Zał. nr 5 do ZW 78/2023

Attachment no. 4. to the Program of Studies

FACULTY OF CHEMISTRY

SUBJECT CARD

Name of subject in Polish:	**Zaawansowane Technologie Chemiczne – nanotechnologie i energia**
Name of subject in English:	**Advanced Chemical Technologies – Nanotechnologies and Energy**
Main field of study:	Chemical Engineering and Technology
Specialization (if applicable):	Advanced Chemical Technology
Profile:	academic
Level and form of studies:	2nd level, full-time
Kind of subject:	obligatory
Subject code:	W03CET-SM2020W, W03CET-SM2020L
Group of courses:	NO

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30		45		
Number of hours of total student workload (CNPS)	50		100		
Form of crediting (Examination / crediting with grade)	exam		crediting with grade		
For group of courses mark (X) final course					
Number of ECTS points	2		4		
including number of ECTS points for practical classes (P)			4		
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1,2		1,8		

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1.

SUBJECT OBJECTIVES

C1 advanced knowledge mastery by students in the field of nanotechnology, production of nanomaterials, their characterization and applications

C2 familiarizing students with issues related to the use of nanomaterials and nanotechnologies in modern systems of energy production, storage and conversion

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01 the student has advanced knowledge in the production of modern materials aimed at generating, storing and converting energy

PEU_W02 the student knows the latest trends in the development of nanotechnology

relating to skills:
PEU_U01student is able to plan and carry out nanomaterials production processes
PEU_U02 the student is able to characterize nanomaterials in terms of their suitability for the production and storage of energy and/or fuels
PEU_U03 the student critically processes the acquired information in the field of nanotechnology and nanomaterials
PEU_U04 the student demonstrates the ability to work in a team

relating to social competences:
PEU_K01 the student is ready to critically evaluate his knowledge
PEU_K02 is aware of the importance of technical and non-technical aspects related to the production and use of nanomaterials, also in the context of environmental protection and sustainable development goals

PROGRAMME CONTENT

Lecture		**Number of hours**
Lec 1	Nanomaterials: review of synthesis methods, classifications, characterization and applications	2
Lec 2	Fullerenes. Synthesis methods, structure, functionalization, properties and applications.	2
Lec 3	Nanofibers and carbon nanotubes. Synthesis methods, structure, functionalization, properties and applications	2
Lec 4	Graphene and graphene oxide. Synthesis methods, properties and potential applications.	2
Lec 5	Metal nanoparticles. Synthesis, characterization, applications.	2
Lec 6-7	Ceramic nanomaterials. Synthesis strategies, properties, applications and prospects.	4
Lec 8-9	Applications of nanotechnology. The role of nanoscience in the development of societies - Medical applications and health care. Introduction to energy applications.	4
Lec 10-12	Nanotechnology in solar cells: applications under development. Nanotechnologies and energy production, storage and conversion.	6
Lec 13	Electrocatalysts. Hydrogen production from water.	2
Lec 14	Nanomaterials in fuel production technologies	2
Lec 15	The future of nanotechnology – summary discussion	2
	Total hours	**30**

Laboratory		**Number of hours**
La1	Safety rules for work in the laboratory and rules for passing the course.	2
La2-La8	Synthesis and characterization of nanostructures and nanosystems	20
La9-La14	Applications of nanostructures and nanosystems	20
La15	Summary lab	3
	Total hours	45

TEACHING TOOLS USED

N1. Multimedia presentation N2. Discussion N3. Case study N4. Laboratory instructions

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
P (lecture)	PEU_W01-PEU_W02, PEU_K01 PEU_K02	Exam result (50% of points required to pass) + 10% for activity (possibility of increasing the grade by 0.5)
P (laboratory) P=0,7xF1+0,2xF2+0,1xF3	PEU_U01-PEU_U04, PEU_K01 PEU_K02	Grades from reports, evaluation of laboratory work, activity

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Nanomaterials for Sustainable Energy Applications, S. P. Kumar, CRC Press Inc. 2023
[2] Nanomaterials: An Introduction to Properties, Synthesis and Applications, E. Craig, Larsen and Keller Education 2019
[3] Nanostructures and Nanomaterials, W. Ying, C. Guozhong, World Scientific Publishing Company 2011

SECONDARY LITERATURE:

[1] Specialized literature provided by the teacher at the beginning of the class
[2] Laboratory instructions

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

Team of lecturers