Warsaw University of Technology

COURSE OFFERED IN THE DOCTORAL SCHOOL

Code of the course	4606-ES-0DEGKLP-0306	Name of the course	Polish	**Nowoczesne Technologie Recyklingu Odpadów**		
			English	**Modern Technologies for Waste Recycling**		
Type of the course	specialized					
Course coordinator	dr hab. inż. Rafał Przekop					
Implementing unit	Faculty of Chemical and Process Engineering	Scientific discipline / disciplines*	Chemical Engineering, Chemical Sciences, Materials Engineering, Biomedical Engineering, Physical Sciences, biotechnology			
Level of education	Education of doctoral students	Semester	Winter semester			
Language of the course	English					
Type of assessment:	Credit with a grade	Number of hours in a semester	30	ECTS credits	2	
Minimum number of participants	12	Maximum number of participants	32	Available for students (BSc, MSc)	Yes	

Type of classes		Lecture	Auditory classes	Project classes	Laboratory	Seminar
Number of hours	in a week	2	-	-	-	-
	in a semester	30	-	-	-	-

* does not apply to the Researcher's Workshop-

1. Prerequisites

General knowledge on mechanics and physical chemistry. Fluid mechanics.

2. Course objectives

The aim of the proposed series of lectures is:

- The basic issues in the field of waste sources and their classification.
- Division of waste management, utilization and recycling methods.
- Presentation, characteristics and criticism of the present knowledge and technologies used for waste recycling.

3. Course content (separate for each type of classes)

Lecture

1. Introduction. Discussion of the lecture program, proposals of supplementary literature on the subject, familiarization with the subject regulations, the form of credit, dates and place of consultation. Roman Club, civilization development. A global view on waste, its management and recycling. Modeling of environmental performance, stable and unstable models.
Definition of waste. Waste in ecological issues. Waste classification. Sources of waste. Legal issues in the field of storage, transport and processing of waste. Sewage sludge management. Waste law in Poland and in the EU. Regulations on environmental protection. Environmental Protection Act, Water Law Act, State Environmental Protection Inspection.

2. Sewage. Sources of sewage generation, calculation of the amount of sewage. Discussion of the parameters characterizing domestic and industrial sewage. Migration of pollutants in surface waters. Migration of pollutants in soils. Wastewater treatment technologies. Pretreatment. Chemical and biological treatment. Water management in industrial plants. Protective zones around industrial plants.

3. Gas purification technologies. Economics of gas cleaning processes.

4. Solid waste, origin, solid waste type, division into waste groups. Solid waste storage. BAT - the best available technologies, waste-free technologies and environmentally friendly technologies, cleaner production.

5. Toxins and harmful compounds, toxin classifications, examples of formation and release into the environment from the chemical industry, migrations, circulation and accumulation in the environment. Heavy metals.
Properties of pollution of basic branches of the chemical industry. Waste transport methods. Hazardous waste and classification.

6. Properties of pollution of various branches of industry. Waste polymer recycling technologies. Technologies for recycling composite materials. Technologies for recycling rubber and rubber waste. **7.** Methods of pollution reduction in chemical industry: inorganic chemicals, electrochemical and organic chemicals, oil rafineries. **8.** Technologies of wood and paper industry waste recycling. Odors. Basic technologies for removing hydrogen sulfide, sulfur dioxide, halogen, and volatile organic compounds from the air. Chemical and physicochemical methods for minimizing pollution.
Laboratory

4. Learning outcomes			
	Learning outcomes description	Reference to the learning outcomes of the WUT DS	Learning outcomes verification methods*
Knowledge			
K01	He has established knowledge useful for engineering of technological processes used for waste management and recycling.	SD_W1 (P8S_WK)	written test
K02	He has established comparative knowledge about chemical and physical methods of waste management, processing and recycling.	SD_W2 (P8S_WG)	written test
K03	He has knowledge of new trends and the most important achievements in the field of chemical and process engineering concerning available technologies for the management and use of various groups and types of waste.	SD_W3 (P8S_WG)	written test
Skills			
S01	He can get information from the literature, data bases and other sources in order to comply projects concerning distribution of pollutants in the natural environment.	SD_U1 (P8S_UW)	written test
S02	He can make a project concerning distribution of pollutants between different environmental compartments (air, water, soil, biota) in the local and global scale.	SD_U2 (P8S_UW)	written test
S03	He can, based on the acquired knowledge of various wastes and use modern chemical and process engineering for design of pro-ecological industrial processes.	SD_U4 (P8S_UK) SD_U7 (P8S_UO) SD_U8 (P8S_UU)	written test
Social competences			
SC01	He has extensive knowledge of the methods of recycling and managing various types of waste, he understands the need for a critical assessment of the achievements of the represented discipline as well as constant training and improvement of his professional competences.	SD_K1 (P8S_KK) SD_K2 (P8S_KK)	written test
SC02	He can use pro-ecological solutions in the studied issues of modern chemical and process engineering and practically apply knowledge about the nature of	SD_K3 (P8S_KO) SD_K4 (P8S_KO)	written test

	circular processes in the issues of recycling with the use of modern chemical and process engineering.		

*Allowed learning outcomes verification methods: exam; oral exam; written test; oral test; project evaluation; report evaluation; presentation evaluation; active participation during classes; homework; tests

5. Assessment criteria
Pass a subject: positive result of the written test concerning the content of the lectures. Grades: Grade - 5.0: 19 - 20 points, Grade - 4.5: 17 - 18 points, Grade - 4.0: 15 - 16 points, Grade - 3.5: 13 - 14 points, Grade - 3.0: 11 - 12 points, failing to pass (Grade - 2.0) ≤ 10 points

6. Literature
Basic literature: [1] "Wybrane Zagadnienia Recyklingu Tworzyw Sztucznych i Gumy" , J. Datta, P. Jutrzenka Trzebiatowska, P. Kasprzyk, Wyd. Politechniki Gdańskiej, 2018 [2] „Odzysk i Recykling Materiałów Polimerowych", J. Kijeński, PWN, 2019 [3] „Podręcznik Gospodarki Odpadami", B Bilitewski, G. Hardtle, K. Marek, Wyd. Seidel Przywecki, 2006

7. PhD student's workload necessary to achieve the learning outcomes**		
No.	Description	Number of hours
1	Hours of scheduled instruction given by the academic teacher in the classroom	30
2	Hours of consultations with the academic teacher, exams, tests, etc.	10
3	Amount of time devoted to the preparation for classes, preparation of presentations, reports, projects, homework	10
4	Amount of time devoted to the preparation for exams, test, assessments	10
	Total number of hours	**60**
	ECTS credits	**2**

** 1 ECTS = 25-30 hours of the PhD students work (2 ECTS = 60 hours; 4 ECTS = 110 hours, etc.)