GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	, PG_00069684		
Field of study	Recycling and Energy Recovery		
Date of commencement of studies	October 2023	Academic year of realisation of subject	2025/2026
Education level	first-cycle studies	Subject group	
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	5.0
Learning profile	general academic profile	Assessment form	assessment
Conducting unit	Department of Chemical Apparatus and Theory of Machines -> Faculty of Chemistry -> Wydziały Politechniki Gdańskiej		
Name and surname of lecturer (lecturers)	Subject supervisor	prof. dr hab. Ewa Klugmann-Radziemska	
	Teachers	dr inż. Anna Kuczyńska-Łażewska prof. dr hab. Ewa Klugmann-Radziemska dr inż. Anna Dettlaff	

Lesson types and methods of instruction

Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
Number of study hours	20.0	20.0	20.0	0.0	0.0	60

E-learning hours included: 0.0

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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	60.0	125

Subject objectives

The aim of the course is to familiarize students with issues related to the management of industrial waste, which constitutes 90% of waste in Poland: the principles of its classification, segregation and management, the basics of recycling technologies for individual waste groups, environmental and economic aspects, with particular emphasis on photovoltaic waste.

Learning outcomes

Course outcome	Subject outcome	Method of verification
[K6_K03] is committed to independent lifelong learning and independently follows the development of science and technology, especially in the area of recycling raw materials and energy.	The student engages in independent lifelong learning and independently tracks developments in science and technology, especially in the area of raw materials and energy recovery.	[SK5] Assessment of ability to solve problems that arise in practice
[K6_U03] designs processes, technologies and systems related to the recovery of raw materials and energy, using appropriate concepts, standards and design methods.	The student designs processes, technologies and systems related to the recovery of raw materials and energy.	[SU2] Assessment of ability to analyse information
[K6_W05] analyzes practical issues in the field of recovery of raw materials and energy, using knowledge and understanding of: materials, devices and tools, processes and technologies.	The student analyzes practical issues in the field of raw material and energy recovery.	[SW1] Assessment of factual knowledge

Subject contents	**Lecture:** 1. Industrial Waste - Classification. 2. EU Directives and National Regulations on Industrial Waste Management. 3. Product Life Cycle Assessment (LCA). 4. 3/4R Principle, Sustainable Development Principle. 5. Hazardous Waste Management. 6. Material, Raw Material, and Energy Recycling in Specific Waste Groups: Production Waste, Packaging Waste, Garage Waste, Construction Waste, Waste Electrical and Electronic Equipment, and Medical Waste. 7. Basic Technology for Manufacturing Crystalline Silicon and Thin-Film Photovoltaic Modules. 8. Life Cycle of Photovoltaic Modules. 9. Recycling and Disposal of Photovoltaic Waste - Regulations on Waste Electrical and Electronic Equipment (WEEE). 10. Possibilities of Recovering Clean Materials in the Recycling of Crystalline Silicon and Thin-Film Photovoltaic Waste. 11. Reuse of Whole PV Cells and Materials Recovered in the Recycling Process. 12. Recycling of energy storage batteries in renewable energy installations. **Laboratory and exercises:** Work in groups of two, with a topic selected from two thematic groups: 1. Recycling of used technical components of photovoltaic installations: a case study for specific fractions, e.g., glass, aluminum, silicon, silver, and metals, and their reuse in the production of new PV modules. 2. Mechanical and hydrometallurgical technologies in the recycling of battery materials: a case study for the recovery of lithium, cobalt, manganese, and nickel, and their reuse in the production of new batteries.
Prerequisites and co-requisites	n/d
Assessment methods and criteria	

Subject passing criteria	Passing threshold	Percentage of the final grade
exercises and laboratory	60.0%	50.0%
lecture content	60.0%	50.0%

Recommended reading	Basic literature	1. Waste Act of 14 December 2012 (Journal of Laws 2022, item 699) https://sip.lex.pl/akty-prawne/dzu-dziennik-ustaw/odpady-17940659 2. COUNCIL DIRECTIVE 1999/31/EC of 26 April 1999 on the landfill of waste https://sip.lex.pl/akty-prawne/dzienniki-UE/kierunki-1999-31-we-w-sprawie-skladowania-odpadow-67427597 3. Directive 2000/53/EC of the European Parliament and of the Council of 18 September 2000 on end-of-life vehicles https://sip.lex.pl/akty-prawne/dzienniki-UE/wódza-2000-53-we-w-sprawie-pojazdow-wycofanych-z-korzystacji-67427581 4. Act on the recycling of end-of-life vehicles (Journal of Laws 2020, item 2056) https://isap.sejm.gov.pl/isap.nsf/DocDetails.xsp?id=WDU20200002056 5. COMMUNICATION FROM THE COMMISSION The European Green Deal https://eur-lex.europa.eu/legal-content/PL/TXT/HTML/?uri=CELEX:52019DC0640&from=EN 6. Act of 13 June 2013 on the management of packaging and packaging waste https://sip.lex.pl/akty-prawne/dzu-dziennik-ustaw/gospodarka-opakowaniami-i-odpadami-opakowaniowymi-18015362

	Supplementary literature	1) Błędzki A.K., Recycling of Polymer Materials, Scientific and Technical Publishing House, Warsaw 1997 2) Wilczyński K., Rheology in Plastics Processing, Scientific and Technical Publishing House, Warsaw 2001 3) Oprzędkiewicz J., Technologies and Systems for Car Recycling, WNT Warsaw 2003 4) Czerwinski A., Accumulators, Batteries, Cells, Communication and Communication Publishing House, Warsaw, 2005
	eResources addresses	
Example issues/ example questions/ tasks being completed	Discuss the 3R and 4R principles. What paper recycling methods do you know? Principles for calculating the product fee. Recycling glass packaging.	
Work placement	Not applicable	

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