COURSE SYLLABUS

1. Program information

1.1. Institution	Petroleum-Gas University of Ploieşti
1.2. Faculty	Petroleum Refining and Petrochemistry
1.3. Department	Petroleum Processing and Environmental Engineering
1.4. Field of study	Chemical engineering
1.5. Study cycle	Full time
1.6. Study program	Chemical Engineering for Refineries and Petrochemical Industry

2. Course information

2.1. Course title	Non-conventional separation processes
2.2. Course coordinator	Associate Prof. PhD. Eng. Neagu Mihaela
2.3. Laboratory / seminar / coordinator	Associate Prof. PhD. Eng. Neagu Mihaela
2.4. Project coordinator	
2.5. Year of study	1st
2.6. Semester *	2nd
2.7. Evaluation type	Exam
2.8. Course type - formative category **/ Type of subject matter ***	SC/OPT

* The semester number is according to the curriculum.

** FC – Fundamental courses; SC – Specialization courses; CC – Complementary courses.

*** Mandatory/imposed = MND; Optional = OPT; Elective = ELE.

3. Total estimated time (teaching hours per semester)

3.1. Number of hours per week	4	of which: 3.2. course	2	3.3.Seminar/laboratory	2	3.4.Project	
3.5. Total hours from curriculum	56	of which: 3.6. course	28	3.7. Seminar/laboratory	28	3.8. Project	
3.9. Total hours of individual study (Study of textbook, course support, bibliography, study of textbook, course support, further reading in the library, on online platforms, preparing seminars/laboratories, homework, portfolios and essays)							154
3.10. Total hours per semester							210
3.11. Number of credits							7

4. Requirements (where applicable)

4.1. Curriculum requirements	➢ Completion and graduation of the Bachelor's degree level, regardless of the field of study or specialization
4.2. Course requirements:	➢ Projector, screen, computer
4.3.Seminar/Laboratory requirements:	➢ Laboratory equipped with specific equipment for laboratory works

5. Specific competences acquired and learning achievements* outcomes

Professional competences	Learning achievements*
1. Designs equipment and installations for the chemical industry	**K1** -The student identifies modern technological solutions for process intensification. **K2** - . The student defines criteria for selecting materials and equipment depending on applications **S1** - The student develops technological schemes and mass and energy balances. **LO1**- The student assumes responsibility for coordinating engineering projects. **LO2** - The student collaborates effectively in multidisciplinary teams.
2. Carries out research and innovation activities in chemical engineering	**K1** - The student identifies innovative directions for the development of processes and products. **S1** - The student applies experimental and computational methods to obtain original results **S2** - The student writes scientific papers and research projects. **LO1** - The student demonstrates autonomy in carrying out research projects. **LO2** - The student disseminates results nationally and internationally.
Transversal competences	**Learning achievements***
1. Develops critical thinking and the ability to solve complex problems	**K1** - The student identifies reasoning models applicable in interdisciplinary contexts **S1** - The student applies methods of analysis and synthesis to solve complex problems. **S2** - The student uses modern tools for decision evaluation and substantiation **LO1** -The student takes responsibility for the proposed solutions and their impact. **LO2**- The student demonstrates autonomy in the critical approach of complex situations.
2. Displays social responsibility, professional ethics, and civic spirit	**K1** - The student describes the principles of professional ethics and social responsibility. **S1** - The student applies ethical principles in professional and academic activities. **LO1** - The student takes responsibility for the ethical consequences of decisions.

* K – knowledge; S – skills; LO – responsibility and autonomy.

6. Course objectives (derived from the list of specific competences acquired)

6.1. General objective	➢ Transfer of theoretical and practical knowledge regarding new separation processes (membrane separations, ion exchangers, supercritical solvents, special adsorptions) and their industrial applications.
6.2. Specific objectives	➢ Acquisition of knowledge about the structure and performance of membranes and industrial applications of membrane processes ➢ Acquisition of knowledge about the structure and separation performance of ion exchangers. ➢ Explanation and interpretation of separation concepts by extraction with supercritical solvents; ➢ Integration of special adsorption techniques (PSA, VPSA, TSA) in oil processing processes

	➢ Establishment and selection of membrane separation technologies and their integration into existing processes in the chemical industry. Analysis of the advantages and disadvantages of hybrid processes. ➢ Use of specialized knowledge to explain and interpret new situations, in broader contexts associated with chemical engineering. ➢ Formation of the skills necessary for the design of membrane separation systems

7. Contents

<table>
<tr><th>7.1. Course</th><th>Time</th><th>Teaching methods</th><th>Comments</th></tr>
<tr><td>1. Molecular diffusion in gases. Molecular diffusion in liquids</td><td>4</td><td rowspan="5">Interactive lecture, problematisation, heuristic conversation, exemplification.

