GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Process Engineering , PG_00049399					
Field of study	Green Technologies					
Date of commencement of studies	October 2020		Academic year of realisation of subject		2021/2022	
Education level	first-cycle studies		Subject group		Optional subject group Subject group related to scientific research in the field of study	
Mode of study	Full-time studies		Mode of delivery		at the university	
Year of study	2		Language of instruction		Polish	
Semester of study	4		ECTS credits		7.0	
Learning profile	general academic profile		Assessment form		exam	
Conducting unit	Department of Process Engineering and Chemical Technology -> Faculty of Chemistry					
Name and surname of lecturer (lecturers)	Subject supervisor		dr inż. Iwona Hołowacz			
	Teachers		dr inż. Iwona Hołowacz			

Lesson types and methods of instruction	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	30.0	0.0	30.0	45.0	0.0	105
	E-learning hours included: 0.0						
	Adresy na platformie eNauczanie:						

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	105	5.0	65.0	175

Subject objectives

To familiarize students with the basic concepts of selected dynamic operations (fluid flows, filtration, settling of particles), the heat exchange and the mass exchange. Presenting students the opportunities to use mathematical equations in the description of the unit operations used in proces engineering. Developing students' computing skills for the relevant unit operations.

Learning outcomes

Course outcome	Subject outcome	Method of verification
[K6_W06] has a basic knowledge of chemical engineering, mechanical engineering and chemical equipment, knows and understands basic processes taking place in green, proenvironmental technologies	Student understands and explains fundamental definitions of dynamic operations, heat exchanges of mass transfer processes in the environmental protection and engineering. Student knows and recognizes basic apparatus used in selected unit operations.	[SW2] Assessment of knowledge contained in presentation [SW1] Assessment of factual knowledge
[K6_K01] understands the need for learning throughout life, can inspire and organize the learning process of others. Is aware of his/ her own limitations and knows when to ask the experts, can properly identify priorities for implementation, critically evaluate his knowledge	The student can organize his learning process to develope, project and laboratory exercises.	[SK1] Assessment of group work skills [SK5] Assessment of ability to solve problems that arise in practice [SK3] Assessment of ability to organize work
[K6_U05] can formulate and solve engineering tasks analytical methods, simulation as well as experimental, able to apply knowledge of basic physics and mathematics to analyze the results of experiments, is able to analyze and assess existing technical solutions	Student is able to: indicate the sources of fluid pressure losses in the installation, describe ways of heat transfer and mass transfer, indicate the driving force of processes. Student is able to select a pump, a filter, a heat exchanger and a mass exchanger. The student is able to perform basic calculations of selected unit processes.	[SU4] Assessment of ability to use methods and tools [SU3] Assessment of ability to use knowledge gained from the subject [SU1] Assessment of task fulfilment

Subject contents	Fundamentals of fluid statics. Flow of ideal fluids, Bernoulli's equation. Flow of real fluids: laminar and turbulent flow. Flow resistance in the tubes and through a packed bed. Type of pumps. Free settling. Hydraulic classificator. Dust settling chamber. Filtration under a constant pressure. Types of filters. Heat transfer: heat conduction, free and forced convection, radiation. Heat exchangers. Equilibrium and differential distillation, condensation. Countercurrent absorption, countercurrent absorption with recirculation of the solvent; number of theoretical plates; the efficiency of the plate; height of the packed bed. Construction and principle of operation of mass exchange columnsExtraction: single contact extraction, co-current multistageextraction, multi-stage countercurrent extraction. Drying of porous solids: parameters of humid air, equilibrium and kinetics of drying.
Prerequisites and co-requisites	Knowlege of the properties of liquids and gases. Basic knowlege of physical chemistry.
Assessment methods and criteria	see table below

Subject passing criteria	Passing threshold	Percentage of the final grade
laboratorium	100.0%	30.0%
project tests	60.0%	25.0%
written exam	60.0%	40.0%
mini-projects and project	100.0%	5.0%

