



## Subject card

Subject name and code	Nanotechnology in environmental remediation and hazard neutralization systems, PG_00071220						
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			4.0		
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	dr inż. Marta Prześniak-Welenc					
	Teachers	dr inż. Marta Prześniak-Welenc					
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						
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 aim of this course is to familiarize scientists with the use of nanotechnology in the application and neutralization of hazards in water and air. Elements are subject to the mechanisms of sorption, filtration, and reactive activation, and their applications, which are available, taking into account their limitations.						

Learning outcomes	Course outcome	Subject outcome	Method of verification
	[K7_W02] has in-depth, theoretically grounded and detailed knowledge of phenomena, methods, and theories related to nanotechnology, as well as of related and allied fields of science or engineering	The student has in-depth knowledge of nanomaterials and systems used in the purification and neutralization of environmental hazards in water and air, including knowledge of the mechanisms of sorption, filtration and reactive processes.	[SW1] Assessment of factual knowledge
	[K7_W06] has extended knowledge of scientific laboratory work methodology, supported by experience in laboratory practice. Knows occupational health and safety regulations to an extent enabling independent work at a research or measurement workstation	The student has knowledge of the principles and methodology of laboratory work applied to research on environmental purification and hazard neutralization processes, including experimental design, selection of materials and analytical methods, and safe handling of nanomaterials and chemical agents.	[SW1] Assessment of factual knowledge
	[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 formulate research hypotheses concerning the effectiveness of nanomaterials in environmental purification and hazard neutralization processes, design and conduct experiments to verify these hypotheses, critically analyse the results, and evaluate technological solutions considering technical, economic, and environmental aspects.	[SU3] Assessment of ability to use knowledge gained from the subject [SU1] Assessment of task fulfilment
	[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 responsibility associated with designing and implementing nanotechnology-based purification and hazard neutralization systems, and understands their potential environmental, health, economic and societal impacts.	[SK1] Assessment of group work skills [SK5] Assessment of ability to solve problems that arise in practice

## Subject contents

Course content – lecture

### **Segment A (5 h): Environmental Hazards**

- Types of environmental hazards: chemical, biological, and aerosol-related
- Environmental matrices: water and air differences in technological approaches
- Mobile and field scenarios (accidents, point-source contamination, long-term exposure)
- The role of nanotechnology: sorption, filtration, neutralization, monitoring

### **Segment B (10 h): Sorptive and Filtration Nanomaterials**

- Sorptive nanomaterials: metal oxides, carbon-based materials, hybrid nanocomposites
- Mechanisms of contaminant removal: adsorption, complexation, ion exchange, chemical reduction
- Nanomembranes and nanofibrous filters: water filtration (NF/UF functional approach), air and bioaerosol filtration; limitations: fouling, selectivity, regeneration, durability

### **Segment C (6 h): Neutralization and Deactivation of Hazards**

- Chemical and biological deactivation processes
- Photocatalysis as a tool for hazard neutralization
- Reactive processes (advanced oxidation processes)
- Comparison of removal (filtration, sorption) and neutralization (decomposition/biological deactivation)
- Criteria for selecting appropriate technologies for specific hazard scenarios

### **Segment D (8 h): Nanotechnology in Practical Purification Systems**

- Functional integration in nanomaterials: sorption + catalysis + detection
- Hybrid nanosystems for purification: membranes with photo-/catalytic layers, sorbents with antibacterial functionality, nanocomposites
- Structurefunction coupling: active surface area and mass transport
- Limitations of nanosystems at the macro scale: technology transfer, stability, and regeneration

### **Assessment (1 h)**

Course content – laboratory

#### **Laboratory 1 (5 h): Sorptive Materials Preparation and Characterization**

Preparation of simple sorptive materials, surface modification, and investigation of sorption processes using model water contaminants, including the influence of pH, contact time, and initial concentration.

