Lab 3	Preparation of Metalorganic frameworks via ultrasound assisted solvothermal method.	4
Lab 4	Determination of physicochemical properties of catalysts (determination of phase composition, morphology, textural properties, thermal stability and surface chemistry using XRD, STEM, N_2 sorption, TGA and FTIR).	8
Lab 5	Diffusion in catalytic bed.	4
Lab 6	Catalytic processes in the fixbed flow reactor - determiantion of the activity of heterogeneous catalyst in the reaction of synthesis gas production.	4
Lab 7	Catalytic processes in the batch reactor - determiantion of the activity of MOFs in the reaction of CO_2 conversion.	4
	Total hours	30

Project		**Number of hours**
Proj 1		
Proj 2		
Proj 3		
Proj 4		
…		
	Total hours	

Seminar		**Number of hours**
Semin 1	Methods for determining catalytic activity.	2

Semin 2	Temperature-programmed techniques for assessing the surface properties of the catalysts.	2
Semin 3	Zeolites – structure, properties and application in adsorption and catalysis.	2
Semin 4	Oxidation reactions on oxide catalysts.	2
Semin 5	Reactions in the hydrogen presence on metallic catalysts.	2
Semin 6	Reactions over acid-base catalysts.	2
Semin 7	Advanced materials in catalysis and adsorption.	3
	Total hours	15

TEACHING TOOLS USED

N1. Lecture with a multimedia presentation.
N2. Executive instructions for laboratory classes.
N3. Laboratory classes carried out with the use of research facilities.
N4. Individual consultations with the student.

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
P (lecture)	PEU_W01-PEU_W07	Grade from the exam: grade 2.0: 0-50% grade 3.0: 51- 60% grade 3.5: 61-70% grade 4.0: 71- 80% grade 4.5: 81- 90% grade 5.0: 91- 100%
F1 (laboratory)	PEU_U01-PEU_U03	Grade form the test (T)
F2 (laboratory)	PEU_U01-PEU_U03, PEU_K01-PEU_K04	Grade from the report (R)
P (seminar)	PEU_U04-PEU_U07, PEU_K01-PEU_K04	Grade of the student's presentation (S).
P (laboratory) Grade = 0.5xT + 0.5xR		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] „Handbook of Heterogeneous Catalysis", Editors: G. Erti, H. Knözinger, F. Schüth, J. Weitkamp, 2014, Wiley-VCH, ISBN: 9783527610044.
[2] J. Ross „Heterogeneous catalysis. Fundamentals and Applications." 2011, Elsevier, ISBN: 978-0-444-53363-0.
[3] „Heterogeneous Catalysis and Fine Chemicals II", Editors: M. Guisnet et al.,1991, Elsevier, 978-0-444-88514-2.

SECONDARY LITERATURE:

[1] G. Rothenberg „Catalysis: Concepts and Green Applications" 2008, Wiley-VCH, ISBN 978-3-527-31824-7.
[2] M. Ziółek, I. Nowak „Kataliza heterogeniczna. Wybrane zagadnienia" Wydawnictwo Naukowe UAM
[3] Electrionic sources / Elsevier

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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: Trendy w inżynierii i technologii chemicznej
Name of subject in English: Trends in Chemical Engineering and Technology
Main field of study (if applicable): Chemical Engineering and Technology
Specialization (if applicable):
Profile: academic
Level and form of studies: 2nd level, full-time
Kind of subject: obligatory
Subject code: **W03CET-SM2004W**
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)	Zaliczenie na ocenę				
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)	1,2				

*delete as not necessary

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

n/a

SUBJECT OBJECTIVES

C1 To familiarize the student with the latest trends and achievements in chemical engineering and technology

SUBJECT EDUCATIONAL EFFECTS

In relation to knowledge:

PEU_W01 – has in-depth knowledge of development trends and new achievements in the field of chemical engineering and technology and related sciences

PEU_W02 – has in-depth knowledge of the latest materials, apparatus and devices used in chemical processes at various scales

In relation to social competences:
PEU_K01 – is ready to critically evaluate the knowledge acquired and the content received
PEU_K02 – is aware of the role of a technical university graduate and the need to maintain the ethos of the engineering profession

PROGRAMME CONTENT

	Lecture	**Number of hours**
Wy1-W7	A collection of current topics reflecting the diversity of contemporary trends in chemical engineering. Presenting the latest scientific achievements in the field of chemical engineering.	14
Wy8-Wy14	A collection of current topics reflecting the diversity of contemporary trends in chemical technology. Presenting the latest scientific achievements in the field of chemical technology.	14
Wy15	Summary lecture with discussion.	2
	Total hours	30

TEACHING TOOLS USED

N1. Presentation
N2. Discussion

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
P	PEU_W01-PEU_W02 PEU_K01- PEU_K02	Writing test (to pass minimum 50% of points)

PRIMARY AND SECONDARY LITERATURE

[1] Presentations
[2] Supporting literature provided during classes by the teachers

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

heads of specialties: Advanced chemical engineering, Advanced chemical technology

KARTY PRZEDMIOTÓW – SEMESTR UZUPEŁNIAJĄCY – STUDIA 4-SEMESTRALNE

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: Podstawy grafiki inżynierskiej
Name of subject in English: Basics of technical drawing
Main field of study (if applicable): all fields
Specialization (if applicable):
Profile: academic
Level and form of studies: 1st level, 2nd level – supplementary semester, full-time
Kind of subject: obligatory
Subject code: W03W03-SM2025P
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				crediting with grade	
For group of courses mark (X) final course					
Number of ECTS points				2	
including number of ECTS points for practical (P) classes				2	
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)				1.4	

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Basic knowledge of computers

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SUBJECT OBJECTIVES

C1 Familiarisation with the technical drawing conventions.
C2 Learning to read and making a design drawing.
C3 Working knowledge of using the computer aided design software in making and modifying the technical documentation.

SUBJECT EDUCATIONAL EFFECTS

Related to skills:

PEU_U01 – understands the conventions of technical drawing and the role of standardisation on technical drafting.

PEU_U02 – can project the planar and three-dimensional objects in views.
PEU_U03 – possesses skills at representation and dimensioning of existing and proposing objects according to technical drawing conventions.
PEU_U04 – has the sufficient knowledge of reading the design drawings and chemical plant diagrams.
PEU_U05 – has the working knowledge of using computer aided design applications in making the technical documentation.

