Warsaw University of Technology

COURSE OFFERED IN THE DOCTORAL SCHOOL

Code of the course	4606-ES-00DEGKL-0271	Name of the course	Polish	**Biotechnologiczne Metody Unieszkodliwiania Odpadów**	
			English	**Biotechnological Methods of Waste Disposal**	
Type of the course	Specialty subjects				
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		
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	60	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 mass and energy balancing.

2. Course objectives

The aim of the course is a general presentation of the problem of waste generation as an effect of civilization development and the ecological effects of an increase in the amount of waste. Justification of the need to recycle industrial and municipal waste and classification of known methods of waste handling. Overview of waste management and recycling technologies with the use of bioprocesses and biotechnology.

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

Lecture

1. **Introduction**. The role of biotechnological processes in environmental protection. The use of natural biological processes for the neutralization of waste generated as a result of human economic and living activities. Development directions and history of the use of biotechnological methods. Perspectives of biotechnological methods. **2.** Swamp installations for waste treatment. Principles of construction and operation. Calculation and design of sewage treatment plants. Practical areas of use. Domestic and foreign experience. Characteristics of domestic and industrial sewage. Naturalization of purified water. **3.** Methane fermentation. Types of fermentation techniques. Constructional solutions. Balancing of fermentors. Process efficiency. Characteristics and further use of biogas. **4.** Industrial earthworm breeding. Housing and breeding requirements of oligochaetes. Types of waste processed by earthworms. Principles of construction of earthworm farms. **5.** The active sludge process. The formation of excess sludge. Characteristics of the course of aerobic wastewater treatment. The degree of wastewater treatment. Microflora and microfauna of active sludge. The influence of the conditions on the development of active sludge. Removal of nitrogen and phosphorus from wastewater. **6.** Biological beds. Construction of the deposits beds. Deposit beds development period. Application for the treatment of domestic and industrial wastewater. The use of excess sludge for hydro-seeding and fertilization as a method of waste management. Forest waste sludge management. Vertech technology. Incineration of sewage sludge. **7.** Biological ponds, soil filters, slurry fields, agricultural use of waste coming from animal production, methods of application, doses used per unit area. Bioreactors for the cultivation of algae (algae). Algae growth and
conditions requirements. Separation of biomass from post-reaction suspensions. The use of produced biomass. **8.** Composting. Principles of the composting process. Waste suitable for composting. Hot compost formation. Aging and use of compost. Compost quality control. Composting techniques. Industrial breeding of flies insects. The use of insects to neutralize protein waste. The method of breeding, obtained products and yields. **9.** Alcohol fermentation. Conducting alcohol fermentation, conditions and yields. Waste raw materials suitable for disposal by alcohol fermentation. Biofilters and bio-washers. Construction of porous biological beds. Kinetics of bioxidation and biosorption of gaseous pollutants. Removal of metals from wastewater. Utilization of meat and bone powder. Prospects and directions of further development of biotechnology for industrial waste neutralization.
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 and systematic knowledge on biotechnological processes used for waste management.	SD_W1 (P8S_WK)	written test

K02	He has established knowledge necessary for the analysis of natural environmental processes and comparative knowledge of alternative methods of chemical and physical waste management. i.e. for preparing appropriate mass and energy balances taking into account all the components of natural environment.	SD_W2 (P8S_WG)	written test
K03	He has knowledge of new trends and the most important achievements in the field of the available technologies for waste 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 compare the available bio-waste management technologies.	SD_U2 (P8S_UW)	written test
S03	He is able, based on the acquired knowledge about biological processes, to use modern chemical and process engineering to design pro-ecological industrial processes.	SD_U4 (P8S_UK) SD_U7 (P8S_UO) SD_U8 (P8S_UU)	written test
Social competences			
SC01	Having extensive knowledge of natural environment and emerging new environmental threats he understands the need for a critical evaluation of the achievements of the discipline represented as well as	SD_K1 (P8S_KK) SD_K2 (P8S_KK)	written test
	constant training and improving his professional competences.		
SC02	He can use pro-ecological solutions in the studied issues of modern chemical and process engineering.	SD_K3 (P8S_KO) SD_K4 (P8S_KO)	written test

*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. The understanding of the discussed content of the program, the essence of the presented processes, methods of their conduct, aspects of practical use and the limitation of the usefulness of the discussed separation methods is assessed.

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] "Biologiczne Przeatwarzanie Odpadów" Andrzej Jędrczak, WNP , 2008 [2] „Urządzenia do Oczyszczania Scieków" , Z. Heidrich, A. Witowski, Wydawnictwo 'Seidel-Przywecki" ,2010

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.)