COURSE SYLLABUS [1)]

1. Program information

1.1. Institution	Petroleum-Gas University of Ploieşti
1.2. Faculty	Faculty of 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 analytic methods in the oil refining industry**
2.2. Course coordinator	**BONDAREV ANDREEA**
2.3. Laboratory / seminar / coordinator	**BONDAREV ANDREEA**
2.4. Project coordinator	**-**
2.5. Year of study	I
2.6. Semester *	II
2.7. Evaluation type	**V**
2.8. Course type - formative category **/ Type of subject matter ***	**SC / MND**

* 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	3	of which: 3.2. course	2	3.3.Seminar/laboratory	1	3.4.Project	
3.5. Total hours from curriculum		of which: 3.6. course	28	3.7. Seminar/laboratory	14	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)							138
3.10. Total hours per semester							42
3.11. Number of credits							6

4. Requirements (where applicable)

4.1. Curriculum requirements	➢ Basic petroleum refining knowledge and modern instrumental methods for petroleum products analysis
4.2. Course requirements:	➢ Fundamental concepts of spectroscopy, chromatography and surface analysis techniques in the petroleum industry
4.3.Seminar/Laboratory requirements:	➢ Analytical data processing; active and critical analyses; teamwork skills.

5. Specific competences acquired and learning achievements* outcomes

Professional competences	**Learning achievements***
1.Uses advanced techniques of 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.
2. Carries 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. 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. Communicates effectively 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 communication strategies.
3. Displays social responsibility, professional ethics, and civic spirit	K1- The student describes the principles of professional ethics and social responsibility. K2 - The student explains the ethical implications of professional decisions. S1 - The student applies 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.

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

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

6.1. General objective	➢ The course provides general aspects of modern instrumental analysis techniques used in industrial and research laboratories in the domain of oil refining industry.
6.2. Specific objectives	➢ Essential aspects of theory, instrumentation and practical applications of spectroscopy, chromatography and surface analysis in the domain of oil refining industry. ➢ Critically analysis of an analytical method. ➢ Theory and instrumentation of spectroscopic techniques in the domain of oil refining industry.

7.Contents

7.1. Course	Time	Teaching methods	Comments
Standard methods for the analysis and testing of petroleum products.	4	Explanation Exercise Content-based teaching and cooperative learning	
Chromatographic methods: Gas Chromatography (GC); High Pressure Liquid Chromatography (HPLC); Gas Chromatography – Mass spectrometry (GC-MS).	8	Explanation Content-based teaching and cooperative learning	
Spectroscopic methods: - UV-Vis molecular spectroscopy; - IR absorption spectroscopy; - Raman spectroscopy; - Atomic absorption spectroscopy; - Nuclear Magnetic Resonance (NMR) spectroscopy.	12	Explanation Content-based teaching and cooperative learning	
Surface analysis techniques.	4	Explanation Content-based teaching and cooperative learning	

References

1. Silverstein R., Webster F., Kiemle D., *Spectrometric identification of organic compounds,* Ed. Wiley, 2005.
2. Harvey D., *Modern analytical chemistry,* Ed. McGraw Hill Higher Education, 2000.
3. Qian K., *Molecular Characterization of Heavy Petroleum by Mass Spectrometry and Related Techniques*. Energy Fuels 2021, 35
4. Speight J., *Petroleum Engineering – Downstream - Analytical methods and techniques applied to crude oil and petroleum products*, Encyclopedia of Life Support Systems (EOLSS), 2011
5. Da Silva J., Queiros A., Oliveira A., Kartnaller V., *Advances in the application of spectroscopic techniques in the biofuel area over the last few decades*, Ed. IntechOpen, 2017
6. Bondarev A., *Modern analytic methods in the oil refining industry*, 2021 - course notes
7. Skoog D., Holler F., Crouch S., *Principles of Instrumental Analysis*, Seventh Edition, 2017

8. Harvey D., *Instrumental Analysis*, DePauw University, Open Education Resource (OER) LibreTexts Projects, 2024
9. Ahluwalia V.K., *Instrumental Methods of Chemical Analysis,* Ed. Springer, 2023
10. Shishkova I. , Stratiev D., Kolev I., Nenov S., Nedanovski D., Atanassov K. , Ivanov V., Ribagin S., *Challenges in Petroleum Characterization - A Review*, Energies 2022, 15, 7765

