COURSE DESCRIPTION

Membrane processes

Academic year 2026-2027

1. Programme-related data

1.1. Higher Education Institution	Babeș-Bolyai University, Cluj Napoca
1.2. Faculty	Chemistry and Chemical Engineering
1.3. Department	Chemical Engineering
1.4. Field	Chemical Engineering
1.5. Level of study	Master
1.6. Degree programme / Qualification	Advanced Process Chemical Engineering/ Master's Degree
1.7. Form of education	Full-time education

2. Course-related data

2.1. Course title	Membrane processes			Course 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 assessment	Viva voce
2.7. Course status	Optional			2.8. Course type	Specialisation subject

3. Total estimated time (hours per semester of teaching activities)

3.1. Number of hours per week	**4**	of which: 3.2. course	**2**	3.3. seminar/ laboratory/ project	**2**
3.4. Total of hours in the curriculum	56	of which: 3.5. course	28	3.6. seminar/ laboratory	28
Time allocation for individual study (IS) and self-taught activities (ST)					**hours**
Learning from textbooks, course materials, bibliography, and notes (IS)					21
Additional research in the library, on subject-specific electronic platforms, and on-site					18
Preparing seminars/ laboratories/ projects, assignments, reports, portfolios, and essays					21
Tutoring (professional guidance)					6
Examinations					3
Other activities					
3.7. Total hours of individual study (IS) and self-taught activities (ST)				**69**	
3.8. Total hours per semester				**125**	
3.9. Number of credits				**5**	

4. Prerequisites (where applicable)

4.1. curriculum-related	Not the case
4.2 skills-related	Not the case

5. Specific conditions (where applicable)

5.1. course-related	• The students will switch off the mobile phones • Delays will not be tolerated
5.2. seminar/laboratory-related	• The students will switch off the mobile phones • Delays will be penalised with 0.5 points/day
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6.1. Competencies resulting from the completion of the degree programme *(as referred to in the curriculum)*[1]

Professional competencies	
Competency code	**Competency**
PC1	Description, analysis and use of elaborate theories and concepts in the fields of chemistry and process advanced chemical engineering.
PC4	Development of processes, apparatus and equipment specific to process engineering by promoting new solutions for process intensification, optimum operation and control.
Transversal competencies	
Competency code	**Competency**
TC1	Independent execution of complex professional assignments and autonomous development of project-research activities by using computer-assisted techniques and by observing the norms of professional ethics and moral conduct.

6.2. Learning outcomes relevant to the degree programme (as referred to in the curriculum)[2]

Learning outcomes targeted by the subject		
Competency code	**Knowledge and comprehension**	**Specific academic skills**
CP1 **CP4** **CT1**	1. Formulation of solutions to solve complex chemical engineering problems based on knowledge, identification and application of advanced concepts, methods and theories in the field of chemical engineering and chemistry	*1. Critical analysis and application of advanced principles, methods, and techniques for the evaluation, design, and development of new products and technologies.*

7. Subject-specific learning outcomes

Knowledge and comprehension
1. Definition of notions, concepts, theories and detailed models in the field of membrane processes
2. Use of in-depth engineering knowledge to explain and interpret membrane processes
3. Identification and application of advanced concepts, methods and theories to solve complex problems in the field of membrane processes
4. Use of appropriate qualitative and quantitative methods in the sizing of membrane reactors to ensure advanced management
Specific academic skills
1. Critical analysis and use of advanced principles and working methods for qualitative and quantitative evaluations in membrane process engineering
2. Evaluation and critical analysis of membrane transfer processes for the development of concepts, theories and appropriate design methods
3. Specific resource management and quality assurance in industries involving membrane processes, development of non-polluting technologies with minimal energy consumption in the context of sustainable development

[1] The professional and/or transversal skills targeted by the subject for which the course description is prepared will be copied from the curriculum of the degree programme. For each competency, the complete entry, including the competency code, will be copied with the exact wording that appears in the curriculum, without any changes. If no competency is copied from either of the two categories, the row corresponding to that category is deleted from the table.

[2] The learning outcomes relevant for the degree programme and targeted by the subject for which the course description is prepared will be listed. The entries, copied without any changes from the Curriculum by subject type (Core Subject/Specialisation Subject/Complementary Subject), are listed under the corresponding competency.

