



## Subject card

Subject name and code	Energy storage systems, PG_00062762						
Field of study	Technologies for Industry 5.0						
Date of commencement of studies	October 2024		Academic year of realisation of subject			2026/2027	
Education level	first-cycle studies		Subject group			Optional subject group 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	3		Language of instruction			Polish	
Semester of study	5		ECTS credits			4.0	
Learning profile	general academic profile		Assessment form			assessment	
Conducting unit	Katedra Inżynierii Materiałów Funkcjonalnych WET1 -> Faculty of Electronics, Telecommunications and Informatics						
Name and surname of lecturer (lecturers)	Subject supervisor		dr hab. inż. Sebastian Molin				
	Teachers						
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		5.0		35.0	100
Subject objectives	The objective of the course "Energy Storage Systems" is to provide students with a thorough understanding of various energy storagetechnologies and their applications in practical scenarios. Students learn the basic principles of energy storage, such aselectrochemical, thermal, and mechanical storage methods, and how these methods impact the efficiency and stability of energysystems. The course also aims to understand the challenges associated with integrating energy storage into sustainable anddecentralized energy systems.						

Learning outcomes	Course outcome	Subject outcome	Method of verification
	[K6_W03] demonstrates knowledge on materials used in industrial technologies, their structure and fabrication, knows the principles of conducting research, analyzing it and creating technical documentation	A student achieving this learning outcome will acquire comprehensive knowledge about the materials used in industrial technologies. They will understand their structure and properties, as well as the processes involved in their production. An essential element will be the ability to conduct materials research, which includes planning experiments, performing tests, and analyzing the results obtained. The student will learn to critically evaluate the properties of materials in the context of their industrial applications. Furthermore, they will develop the skill to create professional technical documentation, which is crucial in the work of an engineer. This knowledge and these skills will enable the student to effectively participate in the processes of design, production, and quality control across various industries, contributing to innovation and optimization of technological processes.	[SW1] Assessment of factual knowledge
	[K6_U03] has the ability to plan, prepare and carry out engineering activities using practical knowledge and understanding of the specificity of materials, devices and tools, processes and technologies, and prepare a substantive report	A student achieving this learning outcome will demonstrate the ability to comprehensively manage engineering activities. They will be able to plan, prepare, and execute projects using practical knowledge of materials, devices, tools, processes, and technologies. A key element will be the ability to apply this knowledge practically in real engineering situations. Additionally, the student will develop the skill to synthesize and present the results of their work in the form of a substantive report, which is essential for effective communication in a professional environment.	[SU3] Assessment of ability to use knowledge gained from the subject [SU2] Assessment of ability to analyse information
	[K6_K03] effectively, clearly and unambiguously conveys information, describes activities and communicates their results and opinions of a specialist engineer using appropriate communication methods and tools	A student achieving this learning outcome will develop key competencies in effective engineering communication. They will be able to precisely and unambiguously convey technical information, describe engineering activities in detail, and clearly communicate their results. An important element will be the ability to formulate and present opinions from the perspective of a specialist engineer. The student will learn to select and use appropriate communication methods and tools, adapted to various audiences and professional situations. This competency will contribute to effective collaboration in engineering teams and efficient transfer of technical knowledge to both specialists and non-specialists in the field.	[SK4] Assessment of communication skills, including language correctness

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

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