PROGRAMME CONTENT		
Project		**Number of hours**
Pr 1	Organising class. Familiarisation with the safety rules in the computer room. Teaching tools and conditions of course completion. Standardisation of technical drawing. Searching for standard exercises.	2
Pr 2	Introduction to CAD application. The user interface, workspace, drawing area, creating and modifying of objects in AutoCAD. Setting the desired AutoCAD operating parameters. Creating a drawing based on the coordinates of points.	2
Pr 3	Introduction to CAD application. Creation and organisation of 2D objects. Drawing objects in AutoCAD: line, polyline, arc, circle, ellipse, rectangle, polygon.	2
Pr 4	Introduction to CAD application. Selection and modifications of objects in AutoCAD: move, copy, rotate, mirror, scale, trim, extend, break, fillet, chamfer, explode, offset.	2
Pr 5	Principles of technical drawing (types of drawings, sheet formats, drawing plates, types and thickness of drawing lines, technical writing). Auto CAD: the creation of inscriptions, managing layers, printing technical documentation.	2
Pr 6-7	Representation of planar and spatial objects in projections (axonometric, orthographic and central projection). Dimensioning the drawings.	4
Pr 8-10	Representation of the interior details of an object. Cross-sections of objects: straight cross-section, half-section, cross-section with several intersecting planes, laying, local cross-section, cross-section and partial view. Dimensioning the drawings.	6
Pr11	Graphical symbols and diagrams in technical drawing. Chemical apparatus. Chemical installation diagrams. Test I	2
Pr12	Dimensioning of threaded joints and selected non-separable joints. Drawing simplifications. Dimensioning the drawings continued.	2
Pr13	Principles of preparing working and assembly drawings. Dimensional tolerances and fits of structural components, deviations in shape and position. Determination of the geometrical structure of surfaces.	2
Pr14	Graphical representation of intersecting objects. Sections of solids by planes and lines.	2
Pr15	Test II. Course acceptance.	2
	Total hours	30

TEACHING TOOLS USED

N1. Multimedia presentations N2. Using of AutoCAD software

EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

Evaluation (F – forming (during semester), P – concluding (at semester end)	Educational effect number	Way of evaluating educational effect achievement
F1	PEU_U01-PEU_U02	test I
F2	PEU_U03-PEU_U05	test II
F3-F8	PEU_U02-PEU_U05	drawings made in AutoCAD
P=[(F1+F2)/2+(F3+F4+...+F8)/6]/2 3,0 if 3,00 ≤ P < 3,25 3,5 if 3,25 ≤ P < 3,75 4,0 if 3,75 ≤ P < 4,25 4,5 if 4,25 ≤ P < 4,75 5,0 if 4,75 ≤ P < 5,25 5,5 if 5,25 ≤ P		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] B.Bielefeld, I.Skiba, Basics Technical Drawing, Birkhäuser 2013.
[2] K.Rathnam, A First Course in Engineering Drawing, Springer Singapore Pte. Limited 2017
[3] J.Leach, S.Lockhart, AutoCAD 2022 Instructor: A Student Guide for In-depth Coverage of Autocad's Commands and Features, SDC Publications, 2021

SECONDARY LITERATURE:

[1] C.Simmons, N.Phelps, Manual of Engineering Drawing: Technical Product Specification and Documentation to British and International Standards, Oxford: Elsevier Science & Technology 2012.
[2] A.Congdon-Fuller, A.Ramirez, D.Smith, Technical Drawing 101 with AutoCAD 2022, SDC Publications, 2021.
[3] A.Bhatt, AutoCAD 2022 Beginners Guide, CADFolks 2021.

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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: Bioreaktory
Name of subject in English: Bioreactors
Main field of study (if applicable): all fields of 2nd 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 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)	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

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FACULTY OF CHEMISTRY

SUBJECT CARD

Name in English	Biotechnology with introduction to industrial microbiology
Name in Polish	Biotechnologia z elementami mikrobiologii przemysłowej
Specialization (if applicable)	
Profile:	academic
Level and form of studies:	2nd level – supplementary semester /full-time
Kind of subject	obligatory
Subject code	W03W03-SM2007W, W03W03-SM2019P
Group of courses	NO

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30			15	
Number of hours of total student workload (CNPS)	50			50	
Form of crediting	crediting with grade			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			0,75	

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1.

SUBJECT OBJECTIVES

C1 Cognoscence of structure and functions of basic cells structures
C2 Cognoscence of fundamentals of gaining energy and nitritienst requirmenst of living cells
C3 Cognoscense of possibilities of application of living systems in biotechnology and industrial mmicrobiology - fundamentals

SUBJECT EDUCATIONAL EFFECTS

related to knowledge:

PEU_W01 – Student knows the structures and functions of macromolecules building living cells
PEU_W02 – Student knows the basics about cells metabolism
PEU_W03 – Student knows the basic methods of introduction of living systems into the industrial technology

Related to skills

PEU_U01 – Students can apply the principles of biotechnology to prepare the presentation on defined subject from the area of modern biotechnology

PROGRAMME CONTENT		
Form of classes - lecture		Number of hours
Lec 1	Fundamentals: proteins – general structure and functions	2
Lec 2	Fundamentals: proteins – general structure and functions	2
Lec 3	Fundamentals: – enzymes – classification and mode of action	2
Lec 4	Fundamentals: – enzymes – classification and mode of action	2
Lec 5	Fundamentals: – redox cycle in living cells	2
Lec 6	Fundamentals: – energy gaining cycle in living cells	2
Lec 7	Fundamentals: – nutrition requirements of microbes (bacteria and fungi)	2
Lec 8	Fundamentals: – basics of microbiological techniques	2
Lec 9	Fundamentals: – basics of microbiological techniques	2
Lec 10	Fundamentals: – methodology of scaling of microbial processes	2
Lec 11	Fundamentals: – methodology of scaling of microbial processes	2
Lec 12	Industrial processes with microbes - examples	2
Lec 13	Industrial processes with microbes - examples	2
Lec 14	Subjects repetitions. Final colloquium – I attempt.	2
Lec 15	Subjects repetitions. Final colloquium – II attempt.	2
	Total hours	**30**

Project		**Number of hours**
Proj 1	Students presentation of novel trends in industrial microbiology	15

TEACHING TOOLS USED	
N1	Lecture – multimedia presentation
N2	Project – multimedial presentation

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT		
Evaluation F – forming (during semester), P – concluding (at semester end)	Educational effect number	Way of evaluating educational effect achievement
P - lecture	PEK_W01- PEK_W03	Colloquium
P-project	PEK_U01	Grading of individual presenattion

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

„ Modern Industrial Microbiology and Biotechnology**”** Second Edition**,** Okafor Nduka**;** 2018**,** ISBN13

(EAN): 9781138550186

SUBJECT SUPERVISOR
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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 **Podstawy inżynierii chemicznej i procesowej**
Name of subject in English **Fundamentals of chemical and process engineering**
Main field of study (if applicable): **all fields of 2nd level studies**
Specialization (if applicable):
Profile: **academic**
Level and form of studies: **2nd level, supplementary semester (full-time)**
Kind of subject: **obligatory**
Subject code W03W03-SM2028W, W03W03-SM2028P
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 (Examination / crediting with grade)	Examination			Crediting with grade	
For group of courses mark (X) final course					
Number of ECTS points	2			2	
including number of ECTS points for practical classes (P)				2	
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1.3			1.5	

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Basic principles of chemical engineering.
2. Basic principles of chemical technology.

