Syllabus template

Course title: **Fuel cells and hydrogen technology**		
Programme:**Practice Energy**		Code: **4.29**
Type of course: **Module S6-B**	Course level: **level I**	Semester: **I**
Form of classes: **lectures, tutorials**	Number of hours per week/~~meeting~~: **1L, 1T**	Credit points: **3 ECTS**
Education profile: **practice**		Course language: **English**
Enrolment: ~~yes~~/ no		

GUIDE TO THE SUBJECT

I. COURSE CHART

COURSE OBJECTIVES

C.1. Pass knowledge about how to process chemical energy in different types of cells.
C.2. Familiarize yourself with the principle of operation of fuel cells, types of fuel cells, use, auxiliary equipment.
C.3. Familiarize yourself with the role of individual elements in the link and material requirements.
C.4. Transfer of knowledge about the types of energy carriers in cells, hydrogen properties, possibilities of hydrogen production and storage

PRELIMINARY COURSE REQUIREMENTS FOR KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Knowledge of chemistry and physics, heat engineering.
2. Ability to use professional literature.

LEARNING OUTCOMES

EK 1 - He is knowledgeable about the types of cells, the construction of cells, and the reactions that occur in each cell.

EK 2 - Know the construction of a fuel cell, the individual elements of a cell, and their functions and used materials.

EK 3- Can determine the interaction of the link in hybrid systems.

EK4- Know the construction and functions of auxiliaries necessary for the operation of the fuel cell.

EK 5- Know the properties of hydrogen, methods of obtaining, storing, distributing hydrogen.

COURSE CONTENT

Form of classes - lectures	Hours
W 1 – Cells I and Type II.	1
W 2 – The origins of the development of fuel cells. Fuel cell efficiency.	1
W 3 – The construction of fuel cells, the functions of the individual	1
W 4 – Selection of materials for electrodes, catalysts, membranes.	1
W 5 – Principle of operation of fuel cell type PEMFC, electrochemical	1
W 6-8 - Classification and types of fuel cells.	3
W 9 – Auxiliaries necessary for the operation of the fuel cell.	1
W 10 - Fuel cells as generators of heat and electricity in residential buildings**.**	1
W 11 - Hybrid fuel cell hybrid systems.	1
W 12 – Economic analysis of the fuel cell system.	1
W 13 – Properties of hydrogen, hydrogen as an energy carrier.	1
W 14 – Methods of hydrogen production.	1
W 15 - Storage of hydrogen (types of alloy, cylinder) and distribution of hydrogen.	1
Form of classes - tutorials	**Hours**
L 1 – Introduction, conditions for getting credit.	1
L 2 – Chemical reactions in cells of different types and electrolysis.	1
L 3 – Methods for determining the efficiency of fuel cells.	1
L 4 - Performance characteristics of fuel cells.	1
L 5 - Carbon materials used to build cell elements.	1
L 6 - Types of electrochemical catalysts used in low temperature cells.	1
L 7 – Porous Foaming Electrodes**.**	1
L 8 – Types of materials used to store hydrogen.	1
L 9,10 - Methods of selection of materials for electrodes and membranes - measurement methods, types of measuring instruments (porosity, humidity, structure).	2
L 11,12,13 - Methods of selection of materials for mono / bipolar coverings - measurement methods, types of measuring instruments (corrosion resistance, porosity, roughness, wettability, microstructure, inter-surface resistance).	3
L 14 – The world's fuel cell market.	1
L 15 – Final test.	1

COURSE STUDY METHODS

1. multimedia presentation
2. blackboard, interactive whiteboard

METHODS OF ASSESMENT (F - formative; S - summative)

F1. – activity in classes
F2. – evaluation of task solving
S1. – exam

STUDENT WORKLOAD

Form of activity	Workload (hours)
Participation in lectures	15 h
Participation in classes	15 h
Laboratory	-
Participation in project classes	-
Participation in seminar	-
Preparation course on e-learning	-
Test	2h
Entrance test for laboratory classes	-
Project's defence	-
Exam	-
Consultation hours	4 h
DIRECT TEACHING, hours/ ECTS	**36 h / 1 ECTS**
Preparation for tutorials	4 h
Preparation for laboratories	-
Preparation for projects	-
Preparation for seminars	-
Preparation for e-learning classes	-
Participation in e-learning classes	-
Working on project	-
Preparation for tests	4 h
Preparation for exam	-
SELF-STUDY, hours/ ECTS	**8 h / 2 ECTS**
TOTAL (hours)	**∑ 44 h**
TOTAL ECTS	**3 ECTS**

PRIMARY AND SUPPLEMENTARY TEXTBOOKS

1. Czerwiński A., Akumulatory, baterie, ogniwa, Wydawnictwa Komunikacji i Łączności, Warszawa 2005.
2. Chmielniak T. Technologie energetyczne, Wydawnictwa Naukowo-Techniczne, Warszawa 2008.
3. Redey L., Ogniwa paliwowe, Wydawnictwa Naukowo-Techniczne, Warszawa 1973.
4. Fuel Cell Handbook, Sixth edition, EG&G Technical Services, Inc. Science Applications International Corporation, DOE/NETL- 2002/1179
5. J. Larmine, A. Dicks: Fuel cell system explained, Wiley, New York 2000.

SUBJECT COORDINATOR (NAME, SURNAME, E-MAIL ADDRESS)

1. dr inż. Renata Włodarczyk, rwlodarczyk@is.pcz.czest.pl

NAME OF LECTURER (s) (NAME, SURNAME, E-MAIL ADDRESS)

1. dr inż. Renata Włodarczyk, rwlodarczyk@is.pcz.czest.pl

Learning outcome	In relation to the learning outcomes specified for the field of study	Course objectives	Course content	Course study methods	Methods of assesment
EK 1	K_W17	C.1.	W1-W15, L1-L15	1, 2, 3	F2, P1
EK 2	K_W17	C.2., C.3.	W1-W15, L1-L15	1, 2, 3	F1, P1
EK 3	K_W17, K_U15	C.1.	W1-W15, L1-L15	1, 2, 3	F1, P1
EK 4	K_W17	C.3.	W1-W15, L1-L15	1, 2, 3	F1, P1
EK 5	K_W17	C.3.	W1-W15, L1-L15	1, 2, 3	F1, P1

II. OTHER USEFUL INFORMATION

1. All the information on the class schedule is posted on the student information board and online at: www.is.pcz.pl
2. The information about the consultation hours is provided to students on the first class meeting and posted online at Instytutu Inżynierii Środowiska
3. The information on course completion and grade is provided to students on the first class meeting.