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 Engineering and Environmental Protection
1.4. Field of study	Chemical Engineering
1.5. Study cycle	Master degree
1.6. Study program	Chemical Engineering for Refineries and Petrochemistry

2. Course information

2.1. Course title	Modern technologies for petroleum refining		
2.2. Course coordinator	Lecturer PhD Eng. Liviu FILOTTI		
2.3. Laboratory / seminar coordinator	Lecturer PhD Eng. Liviu FILOTTI		
2.4. Project coordinator	- - -		
2.5. Year of study	1		
2.6. Semester *	1		
2.7. Evaluation type	E1		
2.8. Course type - formative category **	DF	2.9. Type of subject matter ***	C

* 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	5	3.2. of which course	2	3.3. seminar/laboratory	3	3.4. project	-
3.5. Total hours from curriculum	70	3.6. of which course	28	3.7. seminar/laboratory	42	3.8. project	-
3.9. Total hours of individual study (study of textbook, course support, bibliography, further reading in the library, on online platforms, preparing seminars/laboratories, homework, portfolios and essays)							170
3.10. Total hours per semester							240
3.11. Number of credits							8

4. Requirements (where applicable)

4.1. Curriculum requirements	➢ Chemical Physics ; Organic chemistry ➢ Petroleum chemistry ; Chemical reactor engineering
4.2. Course requirements	➢ Classroom equipped with videoprojector, black-/whiteboard
4.3.Seminar/Laboratory requirements	➢ Laboratory with micropilot specialized units comprising chemical reactors, gas-phase or catalytic, pumps, heating systems, and appropriate measurement devices and electronic controlling systems ➢ Instrumentation for petroleum products analysis

5. Specific competences acquired and learning achievements* outcomes

Professional competences	Learning achievements*
1. Development and optimization of complex chemical processes	**K1** - The student describes and correlates advanced models of chemical kinetics and applied thermodynamics. **K2** - The student explains mechanisms of mass, heat, and momentum transfer in complex reactive systems. **K3** - The student defines computational methods for process simulation and optimization.

	S1 - The student applies specialized software for process design and analysis. **S2** - The student integrates experimental data with mathematical models for process optimization. **LO1** - The student takes autonomous decisions regarding process efficiency, safety, and sustainability. **LO2** - The student documents and presents results in technical and scientific reports.
2. Design of equipments and units for the chemical industry	**K1** - The student describes advanced principles of equipment sizing and operation. **K2** - The student identifies modern technological solutions for process intensification. **K3** - The student defines criteria for the selection of materials and equipment depending on applications. **S1** - The student uses computer-aided design methods. **S2** - The student student develops technological flow sheets and mass and energy balances. **LO1** - The student assumes responsibility for coordinating engineering projects. **LO2** - The student The student collaborates effectively in multidisciplinary teams.
3. Integration of principles of sustainable development and circular economy	**K1** - The student describes advanced concepts of sustainable development applicable in chemical engineering. **K2** - The student identifies strategies for saving, reuse and valorize resources. **K3** - The student defines performance indicators for sustainable processes. **S1** - The student evaluates the environmental impact of chemical processes. **S2** - The student proposes technological solutions for pollution reduction and energy efficiency. **LO1** - The student makes decisions in agreement with environmental legislation and sustainability principles. **LO2** - The student promotes ethical conduct in resources use.
4. Use of advanced techniques for analysis and quality control	**K1** - The student describes modern methods of instrumental analysis and material characterization. **K2** - The student explains principles of validation and calibration of analytical methods. **K3** - The student defines quality standards and applicable regulations. **S1** - The student applies advanced experimental methods for product characterization. **S2** - The student uses statistical tools for analytical data interpretation. **LO1** - The student takes responsibility for validating and reporting results. **LO2** - The student prepares quality reports according to international standards.
5. Carrying out research and innovation activities in chemical engineering	**K1** - The student describes advanced research methodologies in chemical engineering. **K2** - The student identifies innovative directions for the development of processes and products. **K3** - The student defines methods for experiment design and interpretation. **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.
6. Leading and management of activities in the chemical industry	**K1** - The student explains modern methods of process and project management. **K2** - The student describes the legal framework and occupational health and safety standards. **K3** - The student identifies mechanisms for project economic evaluation. **S1** - The student applies management tools for coordinating resources and teams. **S2** - The student uses economic and financial analysis methods for processes. **LO1** - The student makes strategic decisions regarding project development and implementation. **LO2** - The student demonstrates autonomy and leadership in coordinating multidisciplinary teams.