SUBJECT OBJECTIVES

C1 Providing the students with the rules of production process design.
C2 Acquiring fundamental knowledge about design procedures and use of this knowledge for solving problems and engineering tasks concerning momentum, heat and mass transfer processes.
C3 Providing the students with the rules of elaboration of production process course in designed plant, rules of general process scheme elaboration, mass and heat balances elaboration, principles of technological-equipment scheme elaboration.
C4 Providing the students with the rules of process apparatuses and equipment selection, with design rules of basic process equipment for momentum, heat and mass transfer processes, selection rules of control and measurement instruments.
C5 Acquiring the fundamental knowledge about calculation methods (design algorithms) of basic equipment in processes and unit operations of momentum, heat and mass transfer processes.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:
PEU_W01 – knows the design rules of production process, knows the rules of elaboration of process project of the industrial plant,
PEU_W02 – knows the design procedures and can apply them for solving the problems and engineering tasks in momentum, heat and mass transfer processes,

PEU_W03 – can elaborate the production process course, elaborate general and technological-equipment schemes, make mass and energy balances for the designed process,
PEU_W04 – can design the basic, simple process equipment used in processes and unit operations of momentum, heat and mass transfer.

relating to skills:
PEU_U01 – can determine productability / economic capacity of batch or continuous plant,
PEU_U02 – can formulate design problems and solve engineering tasks in processes and unit operations of momentum, heat and mass transfer in production processes, including: flow resistances in the apparatuses, balancing the mass and heat streams, process kinetics, characteristics of pipelines, pump selection, sedimentation, filtration, heat transfer and heat exchangers, mass transfer and mass exchangers (e.g. absorption, adsorption, extraction, crystallization), batch and continuous stirred reactors,
PEU_U03 – can make general scheme of production process, propose technological-equipment scheme,
PEU_U04 – can select and design basic process equipment used in processes and unit operations of momentum, heat and mass exchange.

relating to social competences:
PEU_K01 – can cooperate in a design and laboratory group,
PEU_K02 – can present the results of the work.

PROGRAMME CONTENT

	Lecture	**Number of hours**
Lec1	Stages of new technology elaboration. Technical-economical assumptions, process design, technical design.	2
Lec2	Design procedures. Rules of the process project elaboration. Design assumptions. Productability / economic capacity of batch or continuous plant.	2
Lec3	Processes and unit operations of momentum transfer. Hydrodynamics, pumps, sedimentation, filtration, mixing and mixers.	2
Lec4	Processes and unit operations of heat transfer. Conduction and heat transfer, interphase heat transfer, heat exchangers.	2
Lec5	Processes and unit operations of mass transfer. Absorption, adsorption, extraction, distillation – mass exchangers.	2
Lec6	Processes and unit operations of mass transfer (continuation). Crystallization, crystallizers, stirred chemical reactors.	2
Lec7	Production process course. Process data, general scheme of production process. Raw materials, products, wastes, environment protection.	2
Lec8	Material and energetic balances. Indicators of raw materials and energy consumption.	2
Lec9	Selection of process equipment and apparatuses. Selection of constructional materials.	2
Lec10	Technological-equipment scheme of the designed production process. Selection of measurement and control instruments.	2
Lec11	Process equipment requiring individual design. Design algorithms of basic equipment for momentum transfer processes.	2
Lec12	Process equipment requiring individual design. Design algorithms of basic equipment for heat transfer processes.	2
Lec13	Process equipment requiring individual design. Design algorithms of basic equipment for mass transfer processes.	2
Lec14	Design of batch or continuous stirred chemical reactors.	2

Lec15	Technical safety of the plant. Rules of investment costs and exploitation costs estimation.	2
	Total hours	**30**
Project		**Number of hours**
Proj1	Calculation of productability / economic capacity of continuous and batch plants.	2
Proj2, Proj3	Calculations in selected unit operations of momentum transfer: flows in pipeline system and process equipment, sedimentation, filtration, mixing.	4
Proj4	Calculations in selected unit operations of heat transfer: conduction, heat transfer, interphase heat transfer.	2
Proj5, Proj6	Calculations in selected unit operations of mass transfer: absorption, adsorption, extraction, distillation, crystallization, stirred tank chemical reactors.	4
Proj7	Material balances for exemplary production processes, calculation of raw materials consumption indicators.	2
Proj8	Energy balances for exemplary production processes, calculation of energy consumption indicators.	2
Proj9	Elaboration of general scheme of production process, technological-equipment scheme of industrial plant.	2
Proj10	Design of flow tank, pump selection.	2
Proj11	Design of heat exchanger.	2
Proj12	Design of mixer.	2
Proj13	Design of batch and continuous stirred reactor.	2
Proj14	Design of continuous crystallizer with internal circulation of suspension.	2
Proj15	Credit test.	2
	Total hours	**30**

TEACHING TOOLS USED

N1. Lecture with multimedia presentation.
N2. Solving of engineering and design problems.
N3. Project consultations.

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
P (lecture)	PEU_W01 – PEU_W04	Examination.
P2 (project)	PEU_U01 – PEU_U04	Crediting with grade.

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] J. Ciborowski: *Podstawy inżynierii chemicznej*, WNT, Warszawa, 1982.
[2] J. Pikoń: *Aparatura chemiczna*, PWN, Warszawa, 1978.
[3] D.W. Green, R.H. Perry (red.): *Perry's chemical engineers' handbook*, 8th ed., McGraw–Hill, 2007.
[4] S. Kucharski, J. Głowiński: *Podstawy obliczeń projektowych w inżynierii chemicznej*, OWPWr, Wrocław, 2000.
[5] Pr. zbiorowa: *Zadania projektowe z inżynierii procesowej*, OWPW, Warszawa, 1986.

SECONDARY LITERATURE:

[1] Himmelblau: *Basic principles and calculation in chemical engineering*, N. Y., 1986.
[2] G.I. Wells, L.M. Rose: *The art of chemical process design*, Elsevier, 1986.
[3] W.D. Seider: *Process design principles*, J.W.&S., 1999.
[4] U. Bröckel, W. Meier, G. Wagner (red.): Product design and engineering. Vol. 1: *Basics and technologies*, Vol. 2: *Rawmaterials, additives and application*, Wiley, 2007.