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.		
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, updated annualy, Available on-line.
2. R. W. Baker. Membrane technology and applications, John Wiley & Sons,Chichester, 2004.

<table>
<tr><td colspan="3">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.</td></tr>
<tr><td>8.2 Seminar</td><td>Teaching methods</td><td>Remarks</td></tr>
<tr><td>1. Thermodynamics of irreversible processes. Flux and conservation equations.</td><td rowspan="8">Explanation, conversation, description, conceptualisation.</td><td rowspan="8"></td></tr>
<tr><td>2. Donnan and membrane potentials.</td></tr>
<tr><td>3. Mass transport across membranes.</td></tr>
<tr><td>4. Mass balance for dialysis reactors.</td></tr>
<tr><td>5. Mass and electrical charge balance equations in electrodyalisis reactors.</td></tr>
<tr><td>6. Energy balances in membrane reactors.</td></tr>
<tr><td>7. Optimisation of membrane processes.</td></tr>
<tr><td colspan="3">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. Stiinţifică şi Enciclopedică, Bucureşti, 1984.
2. H.P. Hsieh, Inorganic Membranes for Separation and Reaction, Elsevier, Amsterdam, 1996.</td></tr>
<tr><td>8.2 Laboratory</td><td>Teaching methods</td><td>Remarks</td></tr>
<tr><td>8.2.1 Occupational safety protocols, calculation of performance parameters (numerical examples).</td><td rowspan="4">Experiment, explanation, conversation, description, conceptualisation.</td><td rowspan="4">Laboratory activities will be structurated as one introductory session (2h) and three laboratory sessions (4h).</td></tr>
<tr><td>8.2.2. Determination of mass transport through membranes parameters.</td></tr>
<tr><td>8.2.3. Evaluation of ion-exchange membranes selectivity by electrochemical methods.</td></tr>
<tr><td>8.2.4. Dialysis separation of electrolytes.</td></tr>
<tr><td colspan="3">Bibliography
1. Laboratory workbook.</td></tr>
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9. Evaluation

Type of activity	9.1 Evaluation criteria[3]	9.2 Evaluation methods[4]	9.3 Percentage in the final grade

[3] The evaluation criteria must directly reflect the learning outcomes targeted at the level of the degree programme respectively at the level of the subject. More specifically, the learning outcomes set out in the expected learning outcomes are assessed.

[4] Both final evaluation methods and ongoing evaluation strategies should be established.

9.4. Course	Correctness of answers –proper understanding and learning of notions and concepts discussed during lectures; Correct use of learned concept within new contexts. Correct solving of the problems as part of the examination subjects	Written examination. Proven or intended fraud is punished according to the ECST rules of UBB.	70%
9.5. Seminar/ laboratory	The quality of the papers, the correct use of specialized literature. The activity carried out in the seminar and laboratory	Continuous evaluation of seminar and laboratory work. Laboratory papers will be submitted within three days of completing the last laboratory work.	15+15%
9.6 Minimum standard for passing			
Grade 5 (five) both in the laboratory and in the exam according to the scale. Knowledge of introductory concepts, correct identification of transfer phenomena, of the type of membrane process. Correct identification of mass flows. Knowledge of qualitative parameters of processes.			

10. SDG labels (Sustainable Development Goals)[5]

	○	Sustainable Development Generic Label

								
○	○	○	○	○	○	○	○	◉
								No label applies
○	○	○	○	○	○	○	○	○

Date:
27.04.2026

Signature of course coordinator

Conf. Dr.Eng. Adrian NICOARĂ

Signature of seminar coordinator

Conf. Dr.Eng. Adrian NICOARĂ

Date of approval:
30.04.2026

Signature of the head of department

Prof.habil.dr.eng. Graziella Liana Turdean.

[5] Select a single label which, according to the *Implementation of SDG labels in the academic process*, best matches the subject. If the subject addresses sustainable development in a generic manner (i.e. by presenting/introducing the general framework of sustainable development, etc.), then the Sustainable Development generic label may be applied. If none of the labels describe the **subject**, select the last option: *"No label applies."*