Transversal competences	**Learning achievements***
1. Development of critical thinking and of 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. Efficient communication, orally and in writing, in Romanian and in an international language	**K1** - The student explains the specialized terminology in Romanian and in a foreign language. **S1** - The student drafts reports, presentations, and professional documents. **S2** - The student delivers oral presentations and debates in academic and professional contexts. **LO1** - The student takes responsibility for the correct and clear transmission of information. **LO2** - The student demonstrates autonomy in selecting means and strategies in communication.
3. Effective collaborations in multidisciplinary and intercultural teams	**K1** - The student explains the dynamics and roles of members in a multidisciplinary team. **S1** - The student actively participates in team activities and contributes to achieving common goals. **S2** - The student uses collaboration and communication management tools. **LO1** - The student assumes responsibility for their role in the team and respects cultural diversity. **LO2** - The student demonstrates autonomy and initiative in conflict resolution and collaboration promotion.
4. Lifelong learning ability and use of IT resources	**K1** - The student knows the principles of responsible use of IT resources. **S1** - The student uses digital platforms and resources for documentation and learning. **S2** - The student integrates new information in solving professional tasks. **LO1** - The student demonstrates autonomy in selecting and use of learning resources.
5. Social responsibility, professional ethics and civic spirit	**K1** - Principles of professional ethics and social responsibility. **K2** - The student explains the ethical implications of professional decisions. **S1** – Application of the ethical principles in professional and academic activities. **LO1** - The student takes responsibility for the ethical consequences of decisions. **LO2** - The student demonstrates autonomy in promoting ethical and civic conduct.
6. Management of projects and resources in a complex socio-economical context	**K1** – Knowledge of methods of project planning and evaluation. **S1** – Application of project management tools and techniques. **S2** - The student develops plans and reports for the efficient use of resources. **LO1** - The student takes responsibility for decisions regarding project implementation. **LO2** - The student demonstrates autonomy and leadership in managing resources and teams.

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

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

6.1. General objective	➢ Basic theoretical knowledge of the thermal and catalytic processes of petroleum processing. Understanding of the physical and chemical processes during the conversion of hydrocarbons ➢ Interpretation of experimental data to establish kinetic parameters for thermal cracking reactions ➢ Evaluation of the operating parameters influence on the performance of the studied thermal or catalytic process ➢ Equivalence of the reaction time for polytropic reactors with the isothermal reactors at constant or variable volume
6.2. Specific objectives	➢ Comissioning and operating a micro pilot unit that simulates an industrial thermal or catalytic process ➢ Correlation between experimental results and properties of reaction products and operating parameters and feedstock ➢ Understanding the experimental and industrial data, the use of kinetics and carrying out mass and heat balances ➢ Obtaining leadership skills by organizing and carrying out the experimental program ➢ Getting used with work within a team ➢ Responsability for the obtained experimental results

7. Contents

7.1. Course	Time	Teaching methods	Comments
0. Trends in the global demand and production of petroleum products	2	Interactive lecture, Brainstorming Euristic conversation and comparative discussions Exemplification Use of online resources	
1. Theoretical basis of hydrocarbons conversion reactions 1.1 Thermodynamics 1.2 Mechanisms and intermediary species of the chemical reactions 1.3 Kinetics	2		
2. Steam and thermal cracking of hydrocarbons and petroleum cuts 2.1. Industrial reactors and recent advances 2.2. Principles of cracking reactors modeling 2.3. Alternative procedures to tubular reactors	4		
3. Hydrotreatment of petroleum cuts 3.1. Chemical reactions and reactors 3.2. Alternatives to hydrofining: desulfurization by oxidation; catalytic distillation; adsorption; biochemical by microroganisms	3		
4. Catalytic cracking. Catalytic reforming. The industrial processes 4.1. Reactions, raw materials, reaction products 4.2. Catalysts, bi- and multifunction 4.3. Factors affecting the processes	3		
5. Alkylation of alkenes by light alkanes. 5.1. Liquid phase processes with superacids as catalysts. Reactions, chemical reactors, parameters 5.2. Industrial flowsheets in the current context of fuels	4		
6. Basic notions of homogeneous catalysis with organometallic catalysts: relevant reaction mechanisms, uses for hydrocarbon conversion. Supported organometallic catalysts	6		
7. Oligomerization and conversion of alkenes with organometallic complexes as catalysts	2		
8. Refining margins and costs. Conclusions	2		

Bibliography

Monographs

1. S. Raseev, *Thermal and Catalytic Processes in Petroleum Refining*, Marcel Dekker, New York, 2003.
2. R. Sadeghbeigi, *Fluid Catalytic Cracking Handbook*, 3ed., Butterworth-Heinemann, 2012.
3. S. Rașeev, *Conversia hidrocarburilor*, vol I, II, III, Zecasin, București, 1996-1997.
4. Suciu, G., Ionescu, C.-Eds., *Ingineria prelucrării hidrocarburilor* (*Hydrocarbon processing engineering*), vols. 4-5, Ed. Tehnica, București, 1993-1995.
5. *Petroleum refining*, vol. 1 – *Crude oil. Petroleum products. Process flowsheets*, (J.-P. Wauquier, Ed.), Technip – IFP, Paris, 1995.
6. Ionescu, C., Ciuparu, D., Dumitrașcu Gh., *Pollution and Environmental Protection in Petroleum*, Briliant, 1999.
7. R. J. Kee, M. E. Coltrin, P. Glarborg, *Chemically reacting flow - Theory and practice*, Wiley-Interscience, Hoboken (NJ), 2003.
8. V. Vântu, V. Măcriş, R. Mihail, Gh. Ivănuş, *Piroliza hidrocarburilor*, Ed. Tehnică, Bucureşti, 1980.
9. J. G. Speight, *The Chemistry and Technology of Petroleum*, 4th ed., CRC, Boca Raton, 2006.
10. J. Scherzer, A. Gruia, *Hydrocracking Science and Technology*, M. Dekker, New York, 1996.

