

<b>Fuel cells and hydrogen technology</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>			
<b>15</b>	<b>15</b>		<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>5</b>		
<b>Subject coordinator:</b>									
<i>Dr inż. Renata Włodarczyk, renata.wlodarczyk@pcz.pl</i>									

<b>II. COURSE CONTENT</b>		
<b>Course type – Lectures</b>		<b>Number of hours</b>
<b>1-2</b>	The origins of the development of fuel cells. Fuel cell efficiency.	2
<b>2-4</b>	The construction of fuel cells, the functions of the individual elements of the fuel cell. Selection of materials for electrodes, catalysts, membranes. Principle of operation of fuel cell type PEMFC, electrochemical reactions occurring in cells.	3
<b>5-6</b>	Classification and types of fuel cells.	2
<b>7-8</b>	Auxiliaries necessary for the operation of the fuel cell. Fuel cells as generators of heat and electricity in residential buildings.	2
<b>9-10</b>	Properties of hydrogen, hydrogen as an energy carrier. Methods of hydrogen production. Storage of hydrogen (types of alloy, cylinder) and distribution of hydrogen.	2

<b>11-12</b>	Hybrid fuel cell hybrid systems.	2
<b>13-15</b>	Economic analysis of the fuel cell system. Test.	2
<b>TOTAL:</b>		<b>15</b>
<b>Course type – Tutorials</b>		<b>Number of hours</b>
<b>1-3</b>	Chemical reactions in cells of different types and electrolysis. Methods for determining the efficiency of fuel cells. Performance characteristics of fuel cells.	3
<b>4-6</b>	Carbon materials used to build cell elements.	3
<b>7-8</b>	Porous Foaming Electrodes. Types of materials used to store hydrogen. Types of electrochemical catalysts used in low temperature cells.	2
<b>9-10</b>	Methods of selection of materials for electrodes and membranes - measurement methods, types of measuring instruments (porosity, humidity, structure).	2
<b>11-12</b>	Methods of selection of materials for mono / bipolar coverings - measurement methods, types of measuring instruments (corrosion resistance, porosity, roughness, wettability, microstructure, inter-surface resistance).	2
<b>13-14</b>	The world's fuel cell market.	2
<b>15</b>	Test	1
<b>TOTAL:</b>		<b>15</b>

#### **DIDACTIC METHODS**

<b>1.</b>	Blackboard, interactive whiteboard, e-learning platform
<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

<b>III. STUDENT WORKLOAD</b>		
<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	15
<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	12
<b>2.5</b>	Exam Preparation	
<b>2.6</b>	Reading the literature	
<b>Total student's self-studies:</b>		<b>27</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>	
<b>1</b>	Fuel Cell Handbook, Sixth edition, EG&G Technical Services, Inc. Science Applications International Corporation, DOE/NETL- 2002/1179

<b>2</b>	J. Larminie, A. Dicks: Fuel cell system explained, Wiley, New York 2000.
<b>3</b>	Chmielniak T. Technologie energetyczne, Wydawnictwa Naukowo-Techniczne, Warszawa 2008.
<b>Supplementary literature</b>	

<b>VII. OTHER USEFUL INFORMATION ABOUT THE SUBJECT</b>	
<b>1.</b>	Opportunity to review supporting materials and literature: <i>Appropriate to the type of material - in teaching classes, in the TUC Central Library.</i>
<b>2.</b>	Information on when and where the classes will be held <i>Notice board at the Faculty of Infrastructure and Environment and on the website of the Faculty of Infrastructure and Environment, MSz USOS system.</i>
<b>3.</b>	Information about the consultation (times + place): <i>the staff consultation schedule is available on the Faculty of Infrastructure and Environment website and on the staff room door.</i>