GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Organic technology, PG_00060873		
Field of study	Chemical Technology		
Date of commencement of studies	October 2024	Academic year of realisation of subject	2026/2027
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	3	Language of instruction	Polish
Semester of study	6	ECTS credits	6.0
Learning profile	general academic profile	Assessment form	exam
Conducting unit	Department of Chemistry and Technology of Functional Materials -> Faculty of Chemistry -> Faculties of Gdańsk University of Technology		
Name and surname of lecturer (lecturers)	Subject supervisor	dr hab. inż. Anna Schmidt	
	Teachers		

Lesson types

Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
Number of study hours	30.0	0.0	30.0	0.0	15.0	75

E-learning hours included: 0.0

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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	75	5.0	70.0	150

Subject objectives

The aim of the course is to provide students with an advanced understanding of organic technology, including the processing of petrochemical, gaseous and renewable feedstocks, as well as key industrial processes used in the production of organic compounds. Students explore the principles of designing and evaluating technological processes, such as catalytic synthesis, petroleum and natural gas conversion, biomass utilisation, and the manufacturing of specialised products including fragrances, surfactants and pharmaceuticals.

The course develops students ability to analyse organic processes in terms of efficiency, safety, BAT compliance and environmental impact, while preparing them to work in teams involved in technological tasks within the chemical and pharmaceutical industries.

Learning outcomes

Course outcome	Subject outcome	Method of verification
[K6_U06] is able to select the chemical and technological concept of the production method, is able to justify the suitability of the raw materials used, analyses and evaluates the quality of the products obtained, critically analyses the functioning of existing technical solutions and evaluates these solutions	Is able to design and optimize an organic synthesis on a laboratory scale, considering the type of raw materials, substrate purity, and product purification strategies. Can analyze technological efficiency, suggest apparatus improvements, and evaluate the quality and applicability of the obtained compounds based on analytical results (e.g. TLC, NMR, IR, HPLC).	[SU3] Assessment of ability to use knowledge gained from the subject
[K6_K02] understands the non-technical aspects and implications of the activities of a chemical engineer, including the impact on the environment, is aware of professional behaviour, observance of professional ethics and respect for diversity of views and cultures	Is aware of the impact of organic technology on the environment and human health; knows good practices for reducing toxic emissions in synthesis and purification processes, understands the need to minimize chemical waste and choose technologies that comply with the principles of sustainable development.	[SK5] Assessment of ability to solve problems that arise in practice [SK1] Assessment of group work skills
[K6_W05] has knowledge of chemical technology based on mineral or energy resources and modern energy sources, understands the concept of sustainable development, knows the principles of green chemistry and environmentally friendly process engineering, has knowledge of occupational safety in the chemical industry	Has knowledge of the use of renewable raw materials and methods to reduce energy consumption in organic synthesis. Can identify solutions compliant with green chemistry principles, such as designing waste-free processes, minimizing toxic reagents, and optimizing reaction parameters. Understands the basics of personal protective equipment and the handling of organic chemical waste.	[SW1] Assessment of factual knowledge
[K6_W03] has knowledge of environmental protection in chemical technology, the classification of technological processes in terms of their environmental impact and how to eliminate the environmental impact of technological installations	Understands the sources of pollution in organic synthesis processes and can classify technologies based on their environmental impact. Can identify methods for reducing the environmental footprint of organic technologies, such as the use of less hazardous reagents, solvent recovery, closed-loop systems, and equipment that minimizes emissions.	[SW1] Assessment of factual knowledge
[K6_U03] is able to apply knowledge of inorganic, organic, physical and analytical chemistry and identify appropriate sources of information to design and synthesize simple chemical compounds, carry out basic physicochemical and analytical measurements	Can plan and carry out basic processes of organic compound synthesis while maintaining safety requirements and chemical purity of the product. Can also select appropriate literature sources and patents to design organic reactions, assess their synthetic usefulness, and plan basic analytical procedures to verify the course of the reaction.	[SU3] Assessment of ability to use knowledge gained from the subject [SU4] Assessment of ability to use methods and tools [SU2] Assessment of ability to analyse information [SU1] Assessment of task fulfilment

