Wrocław University of Science and Technology
Doctoral School

COURSE CARD

1. Basic information

Course name in English:	Eco-design of chemical energy sources - lithium cells vs. non-lithium cells	
Course name in Polish:	Eko-projektowanie chemicznych źródeł energii - ogniwa litowe vs. ogniwa nielitowe	
Number of hours:	15	
Type of course:	Elective course	
Form of course:	mixed forms (combination of lecture, seminar and laboratory)	
Code of course:		
Course leader:	*dr inż. Agnieszka Sobianowska-Turek & dr inż. Weronika Urbańska*	
Faculty of the course leader:	W7 Faculty of Environmental Engineering	
Email address of the course leader:	agnieszka.sobianowska-turek@pwr.edu.pl; weronika.urbanska@pwr.edu.pl	
Scientific discipline(s) assigned to the course (doctoral students representing the marked disciplines can participate in the course):	Architecture and urban planning	☐
	Automation, electronic, electrical engineering and space technologies	☐
	Information and communication technology	☐
	Biomedical engineering	☒
	Chemical engineering	☒
	Civil engineering, geodesy and transport	☒
	Materials engineering	☒
	Mechanical engineering	☒
	Environmental engineering, mining, and energy	☒
	Mathematics	☐
	Chemical sciences	☒
	Physical sciences	☐
	Management and quality studies	☒

2. Objectives

The main goal of the course is to present and familiarize students with topics related to non-lithium cells, which will soon replace lithium-ion batteries and accumulators currently used on the market, as well as to pay special attention to the design of new cationic and/or anionic cells, which in the near future will be used in recycling and raw material recovery processes, and analyzing the possibilities of adapting recycling processes to waste polymetallic batteries and accumulators already designed and used in industrial conditions, with an indication of potential problems and threats.

3. Content

Detailed information about the course content, including topics and form of classes.

No.	Topic	Number of hours	Form of classes
1	Introduction to the topic of eco-design of chemical energy sources. Lithium-ion cells vs. non-lithium cells - technological and process challenges.	2	lecture
2	Global recycling of chemical lithium-ion energy sources used in industrial settings.	2	lecture
3	Global recycling of chemical lithium-ion energy sources, new technological and process trends.	2	lecture
4	Case studies on newly designed processes and technologies for recycling chemical energy sources.	4	seminar
5	Hydrometallurgical processes in the recovery of valuable raw materials from chemical Li-ion energy sources.	4	laboratory
6	Passing a course.	1	lecture

4. Prerequisites

List of prerequisites relating to knowledge, skills and other competences for course participants.

The course participant should have general knowledge of inorganic and organic chemistry.

5. Learning outcomes

List of learning outcomes at level 8 of the Polish Qualifications Framework assigned to the course (mark the learning outcomes in the last column).

Symbol	**Learning outcome**	
	KNOWLEDGE. Doctoral student knows and understands:	
SzD_W3	the main trends in the development of the scientific or artistic disciplines covered in the curricula;	☒
SzD_W4	research methodology;	☒
SzD_W5	the rules for the dissemination of scientific results, including in open access mode;	☐
SzD_W6	the fundamental dilemmas of modern civilization;	☒
SzD_W7	the legal and ethical conditions of scientific activity;	☐
SzD_W8	the economic and other relevant conditions of scientific activity;	☒
SzD_W9	basic principles of knowledge transfer to the economic and social spheres and commercialisation of results of scientific activity and know-how related to these results.	☒
	SKILLS. Doctoral student is able to:	
SzD_U2	use knowledge from different fields of science or art to creatively identify, formulate and innovatively solve complex problems or perform research tasks, in particular: - define the purpose and subject of scientific research, formulate a research hypothesis,	☒

	- develop research methods, techniques and tools, and use them creatively, - draw conclusions on the basis of scientific research; critically analyse and evaluate the results of scientific research, expertise and other creative work and their contribution to knowledge development; transfer the results of scientific activities to the economic and social spheres;	
SzD_U3	communicate on specialised topics to the extent that they enable an active participation in the international scientific community;	☒
SzD_U4	disseminate research results, including in popular forms;	☐
SzD_U5	initiate debates and participate in a scientific discourse;	☒
SzD_U6	be able to speak a foreign language at B2 level of the Common European Framework of Reference for Languages to a level that enables them to participate in the international scientific and professional environment;	☒
SzD_U7	plan and implement an individual or collective research or creative activity, including in an international environment;	☐
SzD_U8	independently plan and act for one’s own development and inspire and organize the development of others;	☒
SzD_U9	plan classes or groups of classes and implement them using modern methods and tools.	☒
	SOCIAL COMPETENCES. Doctoral student is ready to:	
SzD_K3	fulfilling the social obligations of researchers and creators, initiate public interest activities, thinking and acting in an entrepreneurial way;	☒
SzD_K4	maintaining and developing the ethos of research and creative environments, including: - carrying out scientific activities in an independent manner, - respecting the principle of public ownership of research results, taking into account the principles of intellectual property protection.	☒

6. Evaluation

Short description of the method(s) used to evaluate the learning outcomes assigned to the course, e.g., exam, test, report, presentation, etc.

Lecture – exam, Seminar – presentation, Laboratory - report

7. Teaching methods

Short description of the teaching methods used during the course, e.g., multimedia presentation, discussion, literature studies, developing written documents, own work, etc.

Information and multimedia lecture, discussion, literature studies, independent work, group work and consultations.

8. Literature

List of primary and secondary literature used to prepare the course and including additional knowledge for participants, e.g., books, textbooks, research papers, standards, web pages, etc.

Book:
X. Lin, X. Wang, G. Liu, G. Zhang, Recycling of power lithium-ion batteries. Technology, Equipment and Policies. WILEY-VCH 2023, ISBN: 978-3-527-35108-4

A. Czerwiński, Akumulatory, baterie i ogniwa, WKŁ 2005, ISBN: 83-206-1564-X
Web pages:
European Chemicals Agency - Understanding the Batteries Regulation,
https://echa.europa.eu/understanding-batteries-regulation
European Commission - Ensuring that batteries placed on the EU market are sustainable and circular throughout their whole life cycle,
https://environment.ec.europa.eu/topics/waste-and-recycling/batteries_en
Eurostat, Statistics Explained - Waste statistics - recycling of batteries and accumulators,
https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Waste_statistics_-_recycling_of_batteries_and_accumulators

9. Other remarks

Additional remarks, comments, (e.g., language of the course)

Language of the course - English.