STUDY MODULE DESCRIPTION FORM

Name of the module/subject **Membrane Techniques**		Code
Field of study **Environmental Protection Technologies**	Profile of study (general academic, practical) **general academic**	Year /Semester
Elective path/specialty **-**	Subject offered in: **Polish**	Course (compulsory, elective) **compulsory**
Cycle of study: **I-step**	Form of study (full-time,part-time) **full-time**	
No. of hours Lecture: **15** Classes: **-** Laboratory: **30** Project/seminars: **-**		No. of credits
Status of the course in the study program (Basic, major, other) **Basic**	(university-wide, from another field)	
Education areas and fields of science and art		ECTS distribution (number and %) **2**

Responsible for subject / lecturer:

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Prerequisites in terms of knowledge, skills and social competencies:

1	**Knowledge**	basic knowledge of general chemistry, physical chemistry, thermodynamics, and chemical technology and chemical engineering, as well as broadly understood environmental protection, including its pollutants.
2	**Skills**	The ability to solve elementary problems in the field of inorganic chemistry and chemical technology, including the ability to assess the feasibility of the process on an industrial scale and control its course and analysis of its impact on the natural environment; proposal of waste disposal methods; ability to obtain information from the indicated sources;
3	**Social competencies**	understanding the need to expand competences, thinking creatively, the ability to make responsible decisions

Assumptions and objectives of the course:

Obtaining theoretical and practical knowledge in the field of membrane separation methods. Getting to know the theoretical foundations of individual membrane separation techniques and capabilities and areas of industrial applications. Practical familiarization with the work of modules and membrane installations (laboratory classes and design classes).

Study outcomes and reference to the educational results for a field of study

Knowledge:

1. The student has ordered, theoretically founded knowledge in the field of environmental protection technology and waste management
2. The student has knowledge in the field of separation and concentration processes, including the appropriate selection of materials, apparatus and devices for effective implementation of separation processes.
3. The student knows the basic processes, techniques, methods and tools used in the broadly understood environmental protection technology
4. The student has a basic knowledge of the construction and selection of apparatus used in various separation and concentration processes
5. The student has knowledge about the latest technologies of separation, including technologies for water, soil and atmosphere purification, knows current trends in the development of industrial separation and concentration processes

Skills:

1. The student is able to effectively solve elementary problems in the field of widely understood environmental protection based on literature and experimental data.
2. The student is able to effectively assess the impact of a specific separation and concentration technology on the natural environment.
3. The student is able to plan and design the process of industrial wastewater and atmosphere treatment.
4. The student has the ability to adapt knowledge in the field of chemistry and related fields to solve problems of water, sewage and atmosphere, and planning new membrane installations, including hybrid solutions.

Social competencies:

1. The student is aware of the effects of engineering and related responsibilities.
2. The student has a shaped awareness of the limitations of science and technology related to the protection of the natural environment.
3. The student is aware of the dissemination of knowledge in the field of environmental protection in society

Assessment methods of study outcomes

written / oral exam

assessment of student's activity in laboratory classes, assessment of teamwork and solving scientific problems

Course description

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. Characterization and modeling of concentration polarization and membrane fouling processes
4. Pressure driven separation techniques (theoretical basis of processes: MF, UF, NF, RO and areas of industrial applications)
5. Concentrational processes of membrane separation (characteristics of processes: GS, DD, PV and examples of their applications)
6. Current driven membrane techniques (ED classic and ED bipolar)
7. Membrane distillation (process characteristics and examples of applications)
8. Membrane reactors.

Basic bibliography:

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.

Additional bibliography:

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, Kliwer Academic Publishers, Dfordrecht 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.

Result of average student's workload

Activity	Time (working hours)
Preparation for the exam and exam	10
Participation in lectures	15
Preparation for laboratory exercises and participation in laboratory classes	40

Student's workload

Source of workload	hours	ECTS
Total workload	65	2
Contact hours	45	
Practical activities	30	