Warsaw University of Technology

COURSE OFFERED IN THE DOCTORAL SCHOOL

Code of the course	4606-ES-0DEGKLP-0308	Name of the course	Polish	**Procesy Rozdzielania w Biotechnologii**	
			English	**Separation Processes in Biotechnology**	
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, biotechnologia		
Level of education	Education of doctoral students	Semester	Summer 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

Basics of mass and energy balancing.

2. Course objectives

The aim of the proposed series of lectures is:

Discussion of the needs of separation in industrial processes, especially in biotechnology. Presentation of separation methods used for the separation and purification of components of post-reaction mixtures, especially for applications in biotechnological processes. Systematization of knowledge about separation technologies, their specificity, together with the presentation of the criteria for selecting separation methods.

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

Lecture

1. General concept of a sequence of separation processes in biotechnology. Cell and tissue disintegration. Mechanical methods of grinding. Grinding. Ball mill. Kinetics of the process of mechanical cell disintegration.
2. Various alternative methods of disintegration. Osmotic shock. Cavitation. Solvent methods. Detergents application. Chemical methods of disintegration. Construction of a cell wall.
3. Movement of solid particles in a fluid. Periodic sedimentation. Continuous sedimentation. Centrifuges. Undisturbed and disturb sedimentation.
4. Liquid Chromatography (Elution).
5. Adsorption. Adsorption equilibrium. Characteristics of adsorbents and adsorption process.
6. Drying, drying diagram, division of the drying process into two periods, driving force of the drying process, intensification of the drying process. Calculation of dryers.
7. Extraction, extraction equilibrium on the Gibbs triangular plot, one-stage extraction, countercurrent and cross-step extraction, determination of the number of extraction stages, operating point, industrial extraction apparatus issues, continuous extraction, features of an ideal extractant, graphical method of determining the number of extraction stages. Extraction kinetics.
8. Membrane filtration. Membrane processes. Diafiltration. Staged diafiltration.
9. Absorption**.**
10. Crystallization. Crystallizers. Balance of crystals.

11. Distillation. Calculation of a single-stage evaporator, useful temperature, heat balance of the evaporator, evaporator batteries. Distillation, simple distillation, flash distillation, equilibrium distillation, vapor liquid equilibrium, steam distillation.

Rectification, rectification column, equation of operating lines for the upper and lower part of the column, fed plate, return, graphical method of determining the number of theoretical shelfs, the number of shelfs depending on the return, rectification column construction.

12. Filtration, filtration resistance, filtration chart, filtration under constant pressure, filtration with constant efficiency, two-stage filtration, determination of the optimal filtration time period, dynamic filtration, filtration aid, gas filtration, filtration equipment, operation of the press filter and drum filter, filter cake washing, dynamic filtration.

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 processes of separation in biotechnology.	SD_W1 (P8S_WK)	written test
K02	He has established knowledge on alternative separation methods, both chemical and physical.	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 the separation technologies and the ability to select the appropriate technology for a given purpose.	SD_W3 (P8S_WG)	written test
Skills			
S01	He can get information from the literature, on biorecycling of various types of wastes.	SD_U1 (P8S_UW)	written test
S02	He can possess the ability to analyze and understand the potential efficiency of recycling technologies.	SD_U2 (P8S_UW)	written test
S03	He can obtain information from literature, databases and other sources in order to carry out a project on the transfer of pollutants between different components of the natural environment.	SD_U4 (P8S_UK) SD_U7 (P8S_UO) SD_U8 (P8S_UU)	written test
Social competences			
SC01	He has ability to evaluate the suitability of the various types of available recycling methods and to compare them critically.	SD_K1 (P8S_KK) SD_K2 (P8S_KK)	written test
SC02	He can use solutions from among the separation methods in biotechnology 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. 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. "Zasady Inżynierii Chemicznej" M. Serwiński, WNT, 1976
2. „Podstawy Inżynierii Chemicznej" J. Ciborowski, WNT, 1973
3. „Podstawy Biotechnologii" B.Kristiansen, PWN, 2019

Supplementary literature:

1. „Chromatografia preparatywna jako proces rozdzielania mieszanin" D. Antos, K. Kaczmarski, WNT

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.)