#### **Laboratory 2 (5 h): Sorption-Based Water Treatment Using Nanomaterials**

	<p>Evaluation of water purification efficiency using nanomaterials, including the effects of pH, contact time, and contaminant concentration, with comparison to a previously prepared reference sorbent.</p> <p><b>Laboratory 3 (5 h): Photocatalytic Water Treatment</b></p> <p>Preparation of a photocatalytic system, degradation of a model contaminant, comparison with a passive process (irradiation without photocatalyst; adsorption/desorption equilibrium), and kinetic analysis of the degradation process.</p>											
Prerequisites and co-requisites	Basic knowledge of general chemistry and the physicochemical processes occurring in aqueous solutions and the gas phase. Basic knowledge of nanotechnology and materials science.											
Assessment methods and criteria	<table border="1"> <thead> <tr> <th>Subject passing criteria</th> <th>Passing threshold</th> <th>Percentage of the final grade</th> </tr> </thead> <tbody> <tr> <td>Lecture</td> <td>60.0%</td> <td>70.0%</td> </tr> <tr> <td>Laboratorium</td> <td>100.0%</td> <td>30.0%</td> </tr> </tbody> </table>			Subject passing criteria	Passing threshold	Percentage of the final grade	Lecture	60.0%	70.0%	Laboratorium	100.0%	30.0%
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Lecture	60.0%	70.0%										
Laboratorium	100.0%	30.0%										
Recommended reading	Basic literature	<p><i>Nanotechnology for Water Treatment and Purification</i> By Anming Hu and Allen Apblett Published on 28 July, 2014, Springer Cham ISBN (hardcover): 978-3-319-06577-9 ISBN (softcover): 978-3-319-37470-3 DOI: 10.1007/978-3-319-06578-6 Link: <a href="https://link.springer.com/book/10.1007/978-3-319-06578-6">https://link.springer.com/book/10.1007/978-3-319-06578-6</a></p> <p>Tratnyek, P.G., Johnson, R.L., 2006. Nanotechnologies for environmental cleanup. <i>Nano Today</i>, 1: 4448.</p> <p>Alvarez, P.J.J., Chan, C.K., Elimelech, M., Halad, N.J., Villagran, D., 2009. Emerging opportunities for nanotechnology to enhance water security. <i>Nature Nanotechnology</i>, 13: 634641.</p> <p>Hodges, B.C., Cates, E.L., Kim, J.H. 2009. Challenges and prospects of advanced oxi</p>										
	Supplementary literature	<p><i>Environmental Nanotechnology: Applications and Impacts of Nanomaterials, Second Edition</i> By Mark Wiesner and Jean-Yves Bottero Published on October 7, 2016, Second Edition, McGraw Hill ISBN-10: 0071828443 ISBN-13: 978-0071828444 Link: <a href="https://www.amazon.com/Environmental-Nanotechnology-Applications-ImpactsNanomaterials/dp/0071828443">https://www.amazon.com/Environmental-Nanotechnology-Applications-ImpactsNanomaterials/dp/0071828443</a></p> <p>Perreault, F., de Faria, A.F., Elimelech, M. 2015. Environmental applications of graphene-based nanomaterials. <i>Chemical Society Reviews</i>, 44: 58615896.</p>										
	eResources addresses											

<p>Example issues/ example questions/ tasks being completed</p>	<p><b>Sample Topics / Questions / Assignments</b></p> <p><b>Sample Topics</b></p> <ul style="list-style-type: none"> <li>• Mechanisms involved in environmental purification and hazard neutralization processes</li> <li>• Sorptive and filtration nanomaterials principles of operation and limitations</li> <li>• Photocatalytic processes for contaminant neutralization</li> <li>• Hybrid nanosystems for purification</li> <li>• Purification systems under mass and energy constraints</li> <li>• Stability and durability of nanomaterials in aquatic and atmospheric environments</li> </ul> <p><b>Sample Questions</b></p> <ul style="list-style-type: none"> <li>• What are the differences between sorption, filtration, and neutralization of environmental hazards?</li> <li>• What is the role of nanomaterials in photocatalytic purification processes?</li> <li>• How does pH influence the sorptive properties of materials?</li> </ul> <p><b>Sample Assignments</b></p> <ul style="list-style-type: none"> <li>• Evaluation of purification efficiency using nanomaterials</li> <li>• Kinetic analysis of a photocatalytic degradation process</li> <li>• Selection of an appropriate purification technology for a given environmental scenario</li> </ul>
<p>Practical activities within the subject</p>	<p>Not applicable</p>

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