GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	, PG_00061729		
Field of study	Environmental Engineering		
Date of commencement of studies	October 2023	Academic year of realisation of subject	2024/2025
Education level	second-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	Part-time studies	Mode of delivery	at the university
Year of study	2	Language of instruction	Polish
Semester of study	3	ECTS credits	4.0
Learning profile	general academic profile	Assessment form	exam
Conducting unit	Department of Sanitary Engineering -> Faculty of Civil and Environmental Engineering		
Name and surname of lecturer (lecturers)	Subject supervisor	dr inż. Przemysław Kowal	
	Teachers	mgr inż. Barbara Drewnowska dr inż. Przemysław Kowal	

Lesson types and methods of instruction	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	20.0	10.0	0.0	0.0	0.0	30
	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	30	6.0	70.0	106

Subject objectives	The aim of the Closed Cycle Economy (GOZ) course is for students to acquire the knowledge, skills and competencies necessary to understand and implement the principles of the closed cycle economy in various sectors of the economy.Students will learn the theoretical foundations and practical aspects of the closed loop economy, the differences between the linear and circular models, and the importance of sustainable resource management.Students will learn to analyze the life cycle of products, design sustainable production and consumption systems, and develop strategies to minimize waste and increase efficiency in the use of raw materials.

Learning outcomes

Course outcome	Subject outcome	Method of verification
[K7_W08] has knowledge necessary to understand the social, economic, legal and other non-technical determinants of engineering activities and their incorporation in engineering practice	The student is able to assess the economic and environmental benefits of implementing closed-loop economy strategies in enterprises and cities.	[SW1] Assessment of factual knowledge [SW3] Assessment of knowledge contained in written work and projects
K7_U11	The student is able to design a water treatment and wastewater treatment system taking into account the principles of a closed-loop economy, such as waste minimization and resource recovery.	[SU1] Assessment of task fulfilment [SU2] Assessment of ability to analyse information [SU3] Assessment of ability to use knowledge gained from the subject [SU4] Assessment of ability to use methods and tools [SU5] Assessment of ability to present the results of task
K7_W07	The student is familiar with the principles of a closed-loop economy in the context of water management, including an understanding of the basics regarding the implementation of technologies based on the closed water cycle and the recycling and reuse of wastewater.	[SW1] Assessment of factual knowledge

Subject contents

1. Introduction to the Circular Economy:
- Key concepts of the circular economy (CE).
- Differences between linear and circular economies.
- Goals and benefits of a circular economy for water resource conservation.
- Key CE strategies: reduction, reuse, recycling.

2. Water Resources in the Circular Economy:
- The role of water in the circular economy.
- Optimizing water use in industry, agriculture, and households.
- Closed water loops and water recycling technologies.
- Minimizing water losses and efficient water resource management.

3. Water Treatment Technologies in the Context of CE:
- Modern water treatment technologies in the circular economy (e.g., membrane technologies, reverse osmosis, ultrafiltration).
- Technologies for water-saving and recovering heat and energy from water treatment systems.
- Treatment of industrial and production water in closed cycles.
- Systems for monitoring water quality and optimizing treatment processes.

4. Wastewater Treatment Technologies in CE:
- Biological technologies (activated sludge, biological reactors) and their role in the circular economy.
- Innovative physical and chemical wastewater treatment technologies.
- Methods for resource and energy recovery from wastewater (e.g., biogas recovery, phosphorus recovery, reuse of sewage sludge).
- Wastewater recycling and its reuse in various sectors (e.g., gray water, treated wastewater in industry).

5. Sewage Sludge Management:
- Technologies for sewage sludge processing and disposal.
- The use of sewage sludge in the CE, e.g., for energy production (biogas), as a raw material for composting, in agriculture.
- Legal regulations regarding sewage sludge management.
- Safe and sustainable methods for sludge utilization.

6. Energy and Resource Recovery from Water and Wastewater:
- Energy recovery technologies from water treatment and wastewater treatment processes (e.g., biogas production, heat recovery).
- Processes for recovering resources (e.g., metals, phosphorus, nitrogen) from wastewater.
- Sustainable methods for utilizing water and wastewater resources in closed cycles.

7. Life Cycle Assessment (LCA) of Water and Wastewater Technologies:
- Life Cycle Assessment (LCA) as a tool for analyzing the environmental impact of water and wastewater technologies.
- Cost-benefit analysis of applying CE technologies in water and wastewater management.
- Efficiency indicators in resource management for water and wastewater.

