



Subject card

Subject name and code	CHEMICAL ENGINEERING, PG_00036515						
Field of study	Chemistry						
Date of commencement of studies	October 2023	Academic year of realisation of subject	2024/2025				
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. Karolina Kucharska dr inż. Edyta Słupek					
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						
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 with opportunities 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_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_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_W10	The student knows: - basics of the theory of dimensional analysis, basic criterion numbers, their physical meaning and meaning in engineering sciences - principles of perfect and real fluid flow in pipes and through a porous beds - theory of solids motion in liquids - theory of heat transfer in solids, between fluid and solid, between diaphragm separated fluids and as a result of thermal radiation - basics of diffusive mass movement in one- and two-phase systems - construction of typical chemical apparatus and the basis for designing its elements	[SW1] Assessment of factual knowledge [SW3] Assessment of knowledge contained in written work and projects
Subject contents	Fundamentals of fluid statics. Flow of ideal fluids, Bernoulli's equation. Dimensional analysis. Flow of real fluids: laminar and turbulent flow. Flow resistance in the tubes and through a packed bed. Type of pumps. Free settling. Dust settling chamber. Sedimentation. Filtration under a constant pressure. Heat transfer: heat conduction, free and forced convection, radiation. Heat exchangers. Distillation. Condensation. Rectification periodically; number of theoretical plates; the efficiency of the plate; height of the packed bed. Countercurrent absorption. Extraction: single contact extraction, co-current multistage extraction, multi-stage countercurrent extraction. 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
	Written exam	60.0%	50.0%
	Midterm colloquiums	60.0%	25.0%
	colloquiums and reports	60.0%	25.0%

Recommended reading	Basic literature	<p>1. Z. Orzechowski, J. Prywer, R. Zarzycki: Mechanika płynów w inżynierii i ochronie środowiska, WNT 2009</p> <p>2. R. Zarzycki: Wymiana ciepła i ruch masy w inżynierii środowiska, WNT 2010</p> <p>3. M. Serwiński: Zasady inżynierii chemicznej, WNT 1982</p> <p>4. T. Hobler: Ruch ciepła i wymienniki, WNT 1979</p> <p>5. I. Hołowacz (red.): Przykłady i zadania z podstaw inżynierii chemicznej i procesowej., WPG 2024</p> <p>6. D. Konopacka-Lyskawa (red.): Inżynieria chemiczna i procesowa. Wybrane zagadnienia. WPG 2024</p> <p>D. W. Green (ed.): Perry's Chemical Engineers' Handbook, The McGraw-Hill Comp. Inc. (8th ed.) 2008</p>
	Supplementary literature	<p>1. R. Zarzycki: Zadania rachunkowe z inżynierii chemicznej, PWN 1980</p> <p>2. K. Pawłow i in.: Przykłady i zadania z zakresu aparatury i inżynierii chemicznej, WNT 1981</p> <p>3. Praca zbiorowa: Zadania projektowe z inżynierii procesowej, OWPW 2002</p> <p>4. T. Kudra (red.): Zbiór zadań z podstaw inżynierii chemicznej i procesowej, WNT 1985</p>
	eResources addresses	<p>Adresy na platformie eNauczanie:</p> <p>Inżynieria chemiczna. Laboratorium Chemia 2024/25 - Moodle ID: 36138 https://enauczanie.pg.edu.pl/moodle/course/view.php?id=36138</p> <p>Inżynieria chemiczna Ćwiczenia Chemia 2024/25 - Moodle ID: 27423 https://enauczanie.pg.edu.pl/moodle/course/view.php?id=27423</p> <p>Inżynieria chemiczna. Wykład Chemia 2024/25 - Moodle ID: 36173 https://enauczanie.pg.edu.pl/moodle/course/view.php?id=36173</p>

<p>Example issues/ example questions/ tasks being completed</p>	<p>1. In the Howard chamber, the air dusted with particles with a diameter from d_1 to d_2 ($d_2 > d_1$) should be cleaned at t_p 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.</p> <p>2. 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 t_f 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.</p> <p>3. 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. Present the course of this process on a physicochemical equilibrium graph in the system $t=f(x, y)$ and $y=f(x)$.</p> <p>4. 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.</p> <p>5. Draw the course of the drying speed curve. Indicate its characteristic fragments, for each of them mark the appropriate ranges of solid body moisture and explain what the drying rate depends on.</p> <p>6. 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 the pipe 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.</p> <p>7. 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_{max}. 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.</p> <p>8. Countercurrent absorption : 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.</p> <p>9. 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.</p>
<p>Work placement</p>	<p>Not applicable</p>

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