UNIVERSITATEA BABEŞ-BOLYAI
BABEŞ-BOLYAI TUDOMÁNYEGYETEM
BABEŞ-BOLYAI UNIVERSITÄT
BABEŞ-BOLYAI UNIVERSITY
TRADITIO ET EXCELLENTIA

Tradiție și Excelență prin
Cultură - Știință - Inovație din 1581

Facultatea de Chimie și Inginerie Chimică
Str. Arany János nr. 11
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SYLLABUS

Membrane processes

University year 2025-2026

1. Information regarding the programme

1.1. Higher education institution	Universitatea Babeș-Bolyai din Cluj Napoca
1.2. Faculty	Chemistry and Chemical Engineering
1.3. Department	Chemical Engineering
1.4.Field of study	Chemical Engineering
1.5.Study cycle	Master
1.6. Study programme/Qualification	Advanced chemical process engineering
1.7. Form of education	Învățământ cu frecvență

2. Information regarding the discipline

2.1. Name of the discipline	Membrane processes					Discipline code	**CME7346**
2.2. Course coordinator	Associate Professor Dr. Eng. Adrian NICOARĂ						
2.3. Seminar coordinator	Associate Professor Dr. Eng. Adrian NICOARĂ						
2.4. Year of study	II	2.5. Semester	3	2.6. Type of evaluation	C	2.7. Discipline regime	DS (optional)

3. Total estimated time (hours/semester of didactic activities)

3.1. Hours per week	4	of which: 3.2 course	2	3.3 seminar/laboratory	1/1
3.4. Total hours in the curriculum	56	of which: 3.5 course	28	3.6 seminar/laborator	14/14
Time allotment for individual study (ID) and self-study activities (SA)					**hours**
3.5.1. Learning using manual, course support, bibliography, course notes (SA)					28
3.5.2. Additional documentation (in libraries, on electronic platforms, field documentation)					14
3.5.3. Preparation for seminars/labs, homework, papers, portfolios and essays					18
3.5.4. Tutorship					3
3.5.5. Evaluations					3
3.5.6. Other activities:					3
3.7. Total individual study hours	**69**				
3.8. Total hours per semester	**125**				
3.9. Number of ECTS credits	**5**				

4. Prerequisites (if necessary)

4.1. curriculum	• Not the case
4.2. competencies	• Not the case

5. Conditions (if necessary)

5.1. for the course	• The students will switch off the mobile phones • Delays will not be tolerated
5.2. for the seminar /lab activities	• The students will switch off the mobile phones • Delays will be penalised with 0.5 points/day

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6.1. Specific competencies acquired[1]

Professional/essential competencies	○ Definition of notions, concepts, theories and detailed models in the field of electrochemical process engineering and professional activity ○ Use of thorough knowledge in the field of electrochemical engineering for explanation and interpretation of electrode processes ○ Identification and application of concepts, methods and advanced theories for complex problem solving in the field of electrochemical engineering ○ Critical analysis and use of principles, methods and advanced work techniques for qualitative and quantitative assessments of electrochemical engineering processes ○ Evaluation and critical analysis of processes, equipments and units based on concepts, theories, models, methods and design practice for identification of suitable design solutions ○ Identification of concepts, specific resource management and quality assurance theories in electrochemical process industries in the context of sustainable development ○ Resource management for non-polluting and low energy consumption technologies ○ Use of quantitative and qualitative methods in new project design with respect to the quality and resource management principles
Transversal competencies	• Independent execution of complex professional duties and research projects using computer-aided techniques and comply with professional ethics and moral • Planning, monitoring and assuming professional duties of underline group. Proving the coordination capabilities, analytical thinking, adaptability and flexibility, collaboration with team members • Auto-evaluation of professional performances and establish the needs of continuous learning, documentation in the work fields in correlation with the labour market

6.2. Learning outcomes

Knowledge	The student knows: the basic notions of physical chemistry and chemical engineering applied to membrane processes and reactors.
Skills	The student is able to understand and the chemical and electrical aspects of the elementary processes from membrane processes. The practical activities will allow the student de identify and use the proper electrochemical reactor type, to design for given performance criterions of various technologies.
Responsibility and autonomy:	The student has the ability to work independently by completing the exercises/applications presented in the course/seminar; The student has the ability to follow the correctness of experimentally obtained results by comparing them with experimental data/data from specialized literature.

[1] One can choose either competences or learning outcomes, or both. If only one option is chosen, the row related to the other option will be deleted, and the kept one will be numbered 6.

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7. Objectives of the discipline (outcome of the acquired competencies)

7.1 General objective of the discipline	• The course aims at knowing the main membrane processes and industrial applications of membranes used (structure, materials, production, properties). A strong emphasis is placed on practical applications in the current industry and modelling of separation
7.2 Specific objective of the discipline	• Acquiring knowledge about the structure and performance of various membranes widely used in industrial applications. Emphasis will be placed on conducting structure-type correlations obtained performance and modelling capabilities for creating membrane separation processes. In addition, graduates will be able to choose the correct type of membrane processes according to the desired requirements.