Subject contents	Course content – lecture Seminarium służy utrwaleniu treści wykładowych z technologii organicznej poprzez pracę zespołową i analizę rzeczywistych procesów przemysłowych. Studenci, pracując w grupach, opracowują i prezentują zagadnienia dotyczące przetwarzania surowców petrochemicznych, gazowych, odnawialnych i naturalnych, ze szczególnym uwzględnieniem ich znaczenia technologicznego, ekonomicznego i środowiskowego. Zakres seminarium obejmuje: analizę technologii przetwarzania gazu ziemnego, biomasy i węgla, w tym procesów zgazowania, upłynniania i konwersji do gazu syntezowego oraz jego zastosowań (oxo-synteza, metanol, DME, kwasy organiczne, paliwa); omówienie przemysłowych procesów petrochemicznych: krakingu, hydrokrakingu, reformingu, izomeryzacji, oligomeryzacji, alkilowania, koksowania oraz produkcji alkenów i aromatów; ocenę technologii organicznych obejmujących reakcje utleniania, uwodornienia, odwodornienia, nitrowania, sulfonowania, chlorowania, hydratacji, dehydratacji i estryfikacji; analizę wykorzystania alkanów i alkenów (C1C4) oraz surowców odnawialnych w syntezie organicznej i produkcji kluczowych półproduktów oraz związków funkcjonalnych (MTBE, etylobenzen, kumen, alkiloaromaty, alkilofenole, aminy); przegląd procesów wytwarzania kosmetyków, farmaceutyków, surfaktantów i substancji czynnych (API) wraz z omówieniem wymagań czystościowych i farmakopealnych; zespołowe przeglądy literaturowe oraz prezentacje dotyczące wybranych technologii organicznych, trendów przemysłowych, bezpieczeństwa procesowego, BAT i oceny oddziaływania na środowisko. Seminarium rozwija umiejętność interpretacji procesów organicznych, pracy zespołowej oraz krytycznej oceny rozwiązań technologicznych stosowanych w przemyśle chemicznym. Course content – laboratory • Synthesis and application of catalysts (6 hours) • Pharmaceutical production (6 hours) • Thermal decomposition of biomass (3 hours) • Solubility (3 hours) • Renewable raw materials in organic technology (3 hours) • Selected topics in petroleum refining (3 hours) • Fragrance compounds (3 hours) • Treatment of wastewater containing organic compounds (3 hours) Course content – seminar The seminar reinforces key lecture topics in organic technology through group work and practical analysis of industrial processes. Working in teams, students prepare and present case studies on the processing of petrochemical, gaseous, renewable and natural feedstocks, focusing on their technological, economic and environmental significance. The seminar covers: analysis of technologies for processing natural gas, biomass and coal, including gasification, liquefaction and conversion to synthesis gas, along with its applications (oxo synthesis, methanol, DME, organic acids, fuels); discussion of major petrochemical processes: cracking, hydrocracking, reforming, isomerisation, oligomerisation, alkylation, coking, and the production of alkenes and aromatic compounds; evaluation of industrial organic processes such as oxidation, hydrogenation, dehydrogenation, nitration, sulfonation, chlorination, hydration, dehydration and esterification; assessment of the use of alkanes and alkenes (C1C4) and renewable feedstocks in organic synthesis and in the manufacturing of key intermediates and functional chemicals (MTBE, ethylbenzene, cumene, alkyl aromatics, alkylphenols, amines); review of the production of cosmetics, pharmaceuticals, surfactants and active pharmaceutical ingredients (APIs), including purity requirements and pharmacopeial standards; team-based literature reviews and presentations on selected organic technologies, industrial trends, process safety, BAT requirements and environmental impact assessment. The seminar develops students ability to interpret organic processes, work collaboratively and critically evaluate technological solutions used in the chemical industry.

Prerequisites and co-requisites	Students undertaking this course should have: • factual knowledge of organic chemistry (nomenclature, types of reactions, basic mechanisms), • basics of physical and analytical chemistry (chemical equilibria, kinetics, quantitative determination techniques), • the ability to work safely in a chemical laboratory and knowledge of basic procedures for the synthesis and purification of organic compounds, • experience in preparing laboratory documentation (keeping a laboratory journal, interpreting analytical data). Additional requirements (recommended): • ability to use literature and patent databases to search for data on the synthesis of organic compounds, • basic teamwork and communication skills for presenting experiment results.

