



## COURSE DESCRIPTION CARD - SYLLABUS

Course name

Technologie separacji (Separation technologies)

### Course

Field of study

Year/Semester

Technologia chemiczna (Chemical Technology)

I/2

Area of study (specialization)

Profile of study

Technologia organiczna (Organic Technology)

general academic

Level of study

Course offered in

Second-cycle studies

Polish

Form of study

Requirements

full-time

compulsory

### Number of hours

Lecture

Laboratory classes

Other (e.g. online)

30

0

Tutorials

Projects/seminars

0

0

### Number of credit points

3

### Lecturers

Responsible for the course/lecturer:

Responsible for the course/lecturer:

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### Prerequisites

basic knowledge of general chemistry, physical chemistry, thermodynamics, organic chemical technology and chemical engineering (curriculum of the first degree studies), as well as broadly understood environmental protection, including types of pollution; ability to obtain information from indicated sources.

### Course objective

Obtaining theoretical knowledge in the field of membrane separation methods. Theoretical foundations of individual membrane separation techniques and their areas of application in various industries,



wastewater treatment, and water preparation processes. Membrane modules and principles of construction of membrane installations. Hybrid systems in air and wastewater treatment processes, as well as the production of organic bio-compounds

### Course-related learning outcomes

#### Knowledge

K\_W3 - has knowledge of complex chemical processes, including the appropriate selection of materials, raw materials, methods, techniques, apparatus and equipment for carrying out chemical processes and characterizing the products obtained

K\_W8 has extended knowledge of environmental issues related to the implementation of chemical processes

K\_W11 has an established and expanded knowledge of the selected specialty

#### Skills

K\_U1 has the ability to obtain and critically evaluate information from literature, databases and other sources, and formulate opinions and reports on this basis

K\_U11 is able to properly verify the concepts of engineering solutions in relation to the state of knowledge in technology and chemical engineering

K\_U12 has the ability to adapt knowledge of chemistry and related fields to solve problems in the field of chemical technology and planning new industrial processes

K\_U15 is able to critically analyze industrial chemical processes and introduce modifications and improvements in this area, using the acquired knowledge, including knowledge about the latest achievements of science and technology

K\_U17 can critically assess the practical usefulness of using new developments in chemical technology

#### Social competences

K\_K1 is aware of the need for lifelong learning and professional development

K\_K3 professionally recognizes problems and makes the right choices related to the exercise of the profession, in accordance with the principles of professional ethics

K\_K7 understands the need to provide the public with information on the current state and directions of development of chemical technology, on the principles of use and handling of chemical products, about the risks of obtaining raw materials, chemical production and distribution

### Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Written/oral exam graded on the basis of a points system (0-100 points)

3                      50,1 -70,0 points



4	70,1 -90,0 points
5	90,1 -100 points

### Programme content

The lectures cover the following topics:

1. Basic concepts and definitions regarding membrane separation techniques
2. Modeling of mass transport in porous and non-porous membranes
3. Characteristics and modeling of concentration polarization processes and membrane fouling
4. Pressure-driven membrane separation techniques (theoretical foundations of processes: MF, UF, NF, RO and areas of industrial applications)
5. Concentration-driven membrane separation processes (process characteristics: GS, DD, PV and examples of applications)
6. Current-driven membrane techniques (classical ED and bipolar ED)
7. Membrane distillation (process characteristics and application examples)
8. Liquid membranes (characteristics and areas of application)
9. Membrane reactors (construction assumptions, catalytic membranes, examples of applications)
10. Hybrid and multi-stage separation systems based on membrane techniques

### Teaching methods

Lecture: multimedia presentation illustrated with examples shown on a blackboard.

### Bibliography

Basic

1. M. Bodzek, J. Bohdziewicz, K. Konieczny, Techniki membranowe w ochronie środowiska, Wydawnictwo Politechniki Śląskiej, Gliwice, 1997.
2. M. Bodzek, K. Konieczny, Wykorzystanie procesów membranowych w uzdatnianiu wody, Oficyna Wydawnicza Projprzem-EKO, Bydgoszcz 2005.
3. J. Rautenbach, Procesy membranowe, WNT, Warszawa 1996.
4. skrypt pod red. K. Prochaska, Techniki separacji membranowej, Wydawnictwo PP, Poznań 2012.

Additional

1. P. W. Atkins, Chemia fizyczna, Wyd. Nauk. PWN, Warszawa 2003.



2. M. Bodzek, K. Konieczny, Usuwanie zanieczyszczeń nieorganicznych ze środowiska wodnego metodami membranowymi, Wydawnictwo Seidel-Przywecki, Warszawa 2011.
3. Z. J. Grzywna, A. Strzelewicz, Opis matematyczny i analiza transportu masy gazów i par przez membrany polimerowe lite: czyste składniki i mieszaniny gazów, Membrany teoria i praktyka, z. III, Wykłady monograficzne i specjalistyczne, Toruń 2009, 5–29.
4. J. Ceynowa, Membrany selektywne i procesy membranowe, Membrany teoria i praktyka, z. II, Wykłady monograficzne i specjalistyczne, Toruń 2009, 7–29.
5. M. Mulder, Basic Principles of Membrane Technology, Kluwer Academic Publishers, Dordrecht 1992
6. E. Biernacka, T. Suchecka, Techniki membranowe w ochronie środowiska, Wyd. SGGW, Warszawa 2004.
7. H. Strathmann, Ion-Exchange Membrane Separation Processes, Elsevier, New York 2004. International Publishing AG, 2017.

#### Breakdown of average student's workload

	Hours	ECTS
Total workload	60	3,0
Classes requiring direct contact with the teacher	30	1,5
Student's own work (literature studies, preparation for exam) <sup>1</sup>	30	1,5

<sup>1</sup> delete or add other activities as appropriate