8. Content

8.1 Course	Teaching methods	Remarks
8.1.1. Introduction. Definition and classification of types of membranes and membrane processes. Driving forces and mass flows.	Presentation; Explanation, Conversation; Description; Debate; Powerpoint presentation	
8.1.2. Thermodynamic foundations of membrane separation. Elements of thermodynamics of irreversible processes. Phenomenological flows. Liquid junction, Donnan and membrane potentials.		
8.1.3. Membrane transport theory. The diffusion in dense medium. Structure-permeability correlation. The diffusion in porous media.		
8.1.4. Concentration polarization. The limit film model.. Experimental determination of Peclet criterion. Particulars of concentration polarization in gaseous and liquid environments. Cross-flow, co-flow contra-fluxes.		
8.1.5. Description of membranes and membrane modules: structure, preparation, performance. Isotropic and anisotropic membranes. Metallic and ceramic membranes. Liquid membranes.		
8.1.6. Membranes and membrane modules: structure, preparation, performance. Hollow fibre membranes. Membrane modules. Chemical modification of membranes.		
8.1.7. Reverse osmosis. Membranes and materials. Selectivity process. Control of membrane clogging. Methods for cleaning up. Applications.		
8.1.8. Ultra- and microfiltration. Membranes used. Concentration polarization. Clogging and cleaning. Membrane modules. Design. Applications.		

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8.1.9. Separation from gaseous phase. Theoretical foundation. Membrane materials. Design. Applications.		
8.1.10. Pervaporation. Theoretical foundation. Membrane materials. Modules. Design. Applications.		
8.1.11. Membrane separation processes using ion exchange. Theoretical foundation. Chemistry of ion exchange membranes. Dialysis: variants (Donnan dialysis, dialysis speakers). Design, membranes, applications.		
8.1.12. Membrane separation processes ion exchange (continued). Mass transport by migration. Electrodialysis: design, skins and applications. Mosaic membranes. Piezodialysis; design applications. Membrane contactors and membrane distillation.		
8.1.13. Intensification of membrane transport. Transport against the gradient of chemical potential. Transporters. Coupled transport and facilitated. Applications.		
8.1.14. Membrane reactors. Theoretical basis. Requirements, applications.		
Bibliography 1. A. Nicoara, Lecture support, 2025, Available on-line. 2. R. W. Baker. Membrane technology and applications, John Wiley & Sons,Chichester, 2004. 3. S. P. Nunes, K.-V. Peinemann, Membrane Technology in the Chemical Industry, Wiley-VCH, Weinheim, 2001. 4. J. Koryta, J. Dvorak şi L. Kavan, Principles of Electrochemistry, John Wiley & Sons, Chichester, 1993.		
8.2 Seminar	Teaching methods	Remarks
1. Thermodynamics of irreversible processes. Flux and conservation equations.	Explanation, conversation, description, conceptualisation.	
2. Donnan and membrane potentials.		
3. Mass transport across membranes.		
4. Mass balance for dialysis reactors.		
5. Mass and electrical charge balance equations in electrodyalisis reactors.		
6. Energy balances in membrane reactors.		
7. Optimisation of membrane processes.		
Bibliography 1. Lecture support. 2. E.J. Hoffman, Industrial membrane separation technology. Elsevier, Amsterdam, 2003. Optional bibliography 1. C. Liteanu, G. Rădulescu, Bazele membranologiei, Ed. Stiințifică și Enciclopedică, București, 1984. 2. H.P. Hsieh, Inorganic Membranes for Separation and Reaction, Elsevier, Amsterdam, 1996.		
8.2 Laboratory	Teaching methods	Remarks
1. Determination of mass transport through membranes parameters.	Experiment, explanation, conversation, description, conceptualisation.	Laboratory activities will be structurated as one introductory session (2h) and three laboratory sessions (4h).
2. Evaluation of ion-exchange membranes selectivity by electrochemical methods.		
3. Dialysis separation of electrolytes.		
Bibliography		

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1. Laboratory workbook.

9. Corroborating the content of the discipline with the expectations of the epistemic community, professional associations and representative employers within the field of the program

- By learning the theoretical concepts and methodological approaches, students acquire practical aspects of discipline **Membrane processes**, a body of knowledge consistent with the competencies required by the Supplement at degrees and qualifications of ANC.

10. Evaluation

Activity type	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Percentage of final grade
10.4 Course	Correctness of the answers - learning and understanding of issues addressed in the course. Correctly solve of the problems.	Written examination - examination is conditioned by compliance laboratory works and submission of reports.	70%
10.5 Laboratory activities	Quality of prepared reports. Activity in laboratory.	Papers covering all laboratory practical work are to be delivered until the last week of teaching activity.	15 %
10.6 Seminar activities	Correct responses – deep understanding of the concepts treated in the seminar	Activity during the seminar	15 %
10.6 Minimum standard of performance			
• Mark 5 (five) on both laboratory exam, and the exam according to the scale. Introduction knowledge, correct identification of transfer phenomena and type of membrane process. Correct identification of mass flows. Knowledge of the process quality parameters.			

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11. Labels ODD (Sustainable Development Goals)[2]

Date:
01.04.2025

Signature of course coordinator

Conf. Dr.Eng. Adrian NICOARĂ

Signature of seminar coordinator

Conf. Dr.Eng. Adrian NICOARĂ

Date of approval:

Signature of the head of department

Prof. Dr. Ing. Graziella Liana Turdean

[2] Keep only the labels that, according to the *Procedure for applying ODD labels in the academic process*, suit the discipline and delete the others, including the general one for *Sustainable Development* – if not applicable. If no label describes the discipline, delete them all and write „*Not applicable*.".