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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: Podstawy projektowania w technologii chemicznej
Name of subject in English: Fundamentals of chemical technology design
Main field of study (if applicable): all Faculty of Chemistry
Specialization (if applicable):
Profile: academic
Level and form of studies: 2nd level – supplementary semester, full-time
Kind of subject: obligatory
Subject code: W03W03-SM2030W, W03W03-SM2030P
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)	75			50	
Form of crediting	crediting with grade, exam (2nd level in english)			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			1,5	

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Knowledge of general chemistry: properties of substances, stoichiometry
2. Knowledge of physical chemistry: thermodynamics, kinetics
3. Knowledge of mathematics: differentiation, integration, differential equations

SUBJECT OBJECTIVES

C1 To familiarize with basic concepts and laws in the field of chemical technology
C2 To familiarize with material and thermal balances of the process.
C3 To familiarize with physicochemical properties of substances and methods of their evaluation
C4 To teach methods of engineering calculations of chemical processes
C5 Use of Excel spreadsheet and professional software to create simple projects and simulations

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:
PEU_W01 – knows basic technological principles
PEU_W02 - knows principles of preparing material and energy balances
PEU_W03 - knows methods to estimate physicochemical properties of a studied substance
PEU_W04 - knows basics of composition and temperature of a reacting system calculations
relating to skills:
PEU_U01 – can reach data sources about properties of a studied substance
PEU_U02 - can make simple material and energy balances and analyze them
PEU_U03 - can perform simple engineering calculations
PEU_U04 - can use professional computer software for simple engineering calculations and simulation of selected processes

PROGRAMME CONTENT

Lectures		Number of hours
Lec1	Basic terminology: technological process, chemical method concept, technological method concept. Discussion of technological principles: the principle of the best use of raw materials, the principle of the best use of energy, the principle of the best use of equipment, the principle of technological moderation. Unit operations.	2
Lec2	Material balance of the chemical process: the principle of mass conservation, the principle of atoms conservation, the principle of energy conservation. Analysis of material balance of steady-state processes. Material balance of systems with chemical reaction. The degree of conversion in the stoichiometric and non-stoichiometric mixture of reagents. Process efficiency. Process diagram, stream diagram simulation. Computer programs used to simulate chemical processes.	2
Lec3	Energy balance. Basic concepts: system state variables, system state. Principle of energy conservation, energy components of systems: internal energy, work, heat, enthalpy. Calculation of enthalpy changes. Enthalpy of reaction. The influence of temperature and pressure on the enthalpy of the reaction.	2
Lec4	Ideal gas: the equation of state, properties. Compressibility factor. Compression and expansion work . Polytropic transformation. Classification of chemical processes, types of balance sheets.	2
Lec5	Properties of chemical substances. Sources of technological information - databases. Condensed phases. Estimation of physicochemical properties: density, viscosity, critical parameters. Thermodynamic properties. Critical state of matter.	2
Lec6	Real gas. Deviations from the ideal state. Compressibility factor for real gases. Equations of real gas state. Acentric coefficient. Mixtures of real gases.	2
Lec7	Factor of gas and liquid activity. Definition of volatility and volatility coefficient. Equations for calculating volatility coefficient. Liquid activity factor. LewisRandal's rule. Phase equilibria. Functions of deviation from the ideal state.	2
Lec8	Chemical reaction. Stoichiometry; concentration, degree of conversion relative to a concentration and molar stream (change in volume). Direction of reaction; elimination of component reactions as part of the chemical process concept. Composition calculation (reaction run to the end).	2
Lec9	Composition in a state of equilibrium. Equilibrium constant. Temperature dependence of the equilibrium constant. Reactions with a change in the number of moles; pressure influence; technological treatments (excess reagent, reduction of concentration - examples). Calculation of equilibrium composition based on selected examples.	2
Lec10	Kinetic equation. Rate of an elementary reaction; concentration dependence. Irreversible and reversible elementary reactions; solving appropriate differential equations. Reaction rate constant. Change of composition over time. Rate of real reaction; full kinetic model, simplified descriptions. An approximation of the state of equilibrium and an approximation of the stationary state. Examples of complex reactions. Use of experimental data.	2
Lec11	Tank reactor. Periodic work system; perfect mixing, volume dependency on the degree of conversion and reaction time. Flow system; equation of component continuity, perfect mixing, steady state, design equation of a continuous-stirred tank reactor, conventional reaction time.	2

Lec12	Plug flow reactor. Design equation for a piston type system in a steady state. Comparison of volume and degree of conversion in continuous reactors: tank and tubular.	2
Lec13	Estimation of composition and temperature in the studied system. Heat balance. Examples. Adiabatic reaction.	2
Lec14	Written credit I	2
Lec15	Written credit II	2
	Total hours	**30**
Project		**Number of hours**
Pr1	Introduction. Basics of the used computer software. Principles of a material balance creation without chemical reaction.	2
Pr2	Simulation of selected processes - material balance without chemical reaction, process limitation.	2
Pr3	Simulation of selected processes - material balance, returned stream. Project I.	2
Pr4	Principles of material balance of processes with chemical reactions.	2
Pr5	Simulation of selected processes - material balance with parallel reactions. Project II.	2
Pr6	Projects and material overview.	2
Pr7	Written credit I.	2
Pr8	Analysis of the chemical process with regards to reaction kinetics - elementary reactions, calculations of concentrations of selected reagents, time necessary to achieve the state of equilibrium in studied systems.	2
Pr9	Analysis of the chemical process with regards to reaction kinetics - complex reactions, estimation of reaction order and kinetic parameters on the basis of experimental data.	2
Pr10	Volumetric gas properties determined from third degree real gas state equations. Project III.	2
Pr11	Volumetric gas properties determined from the Lee-Kesler real gas state equation.	2
Pr12	Functions of deviation from the ideal state: free energy, enthalpy, free enthalpy, entropy, volatility. Project IV.	2
Pr13	Influence of pressure and temperature on an equilibrium reaction process.	2
Pr14	Projects overview. Written credit II.	2
Pr15	Written credit - second term.	2
	Total hours	**30**

TEACHING TOOLS USED

N1. Lecture with multimedia presentation
N2. Excel spreadsheet
N3. Polymath computer software
N4. Computer software for simulation of chemical processes (ChemCAD or Aspen Plus)

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming (during semester), P –	Learning outcomes number	Way of evaluating learning outcomes achievement

concluding (at semester end)		
P (lecture)	PEU_W01 – PEU_W03	Written credits I and II, exam
F1 (project)	PEU_U01 – PEU_U04	Written credit I
F2 (project)	PEU_U01 – PEU_U04	Written credit II
P (project) = (F1 + F2) / 2		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] S. Kucharski, J. Głowiński, Podstawy obliczeń projektowych w technologii chemicznej, 3 wyd., Oficyna Wyd. PWr, Wrocław 2010

[2] J. Szarawara, J. Piotrowski, Podstawy teoretyczne technologii chemicznej, WNT, Warszawa 2010

SECONDARY LITERATURE:

[1] R.C. Reid, J.M. Prausnitz, B.E. Poling, The properties of gases and Liquids, 4th ed., Mcgraw-Hill, New York 1987

[2] Praca zbiorowa, Przykłady i zadania do przedmiotu Podstawy technologii chemicznej, Oficyna Wyd. PWr, Wrocław 1991

[3] W. Ufnalski, Wprowadzenie do termodynamiki chemicznej, Oficyna Wyd. PW, Warszawa 2004

[4] H.S. Fogler, Elements of Chemical Reaction Engineering, Fourth Ed., Prentice Hall PTR, New Jersey, 2005.

[5] D. M. Himmelblau, J. B. Riggs, Basic Principles and Calculations in Chemical Engineering, Seventh Ed., Prentice Hall PTR, New Jersey, 2004.