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
The final grade for the lecture is based on a written exam and an oral exam. The written exam assesses knowledge of the lecture content, understanding of technological processes, and the ability to analyse theoretical problems. The oral exam verifies deeper understanding of the material, independence of reasoning, and the ability to explain phenomena related to organic technology.	60.0%	60.0%
The final laboratory grade is calculated as the arithmetic mean of the grades obtained for each laboratory exercise. Each exercise grade consists of three components: Quiz – assessing theoretical preparation for the experiment. Group work – including performance of the experiment, safety, organisation, and teamwork. Report – describing the procedure, results, analysis, and conclusions. Each exercise is graded individually, and the final laboratory grade is the average of all completed exercises.	60.0%	20.0%
The final grade for the seminar is calculated as the arithmetic mean of two components: Quizzes (testing knowledge of the lecture content) Group work (including preparation of presentations, teamwork, and participation in discussions) To pass the seminar, the student must obtain at least 60% in each of the two components. If either component is below 60%, the seminar is considered failed, regardless of the overall average.	60.0%	20.0%

Recommended reading

Basic literature

Weissermel, K.; Arpe, H.-J. *Industrial Organic Chemistry.* 5th revised edition, Wiley-VCH, Weinheim New York, 2010, ISBN 978-3-527-32002-8

Ullmanns Encyclopedia of Industrial Chemistry. 7th Edition (40-volume set), Wiley-VCH, Weinheim / Chichester, 20112014. ISBN 978-3-527-30673-2

Kirk-Othmer Encyclopedia of Chemical Technology. 5th Edition, John Wiley & Sons, 27-volume set, New York / Weinheim, 2004 (rozpoczęta wcześniej; stan aktualnej edycji na 2004).

	Supplementary literature	**Matar, M.S., Mirbach, M.J., Tayim, H.A. (eds.)** *Catalysis in Petrochemical Processes.* Kluwer / Springer, Dordrecht, 1989 (często cytowane także jako 1988), ok. 200216 s. **Kent, J.A., Bommaraju, T.V., Barnicki, S.D. (eds.)** *Handbook of Industrial Chemistry and Biotechnology*. Springer, Cham, 2017, (wyd. 2017, wersja rozszerzona względem ed. 2012).
	eResources addresses	

Example issues/ example questions/ tasks being completed	1. Raw materials and preliminary processes - Discuss the composition, properties, and applications of crude oil fractions. - Explain catalytic reforming and its industrial significance. - Compare natural gas purification methods and their impact on further processing. - Task: propose a technological scheme for preparing natural gas for reforming. 2. Synthesis gas and applications - Compare steam reforming, autothermal reforming, and partial oxidation. - Explain differences between oxo processes and methanol synthesis. - Task: calculate required H/CO ratios. 3. Biomass and renewable feedstocks - Discuss thermal decomposition of biomass. - Compare biomass and coal gasification. - Task: evaluate biomass potential as a C1C4 source. 4. Petroleum refining - Define thermal and catalytic cracking. - Explain hydrocracking. - Task: list key reactions in isomerisation and reforming. 5. Alkenes and aromatics production - Explain ethane/propane pyrolysis. - Discuss olefin metathesis. - Task: design the production of ethylbenzene. 6. Industrial organic processes - Describe nitration mechanisms. - Compare liquid- vs gas-phase oxidation. - Task: propose conditions for dehydrogenation.

	7. C1C4 alkanes and alkenes - Explain MTBE formation. - Discuss cumene technology. - Task: compare ethylbenzene production routes. 8. APIs and specialty products - Pharmacopeial requirements. - Task: propose purification methods for an API intermediate. 9. Wastewater treatment - Methods for removing organic compounds. - Task: select treatment techniques. 10. Catalysis - Role of catalysts. - Compare heterogeneous and homogeneous catalysis.
Practical activites within the subject	Not applicable

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