GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	, PG_00057773		
Field of study	Green Technologies		
Date of commencement of studies	October 2025	Academic year of realisation of subject	2026/2027
Education level	first-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	2	Language of instruction	English
Semester of study	3	ECTS credits	7.0
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
Number of study hours	30.0	0.0	45.0	0.0	0.0	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	15.0	85.0	175

Subject objectives

The aim of the course *Analytical Chemistry* is to provide students with essential knowledge in the field of analytical chemistry, including the fundamental stages of the analytical process, principles of sample collection and preparation, and the theoretical foundations of selected classical and instrumental analytical methods.

Specifically, the course enables students to:

- Understand the complete workflow of the analytical process, from problem definition, sampling, and sample preparation to data interpretation.
- Acquire practical and theoretical knowledge of classical analytical techniques, such as titration, gravimetry, and colorimetry.
- Gain an understanding of basic instrumental methods, including spectroscopic, chromatographic, and electrochemical techniques, as well as their appropriate applications.
- Develop the ability to critically evaluate analytical results, identify potential sources of error, and apply statistical tools for data analysis.
- Recognize the importance of laboratory safety, good analytical practices, and ethical considerations in chemical analysis.

Upon completion of the course, students will have a solid foundation to perform basic analytical determinations and to further specialize in modern analytical techniques in subsequent courses or professional practice.

Learning outcomes	Course outcome	Subject outcome	Method of verification
	[K6_U05] can formulate and solve engineering tasks analytical methods, simulation as well as experimental, able to apply knowledge of basic physics and mathematics to analyze the results of experiments, is able to analyze and assess existing technical solutions	The student is able to apply basic chemical analysis methods, both classical and instrumental, to solve analytical tasks and chemical problems. Uses fundamental knowledge of physical chemistry, mathematics, and statistics to analyze measurement results and assess data quality and reliability. Can evaluate existing analytical procedures.	[SU4] Assessment of ability to use methods and tools [SU2] Assessment of ability to analyse information [SU1] Assessment of task fulfilment
	[K6_U02] is able to operate equipment and perform typical analyzes of studies of environmental pollution, is able to carry out an analysis of typical environmental pollution and simple devices according to specification	he student is able to independently operate basic laboratory equipment used in analytical chemistry, including chromatography, spectroscopy, and electrochemistry instruments. Can perform measurements of pollutants in environmental samples and analyze and interpret the results. Is able to modify existing analytical procedures or design simple procedures and devices according to specified requirements.	[SU4] Assessment of ability to use methods and tools [SU3] Assessment of ability to use knowledge gained from the subject [SU5] Assessment of ability to present the results of task
	[K6_W02] has a basic knowledge of chemistry including general chemistry, inorganic, organic, physical, analytical, including the knowledge necessary to describe and understand the phenomena and chemical processes occurring in the environment; measurement and the determination of the parameters of these processes.	The student possesses fundamental knowledge in general, inorganic, organic, physical, and analytical chemistry, enabling the understanding of chemical phenomena and processes in environmental protection technologies. Can describe and analyze parameters of these processes, apply basic measurement methods, and interpret analytical results.	[SW3] Assessment of knowledge contained in written work and projects [SW2] Assessment of knowledge contained in presentation

Subject contents	Course content – lecture **Treści wykładów Analytical Chemistry** 1. **Introduction to Analytical Chemistry** • Definition, scope, and role of analytical chemistry in science, industry, and environmental protection • Types of analytical information and criteria for method selection • Overview of the analytical process 2. **Basic Concepts of Chemical Analysis** • Accuracy, precision, sensitivity, selectivity • Types of errors in chemical analysis • Propagation of errors, uncertainty, and evaluation of results • Presentation of results, comparison of precision and accuracy 3. **Sampling and Sample Preparation** • Importance of representative sampling • Methods of sample collection, storage, and preparation • Avoiding contamination and sample degradation 4. **Classical (Wet) Quantitative Analysis** • Gravimetric analysis • Acid-base titration (alkacymetry) • Redox titration (redoxometry) • Complexometric titration • Precipitation titration (strąceniometry) 5. **Fundamentals of Instrumental Quantitative Analysis** • Electroggravimetry and elemental analysis of organic compounds • Spectroscopic methods: UV-Vis, IR, NMR, atomic absorption/emission • Chromatographic techniques: GC, HPLC, and their detectors • Electroanalytical methods: potentiometry, voltammetry, amperometry

6.

Data Analysis and Interpretation

- Statistical evaluation of analytical results
- Quality assessment, uncertainty calculation, and error analysis
- Comparison of accuracy and precision between classical and instrumental methods

7.

Green Analytical Chemistry and Safety

- Principles of sustainable, environmentally friendly analysis
- Minimization of hazardous reagents and waste generation
- Laboratory safety rules and good analytical practices

Uwaga: Treści wykładowe mogą być uzupełniane o dodatkowe tematy zgodnie z profilem grupy studentów lub nowymi trendami w chemii analitycznej. Wykłady mogą być prowadzone zdalnie, jeśli zajdzie taka potrzeba.

