GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	NOVEL ANALYTICAL TECHNIQUES, PG_00066001		
Field of study	Green Technologies		
Date of commencement of studies	February 2025	Academic year of realisation of subject	2025/2026
Education level	second-cycle studies	Subject group	Obligatory subject group in the field of study Subject group related to scientific research in the field of study
Mode of study	Full-time studies	Mode of delivery	at the university
Year of study	1	Language of instruction	English
Semester of study	2	ECTS credits	6.0
Learning profile	general academic profile	Assessment form	exam
Conducting unit	Department of Analytical Chemistry -> Faculty of Chemistry -> Wydziały Politechniki Gdańskiej		
Name and surname of lecturer (lecturers)	Subject supervisor	dr hab. inż. Justyna Płotka-Wasylka	
	Teachers		

Lesson types and methods of instruction	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	15.0	0.0	45.0	0.0	15.0	75
	E-learning hours included: 0.0						

Learning activity and number of study hours	Learning activity	Participation in didactic classes included in study plan	Participation in consultation hours	Self-study	SUM
	Number of study hours	75	10.0	65.0	150

Subject objectives

The aim of the course *Modern Analytical Techniques* is to familiarize students with the latest achievements in analytical methods and tools applied in chemistry, environmental engineering, and green technologies. Students will gain both theoretical knowledge and practical skills related to modern techniques such as chromatography (HPLC, GC), mass spectrometry, spectroscopy, and hyphenated techniques, with particular emphasis on their applications in environmental analysis and in the assessment of chemical substances properties.

An essential component of the course is also the development of critical data analysis skills, the application of statistical methods, and the understanding of sample preparation strategies in accordance with the principles of green analytical chemistry. Completion of the course equips students with the knowledge and competencies necessary to conduct modern, efficient, and sustainable analytical research in both academic and industrial settings.

Learning outcomes

Course outcome	Subject outcome	Method of verification
[K7_K03] understands non-technical aspects and effects of graduates' activities, including the impact on the environment	The student is able to assess the significance of non-technical aspects related to the use of modern analytical techniques, including their impact on the environment, public health, and society. The student understands the need to apply sustainable development principles and ethical responsibility in analytical practice.	[SK5] Assessment of ability to solve problems that arise in practice [SK1] Assessment of group work skills
[K7_U04] is able to design and supervise environmentally friendly technologies, waste-free technologies, and also perform expert opinions on the environmental impact of technologies already in use	The student is able to identify and select modern analytical techniques to assess the environmental impact of technologies and to design analytical approaches supporting the development of environmentally friendly and zero-waste processes. The student can also critically evaluate the potential environmental hazards of existing technologies based on analytical results.	[SU5] Assessment of ability to present the results of task [SU4] Assessment of ability to use methods and tools [SU3] Assessment of ability to use knowledge gained from the subject [SU1] Assessment of task fulfilment
[K7_U02] selects analytical, simulation and experimental methods for research and analysis of environmental pollution using appropriately selected equipment and software	The student is able to select and apply suitable analytical techniques (e.g., HPLC, GC, MS, spectroscopy, hyphenated techniques), as well as simulation and experimental approaches, for the study and characterization of environmental pollutants with the use of appropriate instrumentation and software tools.	[SU5] Assessment of ability to present the results of task [SU4] Assessment of ability to use methods and tools [SU3] Assessment of ability to use knowledge gained from the subject
[K7_W01] identifies problems and defines tasks in the field of environmental protection technologies and modern analytical methods	The student is able to identify research problems related to environmental protection and select appropriate modern analytical techniques (HPLC, GC, MS, spectroscopy, hyphenated techniques) to address them.	[SW3] Assessment of knowledge contained in written work and projects [SW2] Assessment of knowledge contained in presentation

Subject contents	1. Introduction 2. Statistics 1 3. Statistics 2 4. Overview of Modern Analytical Techniques 5. Omics Analysis in Environmental Chemistry 6. HPLC Principles and Applications 7. Detectors in HPLC 8. Application of HPLC in QSAR Analysis for Predicting Substance Properties 9. Application of GC in Industrial Environments 10. Direct Analysis Techniques Using Mass Spectrometry 11. Modern Spectroscopic Techniques 12. Sample Preparation and Green Analytical Chemistry 13. Hyphenated Techniques Part I 14. Hyphenated Techniques Part II *Note: Lecture content may be supplemented with additional topics according to the needs and profile of the enrolled student group. Lectures may be conducted remotely if necessary.* **Laboratory Classes** 1. Introduction and Safety Rules (BHP) 2. Electrochemistry Basics and Applications 3. Determination of Toxicity Levels and Types of Toxic Interactions in Binary Mixtures 4. MS/MS: MRM for the Determination of Emerging Contaminants 5. Determination of Emerging Contaminants in Selected Pharmaceutical and Food Samples 6. Wine Quality Control Analysis of Wine Under the Cork (GC-TOFMS) 7. Wine Quality Control from Fruits Exposed to Volatile Environmental Contaminants Using UFGC 8. HPLC-DAD: Identification of Organic Compounds (PAHs), Determination of Analyte Properties Based on Retention Time (QSAR)

