GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Chemical Engineering, PG_00060865		
Field of study	Chemical Technology		
Date of commencement of studies	October 2024	Academic year of realisation of subject	2026/2027
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	5.0
Learning profile	general academic profile	Assessment form	exam
Conducting unit	Department of Process Engineering and Chemical Technology -> Faculty of Chemistry -> Faculties of Gdańsk University of Technology		
Name and surname of lecturer (lecturers)	Subject supervisor	dr inż. Iwona Hołowacz	
	Teachers		

Lesson types							
	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	15.0	0.0	15.0	30.0	0.0	60
	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	60	10.0	80.0	150

Subject objectives	To familiarize students with the basic concepts of dynamic operations (fluid flows, mixing, filtration, settling of particles, fluidization) and the heat exchange processes (conduction, convection, radiation). 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_K02] understands the non-technical aspects and implications of the activities of a chemical engineer, including the impact on the environment, is aware of professional behaviour, observance of professional ethics and respect for diversity of views and cultures	The student is aware of the impact of chemical industry processes on the surroundings and the environment.	[SK1] Assessment of group work skills [SK4] Assessment of communication skills, including language correctness
	[K6_U12] applies the principles of health and safety at work	The student understands and complies with the health and safety regulations in force at laboratory workstations. The student maintains order and the proper use of equipment, and wears appropriate protective clothing.	[SU1] Assessment of task fulfilment [SU5] Assessment of ability to present the results of task [SU4] Assessment of ability to use methods and tools
	[K6_W04] understands processes occurring in the life cycle of equipment and facilities and has knowledge of mechanical engineering, chemical apparatus, technical thermodynamics and chemical engineering and chemical reactor engineering necessary to analyse technological processes and correctly design installations and systems in the chemical industry	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 - the basis for designing of typical chemical apparatus	[SW3] Assessment of knowledge contained in written work and projects [SW1] Assessment of factual knowledge
	[K6_U04] performs basic design calculations of selected processes and unit operations, is able to calculate and select the basic apparatus of chemical industry in a process line	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	[SU5] Assessment of ability to present the results of task [SU4] Assessment of ability to use methods and tools [SU2] Assessment of ability to analyse information [SU1] Assessment of task fulfilment

Subject contents	Course content – lecture 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. Course content – laboratory Experimental determination of the resistance coefficients for air flow through a straight pipe and a porous layer and comparison of them with theoretical values. Heat transfer in a diaphragm shell-and-tube heat exchanger: ¨ balance and efficiency of the co- and counter-current heat exchange process, ¨ determination of experimental values of heat transfer coefficients, ¨ determination of water flow velocity, the nature of the movement, and heat transfer coefficients in the tubes and intertube space of the exchanger, - determination of theoretical overall heat transfer coefficients and comparison with experimentally determined overall heat transfer coefficient values. Heat transfer under natural convection conditions. Determination of heating surface temperature and air temperature under variable heating source conditions. Calculation of experimental and theoretical heat - transfer coefficients. Practical application to the constant-pressure filtration process. Conducting the filtration process on a rotary - drum vacuum filter. Determining the filtration constant K and C in the Ruth equation and the cake compressibility coefficient based on the results of filtrate volume changes obtained during the filtration process. Course content – project The flow of fluids. Fluid properties. The continuity of the stream. Bernoulli's equation. Flow of real fluids. Laminar flow and turbulent flow. Flow resistance of the tubes and through a packed bed. 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 - - evaporator battery design.
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 design task	60.0%	25.0%
tests and reports	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. 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	

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. 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.
Practical activites within the subject	Not applicable