8. Legal Regulations and Policies Supporting CE in the Water and Wastewater Sector:
- Regulations and laws related to water treatment, wastewater treatment, and water management (e.g., EU directives, national laws).
- Strategies and programs supporting CE in the water and wastewater sector at the national and international levels.

9. Case Studies on Implementing the Circular Economy in the Water and Wastewater Sector:
- Case studies of implementing CE technologies in the water and wastewater industry.
- Examples of cities and companies adopting circular solutions in water and wastewater management.
- Challenges and best practices in the implementation of CE in the water and wastewater sector.

10. The Future of the Circular Economy in the Water and Wastewater Sector:
- New technologies and innovative approaches to water treatment and wastewater treatment in the context of CE.
- Opportunities for further integration of circular solutions in water and wastewater management.
- The role of society, administration, and businesses in developing sustainable water and wastewater systems.

<table>
<tr><td>Prerequisites and co-requisites</td><td colspan="2">The student should have basic knowledge of chemistry and biology, especially in the context of water and wastewater processes, such as chemical reactions, biological phenomena (e.g., nitrification, denitrification) and basic mechanisms of water pollution.Knowledge of engineering technologies used in water and wastewater management, including the basics of wastewater treatment plants, water treatment plants, sewage and water supply systems.The student should be familiar with the basic technological processes used in water and wastewater treatment, such as filtration, sedimentation, biological processes for removal of contaminants, membrane processes and physicochemical methods</td></tr>
<tr><td>Assessment methods and criteria</td><td colspan="2"><table>
<tr><th>Subject passing criteria</th><th>Passing threshold</th><th>Percentage of the final grade</th></tr>
<tr><td>Test of the knowledge acquired during lectures</td><td>60.0%</td><td>60.0%</td></tr>
<tr><td>Project considering CE approach</td><td>60.0%</td><td>40.0%</td></tr>
</table></td></tr>
<tr><td rowspan="3">Recommended reading</td><td>Basic literature</td><td>1. "Wastewater Engineering: Treatment and Resource Recovery" Metcalf & Eddy, 5th edition, McGraw-Hill, 2013.

2. "Water Reuse: Issues, Technologies, and Applications" Takashi Asano, Franklin L. Burton, Harold L. Leverenz, Ryujiro Tsuchihashi, George Tchobanoglous, McGraw-Hill, 2007.

3. "Principles of Water Treatment" Kerry J. Howe, David W. Hand, John C. Crittenden, Richard Rhodes Trussell, George Tchobanoglous, Wiley, 2012.

4. Water, Wastewater, and Stormwater Infrastructure Management" Neil S. Grigg, CRC Press, 2012.</td></tr>
<tr><td>Supplementary literature</td><td>1. "The Circular Economy: A User's Guide" Walter Stahel, Routledge, 2019.
2. "The Water-Energy Nexus in the Urban Environment" Vincenzo Naddeo, Malini Balakrishnan, Water Intelligence Online, 2014.
3. "Circular Economy in the Water Industry: Towards Water Sustainability" Xiaoyan Liu, Qingshi Tu, Yingxin Zhang, Science of The Total Environment, 2021.</td></tr>
<tr><td>eResources addresses</td><td>Adresy na platformie eNauczanie:</td></tr>
<tr><td>Example issues/ example questions/ tasks being completed</td><td colspan="2">1. Evaluating the Impact of Circular Economy Principles on Water Treatment Processes:

• Analyze how integrating circular economy principles can affect the efficiency and sustainability of water treatment technologies.
• Develop a case study on the application of circular economy concepts in a specific water treatment plant.

2. Designing a Water Recycling System for a Residential Community:

• Propose a design for a water recycling system that includes rainwater harvesting and greywater reuse in a multi-family residential setting.
• Evaluate the environmental and economic benefits of the proposed system.

3. Assessing the Feasibility of Resource Recovery from Wastewater:

• Examine various technologies for resource recovery from wastewater, such as phosphorus recovery or biogas production.
• Compare the effectiveness and cost of different recovery technologies and recommend the most suitable option for a specific application.

4. Developing a Wastewater Management Plan for a Growing Urban Area:

• Create a comprehensive wastewater management plan that incorporates circular economy principles for a rapidly expanding urban area.
• Address challenges such as increased wastewater volume, infrastructure development, and regulatory compliance.</td></tr>
<tr><td>Work placement</td><td colspan="2">Not applicable</td></tr>
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