	9. HPLC-QTOF: Determination of Organic Compounds 10. Speciation: Determination of TBT in Sediment Samples 11. Mercury in the Environment ICP-MS vs. MIP-OES, Comparative Studies **Seminars** • Solving research problems individually and in groups. • Discussion and analysis of results obtained in laboratory classes and projects. • Development of soft skills, including presentation skills, teamwork, and critical evaluation of scientific data.
Prerequisites and co-requisites	**Prerequisites and requirements:** Students taking this course should have: • basic knowledge of general, inorganic, and organic chemistry, • understanding of fundamental concepts in analytical chemistry and chemical technology, • ability to operate basic laboratory equipment and knowledge of fundamental safety and hygiene principles in the laboratory, • basic skills in data analysis and statistics (introductory level). **Recommended prior courses:** It is recommended that students complete *Analytical Chemistry*, *Fundamentals of Chemical Technology*, and *Statistics and Data Analysis* (or equivalent courses) before enrolling in this course. If the student does not meet these requirements, it is recommended to supplement the missing knowledge and skills prior to the start of the course.
Assessment methods and criteria	

Subject passing criteria	Passing threshold	Percentage of the final grade
exam	60.0%	45.0%
seminars	60.0%	10.0%
laboratory experiments	60.0%	45.0%

Recommended reading	Basic literature	**Hussain, M., & Kecili, R. (2020).** *Modern Environmental Analysis Techniques for Pollutants*. Elsevier. Comprehensive overview of modern analytical techniques used in environmental pollutant analysis, including sampling methods, sample preparation, quantification, and statistical evaluation. **Lawrence, J. F. (Ed.). (1984).** *Liquid Chromatography in Environmental Analysis*. Humana Press. A collection of chapters on the use of HPLC in environmental analysis, including hydrocarbons, pesticides, surfactants, and trace metals. **Koel, M., & Kecili, R. (Eds.). (2019).** *Green Analytical Chemistry*. Royal Society of Chemistry. A guide to principles and practices of green analytical chemistry, focusing on minimizing the use of hazardous reagents and solvents in environmental analyses. **Lebedev, A. T. (2020).** *Comprehensive Environmental Mass Spectrometry*. Wiley. Discussion of mass spectrometry applications in environmental analysis, including GC-MS, LC-MS, ambient MS, and miniaturized mass spectrometers. **Dean, J. R. (2020).** *Extraction Techniques for Environmental Analysis*. Wiley. Guide to extraction techniques for environmental samples, including liquids, air, and sediments, with application case studies.
	Supplementary literature	**Duarte, R., & Duarte, A. C. (Eds.). (2020).** *Multidimensional Analytical Techniques in Environmental Research*. Elsevier. Comprehensive coverage of multidimensional analytical techniques, such as 2D-HPLC, 2D-GC, NMR, MS, and fluorescence spectroscopy, applied to organic and inorganic environmental pollutant analysis. **Patnaik, P. (2010).** *Handbook of Environmental Analysis: Chemical Pollutants in Air, Water, Soil, and Solid Wastes*. CRC Press. Handbook discussing techniques for analyzing chemical pollutants in various environmental matrices, including air, water, soil, and solid wastes.
	eResources addresses	

Example issues/ example questions/ tasks being completed	1. Draw schematic diagram of a) GC-MS and b) LC-MS system. 2. Point out advantages of Atomic Absorption Spectrometry. 3. How to apply absorption of the light (UV-VIS) for the identification of compounds 4. List the validation parameters and define the two of them. 5. How to perform quantitative analysis point out main steps. 6. Retention time in GC chromatography depends on: *(point out)* 7. Propose analytical technique that can be applied for; a) vitamins determination in drinking water _____ b) sweeteners determination in waste water samples _____ c) ethanol content in blood _____ d) BTEX emitted from paints _____ e) solvent residue in medicaments _____ f) protein mass determination _____ g) mercury content in sediment _____ i) content of cations and ions in mineral water _____ 8. List lab experomental subjects that You have experienced during Novel Anal. Techniques. Underline the best *(in You opinion)*. 9. Explain the differences in MS and MS/MS mode. 10. What are supercritical fluids? What are their properties (physical and chemical)? 11. Draw chromatogram showing separation of 4 compounds. Draw example of UV spectrum. Draw example of MS spectrum. Describe axis.
Work placement	Not applicable

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