

## 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, sociology, 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	<b>Basics of chemical production:</b> 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	<b>Industry-environment relationship, measurements:</b> 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	<b>Structure of the chemical industry in Poland, environmental management systems:</b> 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	<b>Energy management:</b> 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	<b>Water environment protection:</b> 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	<b>Soil and atmosphere protection:</b> the impact of the chemical industry on atmosphere and soil pollution; characteristics of gaseous pollutants; methods of preventing atmospheric pollution; remediation.	2
Lec 7	<b>Waste management in the chemical industry:</b> 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	<b>Summary of the lecture and crediting with grade.</b>	1
	Total hours	<b>15</b>
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	<b>30</b>

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
<b>P (lecture)</b>	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
<b>P (laboratory)</b> =(F1+F2+F3+F4+F5+F6+F7)/7		

PRIMARY AND SECONDARY LITERATURE
<b><u>PRIMARY LITERATURE:</u></b> [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 <b><u>SECONDARY LITERATURE:</u></b> [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

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