



## Subject card

Subject name and code	, PG_00037586						
Field of study	Green Technologies						
Date of commencement of studies	October 2020	Academic year of realisation of subject			2023/2024		
Education level	first-cycle studies	Subject group			Obligatory subject group in the field of study Subject group related to scientific research in the field of study		
Mode of study	Full-time studies	Mode of delivery			at the university		
Year of study	4	Language of instruction			Polish		
Semester of study	7	ECTS credits			3.0		
Learning profile	general academic profile	Assessment form			assessment		
Conducting unit	Department of Chemistry and Technology of Functional Materials -> Faculty of Chemistry						
Name and surname of lecturer (lecturers)	Subject supervisor	dr hab. inż. Anna Skwierawska					
	Teachers	dr hab. inż. Anna Skwierawska					
Lesson types and methods of instruction	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	30.0	0.0	0.0	0.0	0.0	30
	E-learning hours included: 0.0 Additional information: All lectures conducted in the 2023/2024 academic year are carried out remotely.						
Learning activity and number of study hours	Learning activity	Participation in didactic classes included in study plan	Participation in consultation hours		Self-study	SUM	
	Number of study hours	30	10.0		35.0	75	
Subject objectives	<ol style="list-style-type: none"><li>1. Acquainting students with environmental problems occurring during extraction and purification of raw materials of the organic industry.</li><li>2. To familiarize students with large-volume processes based on non-renewable raw materials:<ul style="list-style-type: none"><li>• fuel production</li><li>• production of organic chemicals</li><li>• emission of dusts, gases, sewage and solid waste.</li></ul></li><li>3. Comparison of primary methods with processes that meet the assumptions of green chemistry</li><li>4. Understanding examples of processes based on renewable raw materials.</li></ol>						

Learning outcomes	Course outcome	Subject outcome	Method of verification
	[K6_W02] has a basic knowledge of chemistry including general chemistry, inorganic, organic, physical, analytical, including the knowledge necessary to describe and understand the phenomena and chemical processes occurring in the environment; measurement and the determination of the parameters of these processes.	The student uses the acquired knowledge to understand technological processes. The student proposes changes to existing technologies aimed at reducing the waste generated.	[SW1] Assessment of factual knowledge [SW2] Assessment of knowledge contained in presentation
	[K6_U02] is able to operate equipment and perform typical analyzes of studies of environmental pollution, is able to carry out an analysis of typical environmental pollution and simple devices according to specification	The student is able to select appropriate techniques for controlling technological processes.	[SU2] Assessment of ability to analyse information [SU3] Assessment of ability to use knowledge gained from the subject [SU4] Assessment of ability to use methods and tools
Subject contents	<p>Overview of catalysts used in organic technology. Examples of industrial catalysts production.</p> <p>Processes based on coal: coking, liquefaction and gasification. Fuel production. Can they be carried out under non-waste conditions and low emissions to the environment?</p> <p>Natural gas: Are extraction and preliminary purification carried out in accordance with the principles of green chemistry. Is production of syngas from natural gas more environmentally friendly process compared to gasification of coal? Are processes based on syngas examples of green organic technology?</p> <p>Crude oil: Does extraction of crude oil cause environmental threats?. Does pretreatment of crude oil is a waste-producing process? Crude oil processing: distillation, reforming. Production of aromatic compounds from crude oil. Are they implemented in accordance with the principles of green chemistry?</p> <p>Are processes: cracking, hydrocracking, oligomerization, isomerization and alkylation and delayed coking being examples of unfriendly technologies? Is the production of synthetic fuels a better solution than oil-based technologies?</p> <p>Olefin pyrolysis. Industrial use of alkanes and alkenes (C1 - C4). Production of ethylbenzene, styrene, cumene, phenol. Production of higher alkylaromatic hydrocarbons. MTBE production. Amine production. Do there alternative, fully green processes exist?</p> <p>Oxidation, oxidizing agents and problems of operation of the oxidation plant. Exothermicity of oxidation processes. Types of industrial oxidation processes. Catalytic liquid phase oxidation processes. Catalytic gas phase oxidation processes. Environmental threats.</p> <p>Halogenation processes. The importance of halogenation and fluorination processes in the organic synthesis industry. Issues related to the safety of operation of a halogen-derivative plant. Processes of halogenation of aliphatic hydrocarbons. Chlorohydrin production. Chlorination processes of aromatic compounds. Organochlorine residue chlorosis processes. Environmental threats.</p> <p>Issues related to the operational safety of nitration installations. Engineering issues. Nitration of aliphatic compounds. Nitration of aromatic compounds. Esters of nitric acid (V). Sulfonation of aromatic compounds. Sulphonation of alkanes. O-sulfonation. Production of selected surfactants. Production of sulfonamides. Pesticide and drug production.</p> <p>Renewable raw materials in organic technology .</p>		
Prerequisites and co-requisites	<ul style="list-style-type: none"> <li>• Knowledge of industrial analytical techniques.</li> <li>• Knowledge of organic chemistry.</li> <li>• Knowledge of basic techniques of water, air and soil protection.</li> <li>• Basic knowledge of technology and chemical engineering.</li> <li>• Knowledge of green inorganic technologies.</li> </ul>		
Assessment methods and criteria	Subject passing criteria	Passing threshold	Percentage of the final grade
	written colloquium no. 1; time 60 min.	60.0%	50.0%
	written colloquium no. 2; time 60 min.	60.0%	50.0%

Recommended reading	Basic literature	<p>Nicholas E. Leadbeater, Microwave Heating as a Tool for Sustainable Chemistry, 2010;</p> <p><a href="https://doi.org/10.1201/97814398127096">https://doi.org/10.1201/97814398127096</a>.</p> <p>Andrew P. Dicks, Green Organic Chemistry in Lecture and Laboratory, 2012;</p> <p><a href="https://doi.org/10.1201/b11236">https://doi.org/10.1201/b11236</a></p> <p>Suresh C. Ameta, Rakshit Ameta, Green Chemistry Fundamentals and Applications, 2014; <a href="https://doi.org/10.1201/b15500">https://doi.org/10.1201/b15500</a></p> <p>Vera M. Kolb, Green Organic Chemistry and Its Interdisciplinary Applications, 2016; <a href="https://doi.org/10.1201/9781315371856">https://doi.org/10.1201/9781315371856</a></p> <p>Miguel A. Esteso, Ana Cristina Faria Ribeiro, A. K. Haghi, Chemistry and Chemical Engineering for Sustainable Development. Best Practices and Research Directions, 2020;</p> <p><a href="https://doi.org/10.1201/9780367815967">https://doi.org/10.1201/9780367815967</a></p> <p>Shrikaant Kulkarni, Ann Rose Abraham, A. K. Haghi, Renewable Materials and Green Technology Products Environmental and Safety Aspects, 2021;</p> <p><a href="https://doi.org/10.1201/9781003055471">https://doi.org/10.1201/9781003055471</a></p>
	Supplementary literature	Current scientific articles devoted to the discussed. issues.
	eResources addresses	Adresy na platformie eNauczanie:
	Example issues/ example questions/ tasks being completed	<p>Emission of pollutants and production of waste during the production of syngas from various raw materials. Production of organic compounds. Environmental threats. Production of fuels from gas, oil and coal. Environmental threats. Waste management. Technologies without waste.</p>
Work placement	Not applicable	