GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	CHEMICAL ENGINEERING, PG_00036515		
Field of study	Chemistry		
Date of commencement of studies	October 2020	Academic year of realisation of subject	2021/2022
Education level	first-cycle studies	Subject group	Obligatory subject group 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	6.0
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 dr inż. Piotr Rybarczyk dr inż. Karolina Kucharska mgr inż. Natalia Czaplicka dr hab. inż. Donata Konopacka-Łyskawa	

Lesson types and methods of instruction							
	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	30.0	15.0	30.0	0.0	0.0	75
	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	75	5.0	70.0	150

Subject objectives	To familiarize students with the basic concepts of dynamic operations, the heat exchange processes and the mass exchange processes. Presenting students withopportunities to use mathematical equations in the description of the unit operations used in chemical engineering Developing students computing skills for the relevant unit operations. To familiarize students with the construction, principle of operation and characteristics of instruments for measuring pressure, fluid flow velocity and apparatus for conducting unit operations.

Learning outcomes	**Course outcome**	**Subject outcome**	**Method of verification**
	[K6_K03] understands the importance of group and team activities in which members adopt various roles	Student is involved in team work during laboratory exercises. The student proposes and chooses the method of timely implementation of reports.	[SK1] Assessment of group work skills [SK3] Assessment of ability to organize work
	[K6_U06] can analyze the functioning of equipment, apparatus and technology lines used in laboratories and chemical industry, and can recognize and propose methods to solve the simple engineering tasks which he can meet as an Engineer and select and use routine methods, chemical apparatus and tools to solve practical engineering tasks, including also technological processes; can himself/herself read and make technical drawings using CAD software	The student is prepared to use mathematical and physicochemical knowledge to calculate and analyze the course of basic unit operations in chemical engineering. The student knows how to make measurements of fluid motion parameters during dynamic, thermal and diffusion processes. The student can: - determine fluid movement parameters and design a typical hydraulic system for the chemical industry on the basis of mass and energy balance - apply theories of solids motion in fluids for basic calculations in filtration processes, gas dedusting and suspension sedimentation - determine heat fluxes for established conduction, penetration and thermal radiation processes - perform thermal calculations for heat exchangers - write mass and heat balances and apply these equations in distillation, condensation, rectification, extraction and drying processes	[SU4] Assessment of ability to use methods and tools [SU3] Assessment of ability to use knowledge gained from the subject [SU2] Assessment of ability to analyse information [SU1] Assessment of task fulfilment
	[K6_U04] can use professional vocabulary, can prepare and communicate technical information in the form of text documents, spreadsheets, charts and technological schema	Student individually performs relevant analysis of the collected data.	[SU4] Assessment of ability to use methods and tools [SU2] Assessment of ability to analyse information
	K6_W10	Student understands and explains fundamental definitions of dynamic operations, heat exchanges of mass transfer processes in the environmental protection and engineering.	[SW1] Assessment of factual knowledge

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. 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. Extraction: single contact extraction, co-current multistage extraction, multi-stage countercurrent extraction. Equipment for rectification and gas absorption: tray and packed kolumn. Drying of porous solids: parameters of humid air, equilibrium and kinetics of drying. Convective and contact dryers.
Prerequisites and co-requisites	Properties of liquids and gases. Basic knowledge of physical chemistry. Differential and integral calculus. Knowledge of the structure and operation of typical instruments and equipment used in the chemical and related industries. Basic knowledge of reading of technical drawing.

Assessment methods and criteria	**Subject passing criteria**	**Passing threshold**	**Percentage of the final grade**
	Practical exercises	100.0%	25.0%
	Written exam	60.0%	50.0%
	Midterm colloquiums	60.0%	25.0%

Recommended reading	Basic literature	1. Z. Orzechowski, J. Prywer, R. Zarzycki: Mechanika płynów w inżynierii i ochronie środowiska, WNT 2009 2. R. Zarzycki: Wymiana ciepła i ruch masy w inżynierii środowiska, WNT 2010 3. M. Serwiński: Zasady inżynierii chemicznej, WNT 1982 4. T. Hobler: Ruch ciepła i wymienniki, WNT 1979 5. I. Hołowacz (red.): Przykłady i zadania z podstaw inżynierii chemicznej i procesowej., WPG 2018 6. D. Konopacka-Łyskawa (red.): Podstawy inżynierii chemicznej i procesowej. WPG 2012 D. W. Green (ed.): Perry's Chemical Engineers'Handbook, The McGrow-Hill Comp. Inc. (8th ed.) 2008
	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 |