GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Physical Sensors and Biosensors, PG_00069697						
Field of study	Nanotechnology						
Date of commencement of studies	October 2024		Academic year of realisation of subject	2026/2027			
Education level	first-cycle studies		Subject group	Optional 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	3		Language of instruction	Polish			
Semester of study	5		ECTS credits	3.0			
Learning profile	general academic profile		Assessment form	exam			
Conducting unit	Institute of Nanotechnology and Materials Engineering -> Faculty of Applied Physics and Mathematics -> Wydziały Politechniki Gdańskiej						
Name and surname of lecturer (lecturers)	Subject supervisor	dr inż. Leszek Wicikowski					
	Teachers						
Lesson types and methods of instruction	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						
	eNauczanie source addresses: Moodle ID: 1541 Sensory i biosensory fizyczne https://enauczanie.pg.edu.pl/2025/course/view.php?id=1541						
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	5.0	40.0	75		
Subject objectives	1. Familiarize students with the operating principles of modern sensors and biosensors. 2. Introduce materials and technologies used in sensor construction, with particular emphasis on nanomaterials. 3. Develop skills in designing and selecting sensors for specific engineering applications. 4. Acquire practical measurement skills using chemical, biological, and physical sensors.						

Learning outcomes

Course outcome	Subject outcome	Method of verification
[K6_U10] can forecast and assess potential negative biological and ecological effects of producing nanostructures on an industrial scale and their practical application.	Can predict the potential ecological and biological effects of using sensors and biosensors containing nanostructures. Knows the materials (including nanostructures) used in sensors and their properties. Understands the principles of sensor signal processing and methods for improving sensitivity and selectivity. Is aware of the importance of modern sensory and biosensory techniques for civilizational development and health/ environmental protection.	[SU3] Assessment of ability to use knowledge gained from the subject
[K6_U05] can design and build a simple measuring device or instrument.	Can select a sensor for a specific application. Can conduct experiments using simple sensors and biosensors. Can analyze measurement results and interpret sensor characteristics.	[SU1] Assessment of task fulfilment
[K6_W01] has knowledge of materials science and understands its key role in the progress of civilization	knows the basic classes of sensors and biosensors and their mechanisms of operation. knows the materials (including nanostructures) used in sensors and their properties. understands the principles of sensor signal processing and methods for improving sensitivity and selectivity.	[SW1] Assessment of factual knowledge

Subject contents

Lecture (15 h)
1. Introduction to sensor science classification of sensors.
2. Physical sensors: optical, resistive, piezoelectric, magnetic.
3. Chemical sensors: potentiometric, amperometric, conductometric.
4. Biosensors: definition, classification, biological elements (enzymes, receptors, DNA, antibodies).
5. Transduction methods in biosensors (optical, electrochemical, bulk, nanomechanical).
6. Nanomaterials in sensors: nanoparticles, nanotubes, graphene, quantum dots.
7. Practical applications: medicine, environmental protection, industry, safety.
8. Development trends in modern sensors and biosensors.

Laboratory (15 h)
1. Electrical characterization of simple resistive sensors.
2. Measurement of gas concentration using a semiconductor sensor.
3. Study of an optical (fiber optic) sensor.
4. Construction of a simple enzymatic biosensor (e.g., glucose).
5. Recording and analyzing the biosensor's current-voltage characteristics.
6. Presentation of results and analysis of measurement data.

Prerequisites and co-requisites

Fundamentals of solid-state physics and optics.
Fundamentals of physical and analytical chemistry.
Elements of electronics and measurement technology.

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
exercise reports and assessment of practical skills.	100.0%	40.0%
Exam	50.0%	60.0%

Recommended reading

Basic literature

1. J. Janata, *Principles of Chemical Sensors*, Springer.
2. D. Diamond, *Principles of Chemical and Biological Sensors*, Wiley.
3. R. P. Buck et al., *Biosensors: Fundamentals and Applications*, Oxford University Press.

	Supplementary literature	1. P. Gründler, Chemical Sensors: An Introduction for Scientists and Engineers, Springer. 2. Current articles from the journals: Biosensors and Bioelectronics, Sensors and Actuators B.
	eResources addresses	
Example issues/ example questions/ tasks being completed	Classification and Basics 1. Define a sensor and a biosensor. How do they differ? 2. List the main classes of physical sensors and provide examples of their applications. 3. Explain the meaning of the terms sensitivity, selectivity, and detection limit of a sensor. 4. What are the differences between potentiometric and amperometric chemical sensors? Biosensors 1. Describe the components of a biosensor. 2. What biological components can be used in biosensors? Provide examples. 3. How do glucose biosensors work and why are they commonly used in medicine? 4. Compare electrochemical and optical transducers in biosensors. Nanomaterials in Sensors 1. What properties of carbon nanotubes and graphene make them good materials for building sensors? 2. What are the characteristics of quantum dots and what applications can they have in biological detection? Applications and Safety 1. Provide examples of biosensor applications in environmental protection. 2. What are the potential negative ecological consequences of using nanostructures in sensors? 3. Indicate directions for the development of modern sensor technologies. Resistance Sensor Exercises 1. What is the relationship between sensor resistance and the measured physical parameter? 2. How can the R(T) characteristic of a resistive temperature sensor be determined? Gas Sensors 1. Explain the operating mechanism of a semiconductor gas sensor. 2. How can the selectivity of a gas sensor be improved? Optical Sensors 1. What is detection using a fiber-optic sensor? 2. What factors can interfere with optical measurements? Enzymatic Biosensors 1. Explain the operating principle of a simple enzymatic biosensor. 2. How can a glucose biosensor be prepared and calibrated? 3. How can the current-voltage characteristic of an enzymatic biosensor be interpreted?	
Work placement	Not applicable	

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