

<b>Nanomaterials in environmental science</b>								<b>Code of the course</b>	<b>Year / Semester</b>	
<b>Type of subject:</b>								<b>Education Profile</b>	<b>The level of education</b>	<b>Form of studies</b>
<b>Obligatory</b>								<b>General Academic</b>	<b>Stationary</b>	
<b>Type of subject</b>								<b>ECTS</b>		
<b>Lecture</b>	<b>Exercises</b>	<b>Laboratory</b>	<b>Project</b>	<b>Seminar</b>	<b>Practical classes</b>	<b>Exam</b>				
15	15	-	-	-	-	-	5			
<b>Subject coordinator:</b>										
<i>Dr hab. Inż. Renata Włodarczyk, prof. PCz., renata.wlodarczyk@pcz.pl</i>										

<b>II. COURSE CONTENT</b>		
<b>Course type – Lecture</b>		<b>Number of hours</b>
<b>1-2</b>	Definition of materials in nanoscale and specific properties	2
<b>3-4</b>	Production of nanomaterials, specific role of nanomaterials in environment, procedure of nanoparticles deposition	2
<b>5-6</b>	Structure of nanomaterials (nanowire, dendrimers, nanoparticles, etc.), nanoparticles alloys, kind of compounds of materials	2
<b>7-8</b>	Nanotechnology in agricultural applications	2
<b>9-10</b>	Nanomaterials in hydrogen technology- fuel cells, nanomaterials as catalysts for electrochemical reactions, nanoparticles as energy carrier	2
<b>11-12</b>	Nanomaterials as biomaterials in medicine	2

<b>13-14</b>	Carbon based materials as nanomaterials (crop yield, nanoencapsulation, sorbents, plant protection, antimicrobial agents, etc.)	2
<b>15</b>	Novelty in nanomaterials. Test.	1
<b>TOTAL:</b>		<b>15</b>
<b>Course type - Exercises</b>		<b>Number of hours</b>
<b>1-4</b>	Selection of the nanomaterial application area	4
<b>5-8</b>	Development of a procedure for the use of nanomaterials	4
<b>9-12</b>	Description of the use of nanomaterials in a given area and elaboration of potential risks related to nanomaterials	4
<b>13-14</b>	Physical analysis of carbon nanomaterials	2
<b>15</b>	Test	1
<b>TOTAL:</b>		<b>15</b>

#### **DIDACTIC METHODS**

<b>1.</b>	Blackboard
<b>2.</b>	Multimedia presentation

#### **METHODS OF ASSESSMENTS: (F – FORMATIVE; S – SUMMATIVE)**

<b>F01</b>	activity in classes
<b>F02</b>	evaluation of task solving
<b>S01</b>	Test
<b>S02</b>	seminary/presentation

#### **III. STUDENT WORKLOAD**

<b>L.p.</b>	<b>Form of activity</b>	<b>Numer of hours for activity</b>
		<b>[hours]</b>
<b>1. Direct teaching hours:</b>		
<b>1.1</b>	Hours of classes organized by universities – lectures	15

<b>1.2</b>	Hours of classes organized by universities – exercises	15
<b>1.3</b>	Hours of classes organized by universities – laboratory	
<b>1.4</b>	Hours of classes organized by universities – project	
<b>1.5</b>	Hours of classes organized by universities – field activities	
<b>1.6</b>	Hours of classes organized by universities – seminar	
<b>1.7</b>	Exam	
<b>Total direct hours:</b>		<b>30</b>
<b>2. Student's own work</b>		
<b>2.1</b>	Preparation for exercises and for final exams	27
<b>2.2</b>	Preparation for laboratory test reports, preparation of individual	
<b>2.3</b>	Preparing your own project	
<b>2.4</b>	Preparation for the final exam from the lecture	
<b>2.5</b>	Exam Preparation	
<b>2.6</b>	Reading the literature	
<b>Total student's self-studies:</b>		<b>57</b>
<b>Overall student workload:</b>		<b>57</b>
<b>TOTAL NUMBER OF ECTS FOR THE COURSE:</b>		<b>5</b>
The number of ECTS credits that a student obtains in classes requiring the direct participation of the teacher:		<b>2,63</b>
The number of ECTS credits that the student obtains as part of his/her own work		<b>2,36</b>

<b>IV. PRIMARY AND SUPPLEMENTARY LITERATURE</b>	
<b>Primary literature</b>	
A. Kacprzak. R. Włodarczyk, Utilization of Organic Waste in a Direct Carbon Fuel Cell for Sustainable Electricity Generation, Energies, vol. 16, Iss. 21, DOI: 10.3390/en16217359	
Renata Włodarczyk, Paulina Kaleja, Janusz Stępnik, Beata Barszczowska, Katowice Business University, Poland, Green solutions in the smart city, Rozdział w monografii: The use of information and communication technologies (ICT) in the management, Taylor & Francis Group, <a href="https://doi.org/10.1201/9781003465157">https://doi.org/10.1201/9781003465157</a>	
R. Włodarczyk. P. Kaleja, Modern Hydrogen Technologies in the Face of Climate Change—Analysis of Strategy and Development in Polish Conditions, Sustainability, Vol. 15, Iss. 17, DOI: 10.3390/su151712891	

R. Włodarczyk, Analysis of the Photovoltaic Waste-Recycling Process in Polish Conditions—A Short Review, Sustainability, Vol.14 Iss.8, DOI: 10.3390/su14084739

Renata Włodarczyk, Zuzanna Cichoń, Nogał Jakub, Analiza możliwości wykorzystania wodoru RFNBO w warunkach polskich, Monografia; Współczesne wyzwania w inżynierii materiałowej i zarządzaniu produkcją, E. Staniewska, M. Suliga , Wydawnictwo Politechniki Częstochowskiej 978-83-65976-37-6, str. 304-318, rozdział 3, DOI: 10.17512/CUT/978836597637

Włodarczyk Renata, Paulina Kaleja, Analiza zagrożeń i bezpieczeństwa instalacji w łańcuchu wodorowym Risk analysis and safety of installations in the hydrogen economy, Instal, vol. 7-8, str. 10-19, ISSN 1640-8160, e-ISSN 2956-6738, DOI 10.36119/15.2025.7-8.1