Laboratory Course Contents Analytical Chemistry

The laboratory classes serve as a base of exercises, which will be presented to students for selection in a given panel. In total, 5 exercises will focus on classical analytical chemistry, while the remaining sessions will be dedicated to instrumental analytical chemistry.

1.

Introduction and Laboratory Safety

- Overview of laboratory rules and safety procedures
- Proper handling of chemicals and laboratory equipment
- Documentation of laboratory work

2.

Basic Laboratory Techniques

- Weighing and preparation of solutions
- Handling glassware and pipettes
- Calibration of volumetric instruments

3.

Gravimetric Analysis

- Determination of an analyte by precipitation
- Filtration, drying, and weighing techniques
- Calculation of results and error analysis

4. **Titrimetric Methods**
   - Acid-base titration (alkacymetry)
   - Redox titration (redoxometry)
   - Complexometric titration (EDTA titration)
   - Precipitation titration
   - Comparison of accuracy and precision of titrimetric methods
5. **Spectroscopic Methods**
   - UV-Vis spectroscopy: calibration, measurement, and analysis
   - Application to the determination of metal ions and organic compounds
   - Introduction to atomic absorption spectroscopy (AAS)
6. **Chromatographic Techniques**
   - Principles of HPLC and GC
   - Sample preparation and injection
   - Qualitative and quantitative analysis of selected compounds
   - Use of detectors (UV, DAD, FID)
7. **Electroanalytical Methods**
   - Potentiometric measurements (pH, ion-selective electrodes)
   - Voltammetric techniques (cyclic voltammetry, stripping)
   - Analysis of environmental samples using electrochemical methods
8. **Analysis of Environmental Samples**
   - Determination of pollutants in water, soil, and food samples
   - Sample preparation, extraction, and pre-concentration
   - Comparison of classical and instrumental methods for real samples

9.

Data Analysis and Reporting

- Calculation of results considering errors
- Graphical presentation of data
- Preparation of laboratory reports in a standardized format

10.

Mini-Projects / Integrated Laboratory Exercises

- Multi-step analysis combining different techniques
- Individual or group projects addressing real environmental or industrial problems
- Critical discussion and presentation of results

Notes:

- Laboratory exercises can be adapted depending on the student group and equipment availability.
- Emphasis is placed on practical skills, laboratory safety, and good analytical practices.
- If necessary, classes may be conducted remotely (e.g., demonstrations or computer simulations).

Prerequisites and co-requisites

Prerequisites and requirements:
Students beginning the *Analytical Chemistry* course should have:

- basic knowledge of general, inorganic, organic, and physical chemistry;
- understanding of basic mathematics, statistics, and data analysis;
- ability to operate basic laboratory equipment;
- knowledge of laboratory safety and hygiene rules.

Recommended prior courses:
It is recommended that students complete *General Chemistry*, *Inorganic Chemistry*, *Organic Chemistry*, *Fundamentals of Physics*, and *Fundamentals of Mathematics* (or equivalent courses) before enrolling.

If students do not possess these competencies, it is recommended to acquire them prior to the start of the course.

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
Tests during thes semester	60.0%	10.0%
Final exam	60.0%	45.0%
Practical exercises	60.0%	45.0%

Recommended reading	Basic literature	1. J. Minczewski, Z. Marczenko, Chemia analityczna, PWN, Warszawa 1985 2. A. Hulanicki, Reakcje kwasów i zasad w chemii analitycznej, PWN, Warszawa 1992 wyd. 3 zm. 3. A. Cygański, Chemiczne metody analizy ilościowej, WNT, Warszawa 1992. 4. P. Konieczka, J. Namieśnik, Ocena i kontrola jakości wyników pomiarów analitycznych, WNT, 2017.
	Supplementary literature	1. Podstawy analityki [red. J. Łukasiak], Akademia Medyczna w Gdańsku, Gdańsk 1990. 2. Metody instrumentalne w kontroli zanieczyszczeń środowiska [red. J. Namieśnik], Wyd. Pol.Gdańskiej, Gdańsk 1992 3. D.A. Skoog, D.M. West, F.J. Holler, S.R. Crouch, Podstawy chemii analitycznej, PWN, Warszawa 2006
	eResources addresses	
Example issues/ example questions/ tasks being completed	Gravimetric analysis: Factors affecting the solubility and purity of sediments, optimal conditions for sediment precipitation, separation of sediments. Sources of errors and methods to avoid them. Precipitation from homogeneous solutions. Characteristics and scope of applications of weighing methods. Alkacymetry: Division of methods. General equations of alkaline titration curves, case of strong acid titration.Titration in non-aqueous environments. Visual endpoint indicators. Redoxometry: Division of methods, analytical reactions, titration curve equations, indicators, the influence of various factors on the course of the reaction. Titration: Titration curve equations. Adsorption point indicators. Complexometry: Equations of titration curves. Indicators. Complexes and complexonometry.	
Practical activites within the subject	Not applicable	

Document generated electronically. Does not require a seal or signature.