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

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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 *Informatyka dla inżynierów*
Name of subject in English *Informatics for engineers*
Main field of study (if applicable): …….
Specialization (if applicable): ……..
Profile: academic / ~~practical~~*
Level and form of studies: ~~1st~~/ 2nd level, ~~uniform magister studies~~*, full-time / ~~part-time~~*
Kind of subject: obligatory / ~~optional / university-wide~~*
Subject code W03W03-SM2018L
Group of courses ~~YES~~ / 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		
For group of courses mark (X) final course					
Number of ECTS points			2		
including number of ECTS points for practical classes (P)			2		
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)			1,4		

*delete as not necessary

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Basic knowledge of general chemistry, linear algebra, mathematical analysis;
2. Basic knowledge of computer science;
3. Specialized English.

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SUBJECT OBJECTIVES

C1 Introducing main chemical, biological and bibliographic databases.
C2 Teaching about basic formats used in chemical and bioinformatic databases.
C3 Introducing software used for drawing and visualization of chemical structures and macromolecules.
C4 Teaching students the basics of the scripting language.
C5 Teaching students the skills allowing the automation of computational tasks.

SUBJECT EDUCATIONAL EFFECTS

relating to skills:
PEU_U01 – ability to search chemical and bibliographic databases and biological sequences databases;
PEU_U02 – ability to use chemical structures visualization tools;
PEU_U03 – ability to select appropriate methods and tools for the studied problem;
PEU_U04 – ability to develop an algorithm;

PEU_U05 – ability to use a scripting language to automate computational tasks and solve simple numerical problems.

PROGRAMME CONTENT

Laboratory		Number of hours
Lab 1	**Introductory classes**: the program of laboratory classes, organization and rules of the computer lab, grading rules. Introduction of basic tools and software used during the course.	2h
Lab 2 & Lab 3	**Scientific databases**: introduction to the selected chemical, scientific and bibliographic databases (e.g. Reaxys, ChemSpider, CSD, PDB, Scopus, WoS, NCBI), data organization and presentation, search options. The importance of obtaining scientific information from reputable and verified sources will be discussed.	4h
Lab 4	**Data formats and visualization of molecule structures:** introduction to data formats used in chemical and structural databases and the formats used for biological sequences. Practical exercises on searching for information in chemical databases. Practical examples of the use of visualization software and tools used for building of molecular structures.	2h
Lab 5	Individual Project I	2h
Lab 6	**Introduction to Python**. Introduction of numerical data types and arithmetic operators. The first scripts - working with numerical data and using arithmetic operators. Introduction of interactive Python.	2h
Lab 7	**Basic data types**. Overview of basic data types: numbers and strings. Writing scripts that use data provided by the user. Practical examples of using Help.	2h
Lab 8	**Conditional statement**. Overview of the principles of creating conditional statements and creating a group of statements. Practical examples e.g. calculating factorials, printing a multiplication table.	2h
Lab 9	**Advanced data types** - lists, tuples, dictionaries. Creating lists, tuples and dictionaries as well as introduction of their operators and methods. Writing scripts using these data types. Programming test I.	2h
Lab 10	**While loop**. Overview of the principles of creating loops controlled by a logical condition together with practical examples.	2h
Lab 11	**Modules**. The rules of importing modules and their use in practice (math and random module). Practical exercises with a while loop.	2h
Lab 12	**For loop**. Overview of the principles of creating a counter controlled loop. Programming test II.	2h
Lab 13	**Counter controlled loop**. Practical examples of scripts using counter-controlled loops, exercises with complex instructions and loop control statements.	2h
Lab 14	**Text Files**. Overview of processing of text files. Exercises using biological sequences.	2h
Lab 15	Programming test III. Repetition of tests I and II. Discussion of Individual Project.	2h
	Total hours	30h

TEACHING TOOLS USED

N1. Lecture/presentation
N2. Scripts writing
N3. Practical usage of databases
N4. Practical usage of software
N5. Solving the exercises

N6. Preparation of reports

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
F1	PEU_U01-PEU_U03	Report from the Individual Project I
F2	PEU_U03-PEU_U05	Programming test I
F3	PEU_U03-PEU_U05	Programming test II
F4	PEU_U03-PEU_U05	Programming test III
P = (F1 + F2 + F3 + F4)/4		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Python 3 documentation: https://docs.python.org/3/
[2] Python Crash Course, 3rd Ed.: A Hands-On, Project-Based Introduction to Programming, Matthes E., No Starch Press, 2023
[3] Python Programming: An Introduction to Computer Science, Zelle J. Ingram short title, 2016

SECONDARY LITERATURE:

[1] Python Programming for Beginners, Robbins P., 2023

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

Renata Grzywa, PhD, renata.grzywa@pwr.edu.pl

FACULTY OF CHEMISTRY

SUBJECT CARD

Name of subject in Polish: Wprowadzenie do nauki o materiałach i inżynierii materiałowej
Name of subject in English: Introduction to material science and engineering
Main field of study (if applicable):
Specialization (if applicable):
Profile: academic
Level and form of studies: 2nd level – supplementary semester, full-time
Kind of subject: obligatory
Subject code: W03W03-SM2003W
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	crediting with grade				
For group of courses mark final course with (X)					
Number of ECTS points	2				
including number of ECTS points for practical (P) classes					
including number of ECTS points for direct teacher-student contact (BU) classes	1,3				

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Basic knowledge of the structure of matter.
2. Fundamentals of physics, mechanics, electronics, chemistry and physical chemistry.
3. Basic knowledge about the structure of popular engineering materials.
4. Communicative English skills.

SUBJECT OBJECTIVES

C1 To familiarize students with the basic relationships between the structure of the material and its properties.
C2 To familiarize students with the principles of selection of materials for various applications.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01 The student has basic knowledge about the structure of popular construction materials.
PEU_W02 The student understands the impact of structure defects on the potential properties of materials.
PEU_W03 The student understands the impact of diffusion on the properties of construction materials.
PEU_W04 The student has basic knowledge about the mechanical properties of materials and the generation of damage.
PEU_W05 Student understands the impact of heat treatment on the properties of metals and alloys.
PEU_W06 The student knows the basic electrical and magnetic properties of materials.
PEU_W07 The student knows the basic optical and thermal properties of materials.
PEU_W08 The student knows the selected methods of fabrication of materials.
PEU_W09 The student understands the concept of composite materials and knows their example applications.
PEU_W10 The student knows the concept of corrosion, its impact on the degradation of materials and how to prevent it.

PROGRAM CONTENT		
Lectures		**Number of hours**
Lec 1	Atomic structure of solids. Bonding in solids.	2
Lec 2	Structures of metals, ceramics and polymers.	2
Lec 3	Defects in solids. Diffusion phenomena.	2
Lec 4	Mechanical properties of materials.	2
Lec 5	Deformation and strengthening of materials.	2
Lec 6	Failure of materials.	2
Lec 7	*I test*	2
Lec 8	Phase diagrams and phase transformations.	2
Lec 9	Electrical and magnetic properties of materials.	2
Lec 10	Optical and thermal properties of materials.	2
Lec 11	Synthesis, fabrication and processing of materials.	2
Lec 12	Composites materials.	2
Lec 13	Corrosion and degradation of materials.	2
Lec 14	*II test*	2
Lec 15	*Correction of test I and/or test II*	2
	Total hours	**30**

TEACHING TOOLS USED

N1. Lecture - multimedia presentation + solving simple calculation tasks.
N2. Discussion with students.
N3. E-books and databases.