Periodicals

- *Advances in Chemical Engineering*

<table>
<tr><td colspan="4">- Hydrocarbon Processing ; Fuel ; Buletinul Universităţii Petrol-Gaze din Ploieşti – Seria Tehnică ; Oil & Gas Science and Technology (Revue de l'IFP) ; Oil & Gas Journal</td></tr>
<tr><td>7.2. Seminar / laboratory</td><td>Time</td><td>Teaching methods</td><td>Comments</td></tr>
<tr><td>1. HSEQ regulations. Presentation of the main laboratory equipment.</td><td>2</td><td rowspan="7">Experimental work carried out in laboratory

Analysis of experimental observations

Debates and colloquial discussions of results

Comparison with the industrial units</td><td></td></tr>
<tr><td>2. Pyrolysis of liquid petroleum fractions:
2.1. Characterization of raw material and reaction products
2.2. Establishment of material balance
2.3. Determination of kinetic parameters</td><td>6</td><td></td></tr>
<tr><td>3. Thermal cracking
3.1.Characterisation of raw materials and reaction products
3.2. Establishment of material balance
3.3. Determination of kinetic parameters</td><td>6</td><td></td></tr>
<tr><td>4. Catalytic cracking
4.1.Characterization of the raw materials and the reaction products
4.2. Yields and material balance
4.3. Determination of kinetic parameters</td><td>4</td><td></td></tr>
<tr><td>5. Catalytic reforming
5.1. Characterization of the raw materials and the reaction products
5.2. Yields and material balance
5.3. Determination of kinetic parameters</td><td>4</td><td></td></tr>
<tr><td>6. Hydrofining:
6.1. Characterization of the raw materials and the reaction products
6.2. Establishment of material balance
6.3. Determination of kinetic parameters</td><td>4</td><td></td></tr>
<tr><td>7. Study case : thermodynamic analysis of butane cracking using Mathcad platform
7.1. Equations for equilibrium constants and equilibrium conversions from thermodynamic data
7.2. Presentation of Mathcad platform
7.3. Solving equations in Mathcad, graphics. Discussion of results and their practical implications</td><td>16</td><td></td></tr>
<tr><td colspan="4">Bibliography
1. Rosca, P., Ciuparu, D., Borcea, A., Dragomir, R., Petre, D., Thermocatalytic processes. Laboratory guide, Petroleum and Gas University of Ploieşti, 2003.
2. Technical databook – Petroleum refining, 6th ed., American Petroleum Institute, Washington D.C., 1997-2005.
3. V. Marinoiu, C. Strătulă, A. Petcu, C. Pătrăşcioiu, C. Marinescu, Metode numerice aplicate în ingineria chimică (Numerical methods applied in chemical engineering), Ed. Tehnică, Bucureşti, 1986.
4. H. S. Fogler, Elements of chemical reaction engineering, 5th ed., Prentice Hall - Pearson, Upper Saddle River, 2016.</td></tr>
<tr><td>8.3. Project</td><td>Time</td><td>Teaching methods</td><td>Comments</td></tr>
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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 course syllabus was developed in cooperation with representatives of engineering companies in Ploiești and Bucharest that have hired graduates of similar master programs. In order to better adapt the content of the discipline to the requirements of the labor market, meetings were held, both with specialists in the field of industry and with graduates working currently in refineries or related fields.

9. Evaluation

Activity	10.1. Evaluation criteria	10.2. Evaluation methods	10.3. Percentage of final grade
10.4. Course	The evaluation takes into account the theoretical knowledge of the topics presented in the course	Written exam	70%
		Cours attendance	10%
10.5. Seminar / laboratory	Attendance and proactive participation during the laboratory sessions	Laboratory attendance	20%
10.6. Minimum performance standard			
➢ For Mark 5: • knowledge of the purpose and basic principles of processes; • completion of the case study; • completion of the laboratory sessions and laboratory notebook with the correponding experimental results. For Mark 10: • knowledge of the kinetics of processes; • knowledge of the influence of the main operating parameters on the process performance; • ability to describe and analyze the reaction systems of the processes.			

Signature/date	Course coordinator	Laboratory coordinator	Project coordinator
22.09.2025	Assistant Professor PhD. Filotti Liviu	Assistant Professor PhD. Filotti Liviu	

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