Recommended reading

Basic literature	1. M. Serwiński: Zasady inżynierii chemicznej, WNT 1982 2. Z. Orzechowski, J. Prywer, R. Zarzycki: Mechanika płynów w inżynierii i ochronie środowiska, WNT 2009 3. R. Zarzycki: Wymiana ciepła i ruch masy w inżynierii środowiska, WNT 2010 4. M. Serwiński: Zasady inżynierii chemicznej, WNT 1982 5. T. Hobler: Ruch ciepła i wymienniki, WNT 1979 6. D. W. Green (ed.): Perry's Chemical Engineers'Handbook, The McGrow-Hill Comp. Inc. (8th ed.) 2008 7. I. Hołowacz (red.): Przykłady i zadania z podstaw inżynierii chemicznej i procesowej., WPG 2018 8. D. Konopacka-Łyskawa (red.): Podstawy inżynierii chemicznej i procesowej. WPG 2012
Supplementary literature	1. R. Zarzycki: Zadania rachunkowe z inżynierii chemicznej, PWN 1980 2. K. Pawłow i in.: Przykłady i zadania z zakresu aparatury i inżynierii chemicznej, WNT 1981 3. Praca zbiorowa: Zadania projektowe z inżynierii procesowej, OWPW 2002 4. T. Kudra (red.): Zbiór zadań z podstaw inżynierii chemicznej i procesowej, WNT 1985
eResources addresses	

Example issues/ example questions/ tasks being completed

The exam. Part 1

1. In the Howard chamber, the air dusted with particles with a diameter from d1 to d2 (d2> d1) should be cleanedat tp temperature. The density of the solid is s. The dimensions of the chamber are known. What condition should be met so that the air leaving the chamber is free of solid particles.
2. A model mixer with known dimensions should be 10 times larger for industrial purposes, maintaining the geometric similarity and the unit power consumption.
How should the rotational speed of the agitator be changed in relation to the model value, assuming turbulent mixing?
3. A shell-and-tube heat exchanger of known dimensions is heated by a stream of heating steam at the pressure p, flowing into the inter-tube space. A water solution with a temperature ranging from rt flows to the exchanger tubes. Specify how, on the basis of the above-mentioned data, to calculate the heat exchange surface in the exchanger and the driving force of the heat exchange. Report the assumptions made.
4. Draw a diagram of a countercurrent condenser in which a differential condensation process is carried out. Mark the streams and their compositions. Record the material balance of the lower boiling component at any point in the process.
5. Draw an exemplary extraction equilibrium in a system with the complete lack of mutual solubility of the primary solvent and the extractant. Plot on the graph an example of the course of one-stage extraction with the use of an extractant contaminated with a small amount of the extracted component. Record the material balance of the extracted component.
6. Draw the course of the drying speed curve. Indicate its characteristic fragments, for each of them mark the appropriate ranges of solid body moisture.

The exam. Part 2

1. Water at temperature t flows from an open tank with a large cross-section through the pipe with a pressure P at its outlet. What should be the height of the liquid level in the tank above the level of the discharge outlet from thepipe so that the volume flow rate of liquid from the conduit is V. Two 90 ° elbows and a valve are mounted on the pipe. Data: diameter and length of all pipe sections. Determine the fluid pressure at the inlet to the pipe.
2. Draw the course of the relationship of the pressure drop of the fluid as a function of the linear velocity of the fluid flowing through the porous layer, if the fluid reaches the bottom of the packed column. Mark the minimum and maximum fluidization speed and explain their meaning. Characterize the bed state for u umax. How the fluidization curve will change and why if: we reduce the bed height; we will increase the density of the solid; we will reduce the particle size of the solid. The comparison should be made on a common graph.
3. Countercurrent absorption with solvent recirculation: column diagram, principle of operation, derive the operating line equation based on the mass balance of the upper part of the column, explain the method of determining the minimum and actual solvent consumption based on the Y = f (X) chart. Explain how to determine the column height based on the number of theoretical plates and the number of mass transfer units in the liquid phase.
4. Define the concept of volatility and relative volatility for a two-component mixture. Give the equation describing the relationship between the composition of the liquid and gas phases for systems applying Raoult's law. Present a diagram of the simple distillation process and describe the principle of operation of the presented system. Show on the graph in the system t = f (x, y) and y = f (x) the course of this process (known feed composition). Write the material balance of the process and the Rayleigh equation. Determine the average composition of the resulting distillate.

Work placement	Not applicable