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	PEU_W01 – PEU_W04	Test with multiple-choice answers. About 20 questions, including one descriptive one.
F2	PEU_W05 – PEU_W10	Test with multiple-choice answers. About 20 questions, including one descriptive one.

P – concluding grade, which consists of the total number of points obtained from both tests, with the obligatory obtaining about half of the points from each partial test. Grade scale according to the following scheme (% of points = grade):
46-55 = dst

56-65 = dst+
66-75 = db
76-85 = db+
>86 = bdb

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Ashby M.F., Materiały inżynierskie. 1. Właściwości i zastosowania, W N-T, Warszawa, 1997.
[2] Ashby M.F., Materiały inżynierskie. 2. Kształtowanie struktury i właściwości, dobór materiałów, WNT, Warszawa, 1998.
[3] Ashby M.F., Shercliff H., Cebon D., Materials: engineering, science, processing and design, Elsevier: Butterworth-Heinemann, Amsterdam, 2007.
[4] Askeland D.R., Phule P. P., The Science and Engineering of Materials, Thomas Brooks/Cole, 2003.
[5] Callister W. D. Jr, Materials science and engineering, John Wiley & Sons, New York, 1990.

SECONDARY LITERATURE:

[1] Blicharski M., Wstęp do inżynierii materiałowej, Wyd. N-T, Warszawa 2003 (i wcześniejsze).
[2] Dobrzański L. A., Podstawy nauki o materiałach i metaloznawstwo, Wyd. N-T, Gliwice-Warszawa, 2002.
[3] Wyatt O. H., Wprowadzenie do inżynierii materiałowej, Wyd. N-T, Warszawa, 1978.
[4] Przybyłowicz K., Przybyłowicz J., Materiałoznawstwo w pytaniach i odpowiedziach, Wyd. N-T, Warszawa, 2004.
[5] Ciszewski A., Radomski T., Szummer A, Materiałoznawstwo, Oficyna Wydawnicza Politechniki Warszawskiej, Warszawa, 1998.
[6] Blicharski M., Inżynieria materiałowa – stal, WNT, Warszawa, 2004.

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

Dr hab. inż. Juliusz Winiarski, juliusz.winiarski@pwr.edu.pl
Department of Advanced Material Technologies

FACULTY OF CHEMISTRY

SUBJECT CARD

Name of subject in Polish	Odzysk i recykling materiałów
Name of subject in English	Material recovery and recycling
Main field of study (if applicable):	all field 2nd level
Specialization (if applicable):	
Profile:	academic
Level and form of studies:	2nd level – supplementary semester, full-time
Kind of subject:	obligatory
Subject code	W03W03-SM2027W
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	crediting with grade				
For group of courses mark (X) final course					
Number of ECTS points	2				
including number of ECTS points for practical (P) classes					
including number of ECTS points for direct teacher-student contact (BU) classes	1,3				

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. General Chemistry

\SUBJECT OBJECTIVES

C1 To familiarize students with the basic terminology of waste
C2 To familiarize students with the structure and systems of waste collection.
C3 To familiarize students with the basic methods of waste management.
C4 Awakening of environmental awareness.

SUBJECT EDUCATIONAL EFFECTS

In the field of knowledge:

A person who has passed the examination:
PEU_W01 – Student knows the basic terminology associated with waste management.
PEU_W02 – Student has a basic knowledge about the symbols and designations used to label the materials for recycling.
PEU_W03 – Student has a basic knowledge of the collection and distribution systems of waste materials.
PEU_W04 – Knows the basic legal conditions for recycled materials.
…

PROGRAMME CONTENT

	Lectures	**Number of hours**
Lec1	**Selective collection systems.** The division, the definition and sources of municipal waste and hazardous waste. Principles of waste management, basic definitions related to waste management. Logistics, waste recycling, its advantages and disadvantages, problems. Examples.	2
Lec2	**Classification, labeling materials.** The overall breakdown of characters and graphic symbols used to mark the packaging, recycling signs, signs indicating the	2

	proper waste handling.	
Lec3	**Waste management in Poland, part 1: Material Recycling** - definition, elements of the system, the barriers in the recycling process, the criteria for suitability for recycling.	2
Lec4	**Waste management in Poland, part 2: Material recycling** - European standards (applicable in Poland), heavy metals in the raw materials from recycling, recycling of paper and cardboard, recycling of glass packaging, metal packaging recycling, recycling of timber packaging and multimaterial packaging.	2
Lec5	**Waste management in Poland, part 3: Material recycling** - recycling of plastic packaging.	2
Lec6	**Waste management in Poland, part 4 Feedstock recycling** - definition, criteria for suitability for recycling of raw materials, disadvantages, advantages. Thermal and solvolytic processes used in the recycling of raw materials, examples.	2
Lec7	**Biological treatment part 1: Composting**. The legal basis, advantages and disadvantages, the criteria for the use of composting, limitations and conditions of composting, discuss progress and process parameters (pH, temperature, microorganisms).	2
Lec8	**Biological treatment, part 2: Methane fermentation.** Definition, classification, advantages, disadvantages, differences between composting and fermentation, fermentation steps, the most important parameters and microorganisms involved in the fermentation process. Fermentation methods one and two-stage, advantages and disadvantages. The substrates and products.	2
Lec9	**Incineration of waste**. Basic problems of waste incineration plants, safety, advantages and disadvantages.	1
Lec10	**Hazardous waste, part 1** - Definition, classification, origin. Methods of dealing with pharmaceuticals, batteries, fluorescent lamps, mercury-containing waste, appliances containing freon, electronics.	2
Lec11	**Hazardous waste, part 2** – Legislation. Disposal of used oils. Proceedings of vehicles spent product.	2
Lec12	**Analysis of the life cycle of consumables**. For selected examples – production, operation, recovery (home appliances, AGD).	2
Lec13	**Waste management in selected countries.**	2
Lec14	**Efforts to improve the situation in the field of waste management.** Shares information and education, legal, collection and transport, recovery, disposal.	2
Lec15	**Ethical problems related to the production and consumption.**	2
Lec 16	**Course credit**	1
	Total hours	30

TEACHING TOOLS USED

N1. Multimedia presentation
N2. Discourse

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
P1 (lecture)	PEU_W01-PEU_W04,	test

PRIMARY AND SECONDARY LITERATURE

BASIC LITERATURE:

[1] Systemy recyklingu odpadów opakowaniowych w asPEUcie wymagań ochrony środowiska / Hanna Żakowska, Wydawnictwo Akademii Ekonomicznej, 2008
[2] Odpady komunalne: zbiórka, recykling, unieszkodliwianie odpadów komunalnych i komunalnopodobnych, Wydawnictwo Politechniki Krakowskiej, 2005
[3] Procesy logistyczne w gospodarce odpadami / Józef Bendkowski, Maria Wengierek, Wydawnictwo Politechniki Śląskiej, 2002

