GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Nanotechnology in environmental remediation and hazard neutralization systems, PG_00071221		
Field of study	Nanotechnology		
Date of commencement of studies	February 2027	Academic year of realisation of subject	2027/2028
Education level	second-cycle studies	Subject group	Specialty subject group 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	2.0
Learning profile	general academic profile	Assessment form	assessment
Conducting unit	Division of Electrochemistry and Surface Physical Chemistry -> 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	prof. dr hab. inż. Jacek Ryl
	Teachers	prof. dr hab. inż. Jacek Ryl

Lesson types	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	15.0	0.0	15.0	0.0	0.0	30
	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	30	1.0	19.0	50

Subject objectives	The aim of this course is to familiarize students with the principles of design and operation of nanostructured detection systems (sensors) for biological and environmental threats, with particular emphasis on electrochemical and optical sensors and biosensors. The course develops skills in material selection, surface functionalization, and sensor integration with protective materials, enabling real-time threat monitoring.

Learning outcomes	Course outcome	Subject outcome	Method of verification
	[K7_K03] is aware of the importance and understands the non-technical aspects and consequences of engineering activity, including its impact on the environment, and the responsibility associated with decisions taken	The student is aware of the non-scientific aspects resulting from the different methods of manufacturing and functioning of biosensors, as well as the free access to information measurable using them.	[SK5] Assessment of ability to solve problems that arise in practice
	[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	The student is able to design the architecture of a biosensor, perform measurements using it, and assess its suitability under specific conditions.	[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
	[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 has knowledge of the physical, chemical and biochemical aspects of the functioning and production of molecular recognition tools based on nanotechnology solutions.	[SW1] Assessment of factual knowledge

Subject contents	Course content – lecture This course will cover key aspects related to the following areas: Basics of nanosensors: definitions and classifications, transduction mechanisms (electrochemical, optical, transistor, mechanical, thermal), basic parameters (sensitivity, selectivity, specificity, detection limits) and nanotechnology Threat factors detection: direct (redox monitoring) and indirect detection (pathogens bacteria, viruses), components of sensor systems Biosensor functionalization: definition of a biosensor, types of surface functionalization (chemical, physical, biofunctionalization), types of receptors (catalytic, affinity), and immobilization methods (physical, chemical, encapsulation) Real-time monitoring: flow analysis, nanosensor systems, sensor integration with protective materials (dressings, etc.), lab-on-a-chip platforms, continuous systems and distributed sensors, the role of machine learning <hr>Course content – laboratory The labs will focus on the following topics: Basics of electrochemical nanosensors: construction of a simple sensor, recording the signal response to an analyte Surface functionalization: surface modification and obtaining electrocatalytic properties, the effect of functionalization on sensitivity and selectivity Detection of environmental contaminants: sensors for detecting metal ions and organic compounds, assessment of degradation, interference, and detection limits Biosensors: immobilization of a biological element, analysis of the biosensor's response to an analyte Online monitoring: Sensor integration and lab-on-a-chip system, simulation of continuous monitoring
Prerequisites and co-requisites	Fundamentals in chemistry, surface physicochemistry

Assessment methods and criteria	Subject passing criteria	Passing threshold	Percentage of the final grade
	lab reports	60.0%	40.0%
	written test	60.0%	60.0%

Recommended reading	Basic literature	Chemical sensors and biosensors: Fundamentals and applications (Wiley), 2012. ISBN:9781118354162
	Supplementary literature	Articles in JCR-rated journals
	eResources addresses	

Example issues/ example questions/ tasks being completed	Explain the differences between the sensitivity, selectivity, and specificity of nanosensors and describe the impact of the nanoscale material on the detection limit. Compare direct detection (redox monitoring) and indirect detection (pathogen biosensors), identifying their advantages and limitations. Discuss the role of surface functionalization in biosensors, including receptor types and immobilization methods. Describe the concept of real-time threat monitoring using nanosensors integrated with lab-on-a-chip systems and protective materials.
Practical activites within the subject	Not applicable

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