GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Chemistry and nanochemistry, PG_00071201						
Field of study	Nanotechnology						
Date of commencement of studies	October 2026		Academic year of realisation of subject	2026/2027			
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	1		ECTS credits	4.0			
Learning profile	general academic profile		Assessment form	exam			
Conducting unit	Division of Physics of Disordered Systems -> Institute of Nanotechnology and Materials Engineering -> Faculty of Applied Physics and Mathematics -> Faculties of Gdańsk University of Technology						
Name and surname of lecturer (lecturers)	Subject supervisor		dr hab. Maciej Bobrowski				
	Teachers						
Lesson types	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	30.0	0.0	15.0	0.0	0.0	45
	E-learning hours included: 0.0						
	eNauczanie source address: https://enauczanie.pg.edu.pl/2025/course/view.php?id=1339						
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	45		2.0	53.0	100	
Subject objectives	The goal of this course is to teach general chemistry and connection of this knowledge with synthesis' methods and analysis of nanostructures. An emphasis is laid on an analysis of electronic structure of molecules and prediction of resulting properties and reasons of onsequent behaviour in chemical reactions. A substantial part is dedicated to nanostructures, their syntehis and proprieties, from monoatomic (carbon (graphen, nanotubes, fulerenes), metals(through diatomic (iron oxides) up to more complex.						

Learning outcomes	Course outcome	Subject outcome	Method of verification
	[K7_U04] is able to formulate hypotheses, plan and conduct experimental research, critically analyze results, verify hypotheses, draw conclusions, and formulate well-founded opinions within nanotechnology and related physical and natural sciences. Recognizes economic and non-technical aspects of the activities performed	Students can work safely in a chemical laboratory, understand the basics of occupational health and safety, and apply lecture knowledge to qualitatively analyze chemical compounds, titrate acids and bases, conduct redox reactions, record their progress, and balance them. They can measure chemicals, and work economically and safely with reagents and laboratory equipment. They recognize the direct connection between chemistry and nanochemistry through the independent synthesis of selected nanometric compounds.	[SU2] Assessment of ability to analyse information [SU3] Assessment of ability to use knowledge gained from the subject [SU4] Assessment of ability to use methods and tools [SU1] Assessment of task fulfilment [SU5] Assessment of ability to present the results of task
	[K7_W04] has theoretical and practical knowledge of physical and chemical experimental methods in nanotechnology and understands the principles of their application in processes occurring throughout the life cycle of technical systems	The student possesses in-depth practical and theoretical knowledge of physical and chemical experimental methods in nanotechnology. The student possesses knowledge of practical calculations of solution concentrations, can balance redox reactions (half- and total), including disproportionation reactions, calculate redox potential, justify the direction of a redox reaction, understands the processes, including redox reactions, that occur in batteries and accumulators, determines the relative strengths of acids and bases (at various levels of theory), distinguishes and names chemical compounds, and is familiar with methods for synthesizing nanomaterials, including thin films and nanoparticles, as well as their applications and properties. The student understands the phenomena of corrosion and anodization, which also lead to the synthesis of nanoparticles. The student has a basic understanding of organic chemistry and the behavior of basic functional groups. The student also understands the structure of all the most important macrocomponents of cells: proteins, fats, carbohydrates, DNA, and RNA.	[SW2] Assessment of knowledge contained in presentation [SW3] Assessment of knowledge contained in written work and projects