SUPPLEMENTARY LITERATURE:

[4] Odzysk ciepła w procesie termicznej utylizacji odpadów medycznych / Janusz Wojciech Bujak, oficyna Wyd.Politechniki Wrocławskiej, 2010
[5] Wybrane zagadnienia recyklingu samochodów, Jerzy Osiński, Piotr Żach, Wydawnictwa Komunikacji i Łączności, 2006

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

Dr inż. Konrad Szustakiewicz, konrad.szustakiewicz@pwr.edu.pl

FACULTY OF CHEMISTRY

SUBJECT CARD

Name of subject in Polish	Techniki separacji i oczyszczania produktów
Name of subject in English:	Separation and purification of products
Main field of study (if applicable):	BIOTECHNOLOGY
Specialization (if applicable):	
Profile:	academic
Level and form of studies:	1st level, 2nd level – supplementary semester, full-time
Kind of subject:	obligatory
Subject code:	W03W03-SM2025W, W03W03-SM2025L
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)	25		50		
Form of crediting	crediting with grade		crediting with grade		
For group of courses mark (X) final course					
Number of ECTS points	1		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. Knowledge of such courses as chemical engineering, microbiology, biochemistry.
2. Ability to manually operate laboratory equipment such as spectrophotometer, analytical balance, automatic pipettes.
3. The ability to create diagrams for different types of functions (by computer), determining the function equation.

SUBJECT OBJECTIVES

C1 Getting familiar with the composition (homo- and heterogeneous systems) and the approach to the separation of post-reaction streams.
C2 Understanding the basics of using processes for the separation of heterogeneous systems.
C3 Learning the basics of diffusion processes application.
C4 Getting familiar with basic membrane techniques.
C5 Understanding the principles of multi-stage separation process designing.

SUBJECT EDUCATIONAL EFFECTS

related to knowledge:

PEU_W01 student knows and understands the basics of construction and the clue of the operation performed on apparatus components in processes conducted in both: laboratory and industrial scale, used for separating bioproducts and wastewater treatment.
PEU_W02 student has basic knowledge of separation techniques of heterogeneous and homogeneous systems.
PEU_W03 student knows the basic equations, which describe the kinetics of a given process.
PEU_W04 student has knowledge enabling him to select a given process (or cascade of processes) for a given application.

related to skills:

PEU_U01 student is able to carry out an experiment on laboratory scale equipment, develop the obtained

	results and present them in the form of a written report.
PEU_U02	student is able to purify biomolecules using a given separation method. He can measure the concentrations of the test ingredient and determine the degree of purification.
PEU_U03	student can assess profits of a given separation method for a given application and apply known equations to describe its kinetics.

PROGRAMME CONTENT

Lectures		**Number of hours**
Lec 1	Introduction to the separation of bioproducts. Division of methods.	2
Lec 2	Filtration - the fundamentals of the process, apparatus, application.	2
Lec 3	Division of suspensions. Sedimentation - the fundamentals of the process, apparatus, application.	2
Lec 4	Filtration - the basics of the process, types of partitions.	2
Lec 5	Filtration - apparatus, application.	2
Lec 6	Micro, ultrafiltration - the idea of membrane processes, apparatus, application.	2
Lec 7	Filtration and sediment centrifuge. Emulsions - structure, formation and disintegration.	2
Lec 8	Flotation - the fundamentals of the process, apparatus, application.	2
Lec 9	Introduction to diffusion processes. Extraction in a liquid-liquid system - the basics of the process, description of kinetics.	2
Lec 10	Extraction in a liquid-liquid system - apparatus. Solid–liquid extraction - the basics of the process, application	2
Lec 11	Classic and membrane distillation - the basics of the process, application.	2
Lec 12	Sorption - the basics of the process, description of kinetics, application.	2
Lec 13	Pervaporation - the basics of the process, description of kinetics, application apparatus.	2
Lec 14	Crystallization - process conditions, apparatus. Co-crystallization - the idea of the process, application.	2
Lec 15	Passing test	2
	Number of hours	**30**
Laboratory		**Number of hours**
Lab 1	Adsorption - determination and mathematical description of the adsorption rate and equilibrium state.	6
Lab 2	Extraction - determination of extraction kinetics and division coefficient in a batch system extraction (mixing); determination of working effectiveness in continuous system extraction (extraction column).	6
Lab 3	Flotation - determination of the enrichment and recovery factors gained during separation process.	6
Lab 4	Vacuum filtration - measuring the variability of the filtrate stream in time, description of the process with determination of compressibility index of the filter cake and determination of the liquid purification degree.	6
Lab 5	Sedimentation - determination of the sinking velocity of suspensions with different solid content. Distillation - determination of the composition of the distillate during periodic distillation duration, determination of the total alcohol mass obtained in the fermentation bottle subjected to distillation, process balance.	6

	Number of hours	**30**

TEACHING TOOLS USED

N1. Lecture
N2. Performing the experiment
N3. Description of results using computer graphics programs
N4. Consultations

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming (during semester), P – concluding (at semester end)	Educational effect number	Way of evaluating educational effect achievement
F1(lecture)	PEU_W01 - PEU_W04	Written test for maximum 10 points.
P (lecture) = F1= 10 pkt. 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-F5 (Laboratory classes)	PEU_U1 – PEU_03, PEU_K01 - PEU_K03	Points for each classes - quiz + report (max 5 points for each lab)
P (laboratory) = (F1 + F2 + F3 + F4 + F5 + F6) P = 3.0 if the sum of points is in the range of 60-67.9% 3.5 if the sum of points is in the range of 68-75.9% 4.0 if the sum of points is in the range of 76-83.9% 4.5 if the sum of points is in the range of 84-89.9% 5.0 if the sum of points is in the range of 90-98% 5.5 if the sum of points is> 98%		
F3		
P		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] R. Gawroński- Procesy oczyszczania cieczy- Oficyna Wydawnicza Politechniki Warszawskiej, W-wa 1996
[2] Pod redakcją P. Lewickiego- Inżynieria procesowa i aparatura przemysłu spożywczegoWyd. Naukowo-Techniczne, W-wa 1999
[3] E. Pijanowski, M. Dłużewski – Ogólna technologia żywności – Wyd. NaukowoTechniczne, W-wa 1997
[4] R. Rautenbach – Procesy membranowe, Wyd. Naukowo-Techniczne, W-wa 1996

SUPPLEMENTARY LITERATURE:

[5] W.W. Blanch, D.S. Clark – Biochemical Eng.- rozdz.6, NY 1996
[6] P. Better, E. Cussler – Bioseparations-downstream processing for biotechnology – Wiley&Sons Publication 1988

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

ANNA TRUSEK, anna.trusek@pwr.edu.pl

FACULTY OF CHEMISTRY

SUBJECT CARD

Name in Polish	Bezpieczeństwo techniczne w przemyśle
Name in English	Technical safety in industry
Main field of study (if applicable):	Chemical Technology, Chemical and Process Engineering,Chemistry, Chemical and Process Engineering, Biotechnology
Level and form of studies:	2nd level – supplementary semester, full-time
Kind of subject:	obligatory
Subject code	W03W03-SM2026W, W03W03-SM2026L
Group of courses	NO

