GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Chemical engineering, PG_00048541		
Field of study	Chemical Technology		
Date of commencement of studies	October 2020	Academic year of realisation of subject	2022/2023
Education level	first-cycle studies	Subject group	Obligatory subject group in the field of study 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	3	Language of instruction	Polish
Semester of study	5	ECTS credits	9.0
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 hab. inż. Donata Konopacka-Łyskawa dr inż. Karolina Kucharska dr inż. Piotr Rybarczyk	

Lesson types and methods of instruction							
	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	30.0	0.0	45.0	45.0	0.0	120
	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	120	5.0	100.0	225

Subject objectives	To familiarize students with the basic concepts of dynamic operations (fluid flows, mixing, filtration, settling of particles, fluidization), the heat exchange processes (conduction, convection, radiation, and the mass exchange processes (distillation, condensation, absorption, extraction, drying). 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.

Learning outcomes	Course outcome	Subject outcome	Method of verification
	K6_U04	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, suspension sedimentation and liquid mixing - 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	[SU1] Assessment of task fulfilment [SU2] Assessment of ability to analyse information [SU3] Assessment of ability to use knowledge gained from the subject [SU4] Assessment of ability to use methods and tools
	K6_W04	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
	K6_U11	The student is able to independently plan his own development in the field of knowledge of basic unit operations in chemical engineering	[SU3] Assessment of ability to use knowledge gained from the subject [SU5] Assessment of ability to present the results of task

Subject contents

The flow of fluids. Fluid properties. The continuity of the stream. Bernoulli's equation. Flow of real fluids. Laminar flow and turbulent flow. Distribution of flow velocity. Measurement of flow rate. Flow resistance of the tubes and through a packed bed. Rheological properties of fluids. Fluidization. Critical velocity of fluidization. The flow of two-phase gas - liquid. Filtration. The motion of particles through fluids. Mixing. Power and efficiency of mixing. Heat transfer. Heat conduction. Heat transfer during forced convection and free convection. Heat transfer during boiling and condensation. Radiation. Overall heat transfer. Heat exchangers. Concentrating the solutions by evaporation.The mass exchange. The basic law of diffusion. Mass transfer coefficients and overall mass transfer coefficients. Absorption. Number of theoretical plates. The height of the column packing layer. Absorption with recirculation of the solvent. Distillation. Differential and equilibrium distillation. Condensation. Cocurrent and countercurrent condensation. Rectification. Method of McCabe and Thiele'a. Number of theoretical plates. The efficiency of the plate. Filled columns. The amount of fill layers. Deflegmator column. Extraction. Extraction of single-stage. Co-current multistage extraction. Multistage countercurrent extraction. Extraction of the mutual insolubility in solvents. Drying of porous solids. Parameters of the drying air. The equilibrium and kinetics of drying.

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.

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
written exam	60.0%	50.0%
tests and reports	60.0%	25.0%
tests and design task	60.0%	25.0%

Recommended reading	Basic literature	M. Serwiński: Zasady inżynierii chemicznej. WNT 1982. A. Selecki, L. Gradoń: Podstawowe procesy przemysłu chemicznego. WNT 1985. P. Lewicki: Inżynieria procesowa i aparatura przemysłu spożywczego. WNT 2005 R. Zarzycki: Wymiana ciepła i ruch masy w inżynierii środowiska. WNT 2010 D. Konopacka-Łyskawa (red.): *Inżynieria chemiczaj i procesowa wybrane zagadnienia*, Wydawnictwo PG, Gdańsk, 2022. D. Konopacka-Łyskawa (red.): Podstawy inżynierii chemicznej i procesowej, Wydawnictwo PG 2012 I. Hołowacz (red.): Przykłady i zadania z podstaw inżynierii chemicznej i procesowej, Wydawnictwo PG 2017 D. W. Green (ed.): Perry's Chemical Engineers' Handbook, The McGrow-Hill Comp. Inc. (8th ed.) 2008.
	Supplementary literature	Z. Orzechowski, J. Prywer, R. Zarzycki: Mechanika płynów w inżynierii i ochronie środowiska. WNT 2009. Z. Orzechowski: Przepływy dwufazowe. PWN 1990. R. Koch, A. Noworyta: Procesy mechaniczne w inżynierii chemicznej. WNT 1992. T. Hobler: Ruch ciepła i wymienniki. WNT 1986. Z. Ziołkowski: Destylacja i rektyfikacja w przemyśle chemicznym, WNT 1980. C. Strumiłło: Podstawy teorii i techniki suszenia, WNT 1983. R. Zarzycki: Zadania rachunkowe w inżynierii chemicznej, PWN 1980. K. Pawłow i in.: Przykłady i zadania z zakresu aparatury i inżynierii chemicznej, WNT 1981 W.L. McCabe, J.C.Smith: Unit operetions of chemical engineering, The McGrow-Hill Comp. Inc. (7th ed.)2005.
	eResources addresses	Adresy na platformie eNauczanie: TCH Inżynieria chemiczna Wykład 2022-223 - Moodle ID: 23894 https://enauczanie.pg.edu.pl/moodle/course/view.php?id=23894 TCH Inżynieria chemiczna Wykład 2022-223 - Moodle ID: 23894 https://enauczanie.pg.edu.pl/moodle/course/view.php?id=23894 TCH Inżynieria chemiczna Wykład 2022-223 - Moodle ID: 23894 https://enauczanie.pg.edu.pl/moodle/course/view.php?id=23894

Example issues/ example questions/ tasks being completed	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