Subject contents	Course content – lecture Divided into lecture weeks: 1. Introduction, organization, examples of applications in modern materials. 2. and 3. Chemical bonds: covalent, ionic, metallic, coordination, Pi-Pi, van der Waals, hydrogen, examples. Course of chemical reactions, energetics, characteristic points. 4. Concentrations in chemistry: molar, molal, mole fractions, mass percentage, volume percentage, other. Example calculations. 5. Redox reactions: balancing, disproportionation, environment, electrochemical cells. 6. Redox potentials, electrochemical series, Nernst equation, Gibbs energy change. 7. Chemical equilibrium constants, batteries, electrolysis, corrosion. 8. Acids and bases. Arrhenius, Brønsted-Lowry, and Lewis theories, acidity and basicity constants, pH, pOH. 9. Strong and weak acids - determining factors, titration, indicators, including their mechanisms of action. 10. Metals, nanoparticles. Synthesis and functionalization methods. 11. Metal oxides. Synthesis and functionalization methods. 12. Saturated, unsaturated, and aromatic hydrocarbons. Sources, properties, and applications. 13. Alcohols, thiols, amines, and ethers. Sources, properties, and applications. 14. Aldehydes and ketones. Sources, properties, and applications. 15. Polymers: synthesis and everyday applications. Chemistry of biomolecules. The biological role of proteins. Course content – laboratory Breakdown by lab week: 1. Organization. Safety in chemistry labs. Laboratory equipment. Overview of topics for the next lab. 2. Chemical identification of the composition of ionic mixtures: cations and anions. 3. Chemical titration of acids and bases. 4-5. Redox reactions.
Prerequisites and co-requisites	Fundamentals of chemistry, mathematics and physics.

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
final exam	51.0%	50.0%
positively reviewed all reports from all laboratories.	51.0%	50.0%

Recommended reading	Basic literature	1. Timberlake, Karen C. Chemistry: An Introduction to General, Organic, and Biological Chemistry, Global Edition, Boston : Pearson. 2015 2. Atkins, P. W. Chemistry: A Very Short Introduction, Oxford : OUP Oxford. 2014 3. General chemistry; principles, patterns, and applications. (http://www.saylor.org/books)

	Supplementary literature	1. Robert J. Ouellette and J. David Rawn. Organic Chemistry.Structure, Mechanism, and Synthesis, Elsevier, 2014. 2. Chemistry Dictionary: http://www.chemistry-dictionary.com/definition/d-orbitals.php 3. Dahm, Donald J. Calculations in chemistry: an introduction, New York: Norton, 2013
	eResources addresses	
Example issues/ example questions/ tasks being completed	Realized at both laboratories and at lectures: • Covalent bonds: understanding, distinguishing, examples, types of covalent bonds, radical orbitals (singly occupied molecular orbitals (SOMOs)), spin of molecules, types of critical points on energy hypersurface: minimas, saddle points. Reactive oxygene species, energy levels of oxygene molecule's molecular orbitals. • Ionic bonds, differences between ionic bonds and covalent bonds, examples, zwitterions, ionic liquids, application of iuonic liquids. • Coordinate and metallic bonds, -interactions, hydrogen bonds, Van der Waals bonds. Examples of systems, differences, delocalization of electrons. • Concentrations: only problems: (given reactions, concentrations, calculate different concentration, also by using metric prefixes). • Redox reactions: half reactions, disproportionation, basic and acidic media, oxidation states, • Typical oxidizers, reductors, construction of voltaic and electrochemical cells redox reactions occuring there): zinc-copper, cadmium-silver • Redox potentials, galvanic series, standard conditions, directionality of a reaction, construction and chemical reactions of following electrodes: SHE, calomel, silver. • Equilibrium constants, description (charging and discharging redox reactions) of zinc-carbon dry-cell battery, lead-storage battery, lithium-ion batteries. • Acids and bases: Arrhenius definition, Bronsted-Lowry definition, Lewis theory. Ka, Kb, pKa, pKb, pH, pOH. Amphoterism. • Strength of acids and bases. Titration. • Metals: occurence, periodic trends in metallic properties. Metal oxides: acidic, basic, amphoteric, neutral, peroxides, trends in acid-base behaviour. In all cases - the reactions! • Metal oxides nanoparticles' synthesis: Hydrothermal/solvothermal, sol-gel, chemical precipitation, CVD, PVD. Ferrofluids. • Hydrocarbons: saturated, unsaturated. Functional organic groups: alkane, alkene, alkyne, phenyl, amine, alcohol, ether, alkyl halides, thiol, aldehyde, ketone, ester, carboxylic acid, amide. • Nutrients, macromolecules: carbohydrates, lipids, proteins, nucleic acids.	
Practical activites within the subject	Not applicable	

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