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	15		15		
Number of hours of total student workload (CNPS)	25		25		
Form of crediting	crediting with grade		crediting with grade		
For group of courses mark final course with (X)					
Number of ECTS points	1		1		
including number of ECTS points for practical (P) classes			1		
including number of ECTS points for direct teacher-student contact (BK) classes	0,65		0,7		

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Knowledge of chemistry on the secondary school level
2. Fundamental knowledge on the chemical safety
3. Skill in computer operation

SUBJECT OBJECTIVES

C1 To familiarize students with the basics of technical safety
C2 National and European law regulations related to the technical safety
C3 Learning algorithms for analysis of industrial installations hazards
C4 Teach students of the health risk assessment associated with industrial failures
C5 Familiarizing students with examples of spreading chemical pollution and with the methodology of calculations of spreading the contaminants in the environment

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01 - familiar with basic concepts and definitions of technical safety
PEU_W02 - can specify the basic legislative acts governing the national and European technical safety rules
PEU_W03 – knows the common elements of industrial operational and emergency response
PEU_W04 – familiar with the main provisions of environmental law, Seveso III directive and of the Convention on the transboundary effects of industrial accidents
PEU_W05 – able to apply methods of risk analysis to identify possible failure in industrial installations
PEU_W06 – knows how to describe the basic methods of analysis of the health risks in areas contaminated as a result of industrial accidents

relating to skills:

PEU_U01 – can use the databases in order to classify plants in terms of the risks involved
PEU_U02 – knows how to carry out an analysis of the hazards in simple industrial installations
PEU_U03 – can suggest remedial measures in the event of an industrial accident in simple chemical installations

PEU_U04 – can perform simple calculations of exposure to the contamination of the environment after the failure of industrial plant PEU_U05 – can use the tools to model the spreading of chemical contamination		
PROGRAM CONTENT		
Lectures		**Number of hours**
Lec 1	**Basic concepts.** The subject of technical safety, safety perception, the essence of enterprise security, basic definitions, security scopes, importance of safety as a guarantee of the existence of an entity, the risk and examples of threats to the elements of the environment. Risks for the environment. The state of insecurity, its social and economic effects. Types of security. Examples of technical failures, the analysis of the causes and effects.	2
Lec 2	**Safety-related items.** Safety features versus general security companies. Organisation and management, skills, specificity of manufacturing technology, infrastructure condition, emergency planning, internal reviews and analysis of accidents, development of safe work, organisation of operational service posts, striving for as few nuisance work. Analysis of the causes of industrial accidents. Characteristics of chemical companies, dangers, hazardous chemical substances.	2
Lec 3	**Polish and the European legislation**. Environmental law, Directive 67/548/EEC. Groups of substances and preparations considered dangerous. Explosive substances (E) oxidizing (O), extremely flammable (F+), flammable (F), flammable (R10), very toxic (T+), toxic (T), harmful (Xn), corrosive (C), irritant (Xi), sensitizing (R42 and/or R43), carcinogenic (karc..), mutagenic (Muta.), toxic to reproduction (Repr.), which are dangerous for the environment (N or/and R52, R53, R59), European Council Directive 96/82/EC, the Convention on the transboundary effects of industrial accidents, environmental law, Seveso-enterprises, non-Seveso enterprises, criteria.	2
Lec 4	**Toxic industrial agents, industrial accidents, severe crashes, industrial contamination.** Process safety. Functional safety, safety assessment map. A comprehensive evaluation of the installation process in the various phases of the realisation of the investment.	2
Lec 5	**Risk assessment methods.** Identification of potential threats. HAZard and OPerability Study (hazard and operability study), its goals, importance, specialty risks. Keywords, main and auxiliary keywords, installations, design objectives, deviations from design intent, hazards, parameter, operational problems, the experts, the process, pairs of keywords in hazards analysis.	2
Lec 6	**Examples of HAZOP analysis.** Chemical process, the analysis of installation nodes, HAZOP team of experts, the structure of the team, the team of experts work scheme, the development of HAZOP report, deviation, deviation result, the security, the action. Certification of persons carrying out safety circuits, design and service.	2
Lec 7	**The principles of contamination assessment** resulted from the industrial accidents, toxicity, carcinogenicity, principles for the risks evaluation in areas contaminated as a result of industrial accidents. Exposure-transmission path-receptor relationship. Elements of the risk assessment procedures, hazard identification, exposure assessment, dose-response identification, risk assessment, uncertainty analysis. Health risk, the risk quotient, the risk index.	2
Lec 8	Elimination of the effects of industrial accidents, environment remediation methods for the areas contaminated as a result of industrial accidents, examples. Summary. Knowledge check.	1
	Total hours	**15**

Laboratory		Number of hours
Lab 1	Determination of the limits of flammability and explosion of chemical substances	2
Lab 2	Determination of the effects related to the influence of toxic vapours of volatile substances resulting from industrial accidents	2
Lab 3	Analysis of explosive substances emissions and risks associated with their spread in the environment	2
Lab 4	Calculation of the level limits of toxic substances during outflow from a tank, taking into account different topography and atmospheric conditions	2
Lab 5	Analysis of risks related to the emission of toxic substances during the free evaporation from the open tank	2
Lab 6	Liquefied gas discharge from a pipeline. Hazard analysis and prevention consultation and the development of exercises.	2
Lab 7	Calculation of the migration limits of dangerous substances and their concentrations in areas with dense infrastructure	2
Lab 8	Consultations and development of laboratory reports.	1
	Total hours	**15**

TEACHING TOOLS USED

N1. Software EFFECTS 9 to calculate the potential risks arising from industrial accidents
N2. ALOHA software to calculate the effects of emissions of hazardous substances into the environment
N3. Multimedia presentations
N4. The laboratory test stand

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
P (lecture)	PEU_W01 – PEU_W06	final test
F (laboratory)	PEU_U01 – PEU_U05,	reports from the laboratory excercises

P1 (laboratory) = (F1+F2+F3+F4+F5+F6)/6

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] M.Ryng, Bezpieczenstwo techniczne w przemsle chemicznym , WNT Warszawa 1985
[2] Praca zbiorowa, Zapobieganie stratom w przemyśle, Pol. Łódzka, Łódź 1999
[3] W. Pihowicz, Inżynieria bezpieczeństwa technicznego, Problematyka podstawowa, WNT 2009

SECONDARY LITERATURE:

[1] Granice palności zgodnie z normą PN-EN 720-2, wskaźniki wybuchowości zgodnie z normą PN-EN26184-2, temperatury zapłonu w tyglu Clevelanda i Pensky'ego Martnsa
[2] Wydawnictwo Ministerstwa Przemysłu Chemicznego pt. "Niebezpieczne materiały chemiczne - charakterystyka, zagrożenia, ratownictwo" - Biuro Wydawnicze "Chemia" Warszawa 1989r.

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

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