7.2. Seminar / laboratory / project	Time	Teaching methods	Comments
1. General laboratory safety rules. Quality characteristics of biodiesel produced from used cooking oil; Characterization and assessment against the quality specifications required by the European biodiesel standard: SR EN 14214:2010.	2	Experiment Explanation Exercise	
2. Determination of heavy metals in petroleum products by atomic absorption method.	2	Experiment Explanation Exercise	
3. Determination of polycyclic hydrocarbons in petroleum products by UV – Vis spectroscopy.	2	Experiment Explanation Exercise	
4. Determination of aromatic compounds in petroleum products by FT-IR spectroscopy.	2	Experiment Explanation Exercise	
5. COV analysis by GC/ MS method.	2	Experiment Explanation Exercise	
6. Interpreting spectra of organic compounds in petroleum processing industry (spectroscopic methods: UV-Vis, IR, ^{1}H-RMN, ^{13}C-RMN).	4	Explanation Exercise	

References

1. Silverstein R., Webster F., Kiemle D., *Spectrometric identification of organic compounds,* Wiley, 2005.
2. Harvey D., *Modern analytical chemistry,* McGraw Hill Higher Education, 2000.
3. Shishkova I. , Stratiev D., Kolev I., Nenov S., Nedanovski D., Atanassov K. , Ivanov V., Ribagin S., *Challenges in Petroleum Characterization - A Review*, Energies 2022, 15, 7765
4. Speight J., Petroleum Engineering – Downstream - *Analytical methods and techniques applied to crude oil and petroleum products*, Encyclopedia of Life Support Systems (EOLSS), 2011
5.Knothe G., *Vegetable oil-based diesel fuels: Overview and current trends. Journal of Air and Waste Management Association*, p. 20-23, 2010.
6. Stutz, J.; Colosimo, S.F.; Cooperdock, S.; Pikelnaya, O.; Polidori, A. *UV-DOAS Measurements of BTEX in Petrochemical Facilities: Performance, Quality Assessment, and Applications.* AGU Fall Meet. Abstr. 2022, A45I-1943
7. Daves, G. *Refinery fence-line monitoring to impact petrochemical operators.* Oil Gas J. 2017, *115*, 68–73
8. Bondarev A., *Modern analytic methods in the oil refining industry*, 2021 - course notes

7.3. Project	Time	Teaching methods	Observations

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

➢ This course aims to enable students to demonstrate critical thinking skills. ➢ This course aims to enable students to demonstrate the ability to work effectively in a team. ➢ This course aims to enable students to demonstrate the attitude and/or ability to accomplish discovery and/or innovation. ➢ Systematic comparison of the course curriculum with the knowledge, skills and competencies identified as critical by experts in the field and employers. ➢ Jobs according to COR: 214501 Petrochemist engineer; 214513 Chemical engineer; 214528 Research engineer in petrochemistry and carbochemistry; 214461 Research enginer in process equipments.

9. Evaluation

Activity	9.1. Evaluation criteria	9.2. Evaluation methods	9.3. Percentage of final grade
9.4. Course	Theoretical questions and problems related to the course content.	Written examination	80%
9.5. Seminar / laboratory	-Students will present, analyse and discuss their laboratory results. - Seminar: Modern instrumental methods for analysis and testing of petroleum products; Project presentation (Power point).	Laboratory reports; Project presentation	20%
9.6. Project	-	-	-
9.7. Minimum performance standard			
➢ The students must demonstrate minimum knowledge required by the content of the Course syllabus (*7. Contents*). ➢ Knowledge of the basic concepts of instrumental methods for petroleum products analysis.			

Signature date	Course coordinator	Laboratory coordinator	Project coordinator
22.09.2025	Assist.Prof. Ph.D Andreea Bondarev	Assoc.Prof. Ph.D Andreea Bondarev	

Date of approval in the department	Head of Department	Dean
26.09.2025	Assoc. Prof. PhD Eng. Neagu Mihaela	Assist.Prof. Ph.D Cristina Dușescu-Vasile