



Subject card

Subject name and code	Energy storage methods, PG_00058343						
Field of study	Hydrogen Technologies and Electromobility						
Date of commencement of studies	October 2022		Academic year of realisation of subject		2023/2024		
Education level	first-cycle studies		Subject group		Obligatory subject group in the field of study Subject group related to scientific research in the field of study		
Mode of study	Full-time studies		Mode of delivery		at the university		
Year of study	2		Language of instruction		Polish		
Semester of study	3		ECTS credits		5.0		
Learning profile	general academic profile		Assessment form		exam		
Conducting unit	Department of Biomedical Engineering -> Faculty of Electronics, Telecommunications and Informatics						
Name and surname of lecturer (lecturers)	Subject supervisor		prof. dr hab. inż. Piotr Jasiński				
	Teachers		dr inż. Iga Szpunar				
			prof. dr hab. inż. Piotr Jasiński				
			dr hab. inż. Sebastian Molin				
Lesson types and methods of instruction	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	30.0	0.0	30.0	0.0	0.0	60
	E-learning hours included: 0.0						
Learning activity and number of study hours	Learning activity	Participation in didactic classes included in study plan		Participation in consultation hours		Self-study	SUM
	Number of study hours	60		8.0		57.0	125
Subject objectives	The objective of the course "Energy Storage Methods" is to provide students with a thorough understanding of various energy storage technologies and their applications in practical scenarios. Students learn the basic principles of energy storage, such as electrochemical, thermal, and mechanical storage methods, and how these methods impact the efficiency and stability of energy systems. The course also aims to understand the challenges associated with integrating energy storage into sustainable and decentralized energy systems.						
Learning outcomes	Course outcome		Subject outcome		Method of verification		
	[K6_W08] has basic knowledge in the field of energy storage systems: mechanical, thermal, electrical and others, knows the basics of thermodynamics and fluid mechanics, as well as the construction and operation of thermal energy equipment, hydrogen installations, process equipment, including renewable energy sources		The student is capable of analyzing and interpreting data on various energy storage technologies, as well as drawing logical conclusions and formulating opinions on them.		[SW2] Assessment of knowledge contained in presentation [SW1] Assessment of factual knowledge		
	[K6_K02] can work in a group taking on different roles in it		The student knows how to work in group, knows different group roles and understands how to divide tasks and responsibility.		[SK3] Assessment of ability to organize work [SK1] Assessment of group work skills		
	[K6_U01] Is able to obtain information from literature, databases and other sources, integrate them, interpret them and draw conclusions and formulate opinions; has the ability to self-educate m.in. in order to improve professional competences		The student is able to identify and utilize various sources of information, such as scientific articles, databases, and technical standards, related to various energy storage technologies.		[SU1] Assessment of task fulfilment [SU2] Assessment of ability to analyse information		

Subject contents	<div>1. Introduction to Energy Storage</div> <div>2. Energy in Traditional Carriers: Coal, Oil, Gas</div> <div>3. Basic Electrochemical Batteries (Lead-Acid, Flow Batteries)</div> <div>4. Modern Electrochemical Batteries (Lithium-Ion, Flow Batteries)</div> <div>5. Energy Storage in Electric Vehicles</div> <div>6. Generation and Storage of Hydrogen Energy</div> <div>7. Hydrogen Storage: Hydrides, Compressed, Liquid</div> <div>8. Supercapacitors</div> <div>9. Chemical Energy Storage: Methanol, Ammonia, Biofuels</div> <div>10. Thermal Energy Storage (PCM, Water Systems, Rocks)</div> <div>11. Mechanical Energy Storage - Compressed Air (CAES), Flywheels, Gravitational Energy Storage</div> <div>12. Hydraulic Energy Storage Systems (PHES)</div> <div>13. Nuclear Energy - Nuclear Fuel</div> <div>14. Energy Storage in Energy Grids</div> <div>15. Case Studies - Analysis of Cases</div>		
Prerequisites and co-requisites			
Assessment methods and criteria	Subject passing criteria	Passing threshold	Percentage of the final grade
	Laboratory	80.0%	25.0%
	Final test	50.0%	75.0%
Recommended reading	Basic literature	<div>1. Barnes F. S., Levine J. G., Large Energy Storage Systems Handbook, CRC Press, Taylor and Francis Group, 2011</div> <div>2. Ahmed Faheem Zobaa, Energy Storage - Technologies and Applications, InTech 2013. ISBN 978-953-51-0951-8, DOI: 10.5772/2550;http://www.intechopen.com/books/energy-storage-technologies-and-applications</div> <div>3. Rafi qul Islam Sheikh, Energy Storage, InTech 2010, ISBN 978-953-307-119-0; http://www.intechopen.com/books/energy-storage</div>	
	Supplementary literature	<div>1) publications from Elsevier, Wiley publishing houses (and others)</div> <div>2) internet resources</div>	
	eResources addresses	Adresy na platformie eNauczanie: METODY MAGAZYNOWANIA ENERGII [2023/24] - Moodle ID: 32106 https://enauczenie.pg.edu.pl/moodle/course/view.php?id=32106	
Example issues/ example questions/ tasks being completed	<div>1. Please describe the basic methods of energy storage in Poland?</div> <div>2. Please describe a possible energy storage scenario 20 years from now?</div> <div>3. What technologies can be used for storing energy on a small and large scale?</div>		
Work placement	Not applicable		

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