Screenings/films about case studies</td><td></td></tr>
<tr><td>2. Membrane separation
2.1. Introduction to the study of membranes. Classification.
2.2. Materials for membrane preparation. Techniques for obtaining synthetic membranes.
2.3. Membrane properties.
2.4. Membrane modules. Membrane systems engineering
2.5. Related phenomena and mitigation/elimination methods
2.6. Industrial applications of membrane processes, depending on the driving force. Examples, case studies.</td><td>10</td><td>Connection with laboratory work (design and simulation with specific software)</td></tr>
<tr><td>3. Separation by ion exchangers
3.1. Types of ion exchange resins
3.2. Ion exchange reactions
3.3. Industrial applications of ion exchangers</td><td>4</td><td>Connection with laboratory work</td></tr>
<tr><td>4. Supercritical Solvent Extraction
4.1. Properties of Supercritical Fluids
4.2. Types of Supercritical Solvent Extraction
4.3. Industrial Applications of Supercritical Solvent Extraction</td><td>6</td><td>Connection with laboratory work</td></tr>
<tr><td>5. Separation by new adsorption techniques
5.1. Basic concepts of separations by special adsorption techniques (PSA, VPSA, TSA)
5.2. Industrial applications of adsorption in the chemical industry and in the oil processing industry.</td><td>4</td><td>Connection with laboratory work</td></tr>
<tr><td colspan="4">Bibliography
1. Oprea, F., Procese neconvenţionale de separare, vol 1, Editura Staff 2001</td></tr>
</table>

2. Oprea, F., Procese neconvenţionale de separare, vol 2, Editura Universităţii Petrol-Gaze din Ploieşti, 2007
3. Membrane Technology and Applications, 3rd Edition, Eds. Richard W. Baker, 2012, John Wiley and Sons Ltd
4. Handbook of environmental engineering, Membrane and Desalination Technologies, vol. 13, Eds. Lawrence K. Wang, Jiaping Paul Chen, Yung-Tse Hung, Nazih K. Shammas, ISBN: 978-1-58829-940-6, e-ISBN: 978-1-59745-278-6, Springer Science þ Business Media, LLC , 2011

7.2. Seminar / laboratory	Time	Teaching methods	Comments
1. Calculation of membrane separation processes based on the driving force of pressure difference (reverse osmosis)	2	Interactive Teaching Colloquial system in which master's students participate in solving problems and in discussions launched based on the experimental results obtained	Attendance at laboratory activities is MANDATORY
2.Calculation of membrane separation processes based on the driving force of the concentration difference (gas separations) 2.Details of the installation for the separation of the methane/carbon dioxide mixture through hollow fiber membranes	4		
3. Calculation of separation processes through ion exchangers.	4		
4. Experimental determination of adsorption isotherms on ion exchange resins	4		
5. Experimental determinations of the breaking point for adsorption on ion exchange resins	6		
6. Supercritical extraction (with CO_2). Technological components of a solids extraction installation under supercritical conditions.	4		
7. Hydrogen purification by pressure swing adsorption. Technological components of a hydrogen purification plant.	2		
8. Discussing, analysing and evaluating laboratory activities	2		

Bibliography
1. F. Oprea, M. Petre (Neagu), Indrumar de laborator – Procese neconvenţionale de separare, Editura Universităţii Petrol-Gaze din Ploieşti, 2003
2. Zeki Berk, Food process enginering and technology (Chapter 10- membrane separation), 2nd Edition, Academic Press, 2014
3. J.C.F. Johner, M- A de Almeida Meireles, Construction of a supercritical fluid extraction (SFE) equipment: validation using annatto and fennel and extract analysis by thin layer chromatography coupled to image, Food Sci. Technol, Campinas, 36(2): 210-247, 2016

8. Correlation of the course contents with the demands of the epistemic community representatives, professional associations, and representative employers in the field of the program

The content of the discipline, as well as the topics of the laboratory works, correspond to the curricula of other university centres, in the country or abroad. For a better adaptation of the content of the discipline to the requirements of the labour market, meetings were held with representatives of economic partners, graduates, as well as with teaching staff from other faculties specializing in chemical engineering.

9. Evaluation

Activity	9.1. Evaluation criteria	9.2. Evaluation methods	9.3. Percentage of

			final grade
9.4. Course	Assessment of theoretical knowledge	Written work	60
	Assessment of exercises/problems knowledge	Written work	30
9.5. Seminar/laboratory	General knowledge of the process assessed through questions related to the topics of the laboratory work.	Active participation in the laboratory work; Preparation of reports and interpretation of the experimental results	10
9.6. Project			
9.7. Minimum performance standard			
For a grade of 5, it is necessary to obtain a score of at least 50% for theoretical knowledge, as well as to prove a minimum level of understanding and solving the problems (minimum 50%).			

Signature/date	Course coordinator	Laboratory coordinator	Project coordinator
22.09.2025	Assoc.Prof.Neagu Mihaela	Assoc.Prof. Neagu Mihaela	

Date of approval in the department	Head of department	Dean
26.09.2025	Associate Professor PhD. Mihaela Neagu	Assistant Professor PhD. Cristina Dusescu – Vasile