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 **3/6**
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 subject of the projects are the following issues:

Path A - Membrane techniques in water treatment processes

1. MF in the treatment of groundwater and surface waters
2. UF in the treatment of underground and surface water
3. The use of NF in the treatment of drinking water and for economic needs
4. NF in the processes of softening sea water
5. Application of RO in the treatment of drinking water and for economic needs
6. RO in the process of desalination of sea water
7. Hybrid processes in water treatment
8. The use of membrane techniques in the preparation of water for the power industry
9. Electrodialysis in desalination of seawater
10. Reversible electrodialysis in water technology
11. Desalination of water by membrane distillation
12. Membranes in the process of denitrification of drinking water
13. Inorganic and organic membranes in water treatment processes
14. Membrane methods of degassing water
15. Membrane bioreactors in drinking water technology

Path B - Membrane techniques in the processing of waste streams

1. MF in wastewater treatment
2. UF in the dairy industry
3. UF in wastewater treatment
4. Pressure-driven membrane techniques in pre-treatment of post-fermentation solutions
5. NF in the processes of solution separation left after bioconversion
6. RO in the food and dairy industry
7. RO in the treatment of leachates from municipal waste landfills
8. Treatment of radioactive waste water using membrane methods
9. Recovery of metal ions from aqueous solutions by membrane techniques
10. Purification of air from the vapors of organic compounds
11. Separation of air components by membrane techniques
12. Classic ED in the food industry
13. ED with bipolar membrane in the processes of obtaining acids and bases
14. Membrane reactors in bioconversion processes
15. Membrane techniques in the separation of components of post-fermentation solutions.

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)**
Participation in design classes	15
Preparation for design classes	10
Consultations	5

Student's workload		
Source of workload	**hours**	**ECTS**
Total workload	30	1
Contact hours	20	
Practical activities	15	