GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

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| Subject name and code | Novel Analytical Techniques , PG_00065971 | | |
| Field of study | Green Technologies | | |
| Date of commencement of studies | February 2026 | Academic year of realisation of subject | 2026/2027 |
| Education level | second-cycle studies | Subject group | Obligatory subject group in the field of study<br>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 | Polish |
| 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 -> Faculties of Gdańsk University of Technology | | |
| Name and surname of lecturer (lecturers) | Subject supervisor | dr hab. inż. Justyna Płotka-Wasylka | |
| | Teachers | | |

| Lesson types | Lesson type | Lecture | Tutorial | Laboratory | Project | Seminar | SUM |
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| | 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 |
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| | 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 current methods and analytical tools used in chemistry, environmental engineering, and green technologies. Students learn the theoretical foundations and practical aspects of techniques such as chromatography (HPLC, GC), mass spectrometry, spectroscopy, and hyphenated techniques, with particular emphasis on their application in environmental analysis and the evaluation of chemical substances. An important element of the course is the development of skills in critical data analysis, the use of statistical methods, and sample preparation strategies consistent with the principles of green analytical chemistry. Completing the course enables students to acquire the knowledge necessary to conduct modern and sustainable analytical research in science and industry. |
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Learning outcomes

| Course outcome | Subject outcome | Method of verification |
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| [K7_K03] understands non-technical aspects and effects of graduates' activities, including the impact on the environment | The student is aware of the non-technical aspects of using modern analytical techniques, in particular their impact on the environment, public health, and society, and understands the need to act in accordance with the principles of sustainable development and ethical responsibility in the work of an analyst. | [SK1] Assessment of group work skills<br>[SK5] Assessment of ability to solve problems that arise in practice |
| [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<br>[SU4] Assessment of ability to use methods and tools<br>[SU3] Assessment of ability to use knowledge gained from the subject<br>[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<br>[SU4] Assessment of ability to use methods and tools<br>[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 familiar with contemporary research issues related to environmental protection and has knowledge of the possibilities of applying modern analytical techniques (HPLC, GC, MS, spectroscopic methods, and combined techniques) to solve them. | [SW3] Assessment of knowledge contained in written work and projects<br>[SW2] Assessment of knowledge contained in presentation |

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| Subject contents | Course content – lecture<br><br>**Lectures**<br><br>1. Introduction<br><br>2. Statistics 1<br><br>3. Statistics 2<br><br>4. Overview of Modern Analytical Techniques<br><br>5. Omics Analysis in Environmental Chemistry<br><br>6. HPLC Principles and Applications<br><br>7. Detectors in HPLC<br><br>8. Application of HPLC in QSAR Analysis for Predicting Substance Properties<br><br>9. Application of GC in Industrial Environments<br><br>10. Direct Analysis Techniques Using Mass Spectrometry<br><br>11. Modern Spectroscopic Techniques<br><br>12. Sample Preparation and Green Analytical Chemistry<br><br>13. Hyphenated Techniques Part I<br><br>14. Hyphenated Techniques Part II<br><br>*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.* |
| | Course content – laboratory<br><br>**Laboratory Classes**<br><br>1. Introduction and Safety Rules (BHP)<br><br>2. Electrochemistry Basics and Applications<br><br>3. Determination of Toxicity Levels and Types of Toxic Interactions in Binary Mixtures<br><br>4. MS/MS: MRM for the Determination of Emerging Contaminants<br><br>5. Determination of Emerging Contaminants in Selected Pharmaceutical and Food Samples<br><br>6. Wine Quality Control Analysis of Wine Under the Cork (GC-TOFMS)<br><br>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

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Course content – seminar

**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

Students taking this course should have:

- basic knowledge of general, inorganic, and organic chemistry,
- understanding of fundamental concepts in analytical chemistry,
- 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 |
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| Seminars | 60.0% | 10.0% |
| Laboratory | 60.0% | 45.0% |
| Lecture | 60.0% | 45.0% |

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

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| Example issues/ example questions/ tasks being completed | 1. Draw a diagram of a) GC-MS system and b) LC-MS.<br><br>2. Indicate the advantages of atomic absorption spectrometry.<br><br>3. How to use light absorption (UV-VIS) to identify compounds<br><br>4. List the validation parameters and define two of them.<br><br>5. How to conduct a quantitative analysis - indicate the main steps.<br><br>6. The retention time in GC chromatography depends on: (indicate)<br><br>7. Propose an analytical technique that can be used;<br><br>a) determination of vitamins in drinking water<br><br>b) Determination of sweeteners in sewage samples<br><br>c) the content of ethanol in the blood<br><br>d) BTEX emitted from paints<br><br>e) residual solvent in drugs<br><br>f) Determination of protein mass<br><br>g) mercury content in sediments<br><br>i) the content of cations and ions in the mineral water<br><br>8. List the laboratory experimental items you experienced during Novel Anal. Techniques. Highlight the best (in your opinion).<br><br>9. Explain the differences in MS and MS / MS mode.<br><br>10. What are supercritical fluids? What are their properties (physical and chemical)?<br><br>11. Draw a chromatogram showing the separation of 4 compounds. Draw an example of a UV spectrum. Draw an example of the MS spectrum. Describe the axis. |
| Practical activites within the subject | Not applicable |

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