COURSE DESCRIPTION CARD - SYLLABUS

Course name

Fluid mechanics

Course

Field of study

Chemical and process engineering

Area of study (specialization)

Level of study

First-cycle studies

Form of study

full-time

Year/Semester

2/4

Profile of study

general academic

Course offered in

Polish

Requirements

compulsory

Number of hours

Lecture	Laboratory classes	Other (e.g. online)
30	30	
Tutorials	Projects/seminars	
	15	

Number of credit points

5

Lecturers

Responsible for the course/lecturer:

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ul. Berdychowo 4, 61-131 Poznań

Responsible for the course/lecturer:

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Prerequisites

The student should have knowledge of mathematics in the field of differential and integral calculus (K_W1).

The student should have knowledge of physics, in particular mechanics and thermodynamics, to the extent that allows introduction to the description of transport phenomena (K_W02).

The student should be able to use specialist literature and draw conclusions on its basis (K_U01).

The student should be able to implement self-education (K_U05).

The student should understand the need for further training and raising their professional competences (K_K01).

Course objective

Mastering knowledge of fluid mechanics, in particular statics, kinematics and dynamics of ideal and Newtonian fluids as well as two-phase flows. The use of this knowledge to calculate the forces interacting between the fluid and solids, hydraulic system calculations, hydraulic measurements, and pump selection.

Course-related learning outcomes

Knowledge

1. knowledge of statics of fluids [K_W13, KW_15]

2. knowledge of fluid kinematics [K_W13, KW_15]

3. knowledge of fluid dynamics [K_W13, KW_15]

4. knowledge of the description of two-phase flows [K_W13, KW_15]

Skills

1. ability to calculate the forces interacting between a fluid and a solid [K_U07, KU_08]

2. ability to calculate and design simple hydraulic systems [K_U07, KU_08]

3. ability to design and perform simple flow measurements [K_U07, KU_08]

4. ability to select pumps for hydraulic systems [K_U19]

5. self-education skill [K_U05]

Social competences

1. understands the need for self-education and raising their professional competences [K_K01]

2. is aware of compliance with ethical principles in a broad sense [K_K03]

3. can work in a team [K_K04]

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Completion of projects based on the assessment of the ability to solve design tasks.

During the semester, each student solves 6 tasks. Each task is scored on a scale from 0 to 1. The final grade is given on a linear scale: 0-3.0 points - 2.0; 3.1-3.6 points - 3.0; 3.7-4.2 points - 3.5; 4.3-4.8 points - 4.0; 4.9-5.4 points - 4.5; 5.5-6.0 points - 5.0.

In the case of a retake test, the student must correctly solve 6 tasks. The scoring of the tasks and the grading scale are the same as above.

Passing the laboratory on the basis of the acquired knowledge, team work during exercises, the ability to carry out simple flow measurements, elaborate the results of experiments and the ability to draw conclusions from the experience. Knowledge and skills acquired during the stationary laboratory classes are verified on the basis of short tests differently scored (passing threshold: 51 % of points). Knowledge and skills acquired during the on-line laboratory classes are verified on the basis of short on-line tests (passing threshold: 51 % of points). In both cases points are calculated into the final grade:

5.0 90-100 %

4.5 81-89 %

4.0 71-80 %

3.5 61-70 %

3.0 51-60 %

2.0 < 51 %

Final, written exam concerning the mastery and understanding of the entire material and the ability to solve simple design tasks.

The exam consists of four theoretical questions and two tasks. Each item is scored on a scale from 0 to 10. The final exam grade is determined on a linear scale: 0-30 points - 2.0; 31-36 points - 3.0; 37-42 points - 3.5; 43-48 points - 4.0; 49-54 points - 4.5; 55-60 points - 5.0.

It is possible to obtain an exemption from the written examination.

If it is necessary to perform the examination remotely, a test examination consisting of 25 closed questions is planned. The maximum number of points can be 27 for solving the test. The number of points obtained is rounded down to the integer value. In the case of a test, the final price for the exam is determined on a linear scale: 0-12 points - 2.0; 13-15 points - 3.0; 16-18 points - 3.5; 19-21 points - 4.0; 22-24 points - 4.5; 25-27 points - 5.0.

There will be no exemption from the exam in the form of a test.

Programme content

The course presents fluid mechanics in the field related to chemical and process engineering. In particular, the following are discussed:

basic concepts of fluid mechanics (definition of fluid, liquid, gas, subject of research and division of fluid mechanics, fluid as a continuous medium, field character of fluid description, fluid properties, forces in fluids, stress vector and tensor, pressure, surface tension, Laplace formula);

fluid statics (hydrostatics and aerostatics, pressure and surface force, fluid equation, connected vessels, Pascal law, chimney draft principle, absolute and relative equilibrium of liquids, liquid pressure on flat and curved surfaces, hydrostatic buoyancy, Archimedes' law);

fluid kinematics (description of fluid motion in terms of Lagrange and Euler, material derivative, steady and transient flows, lines describing fluid motion, physical interpretation of deformation and vortex velocity tensors);

equation of flow continuity (global and local mass balance in closed and open systems, mass flow rate, mass flow density, steady flow, incompressible fluid flow and volumetric flow rate);

momentum, angular momentum and energy balances (global and local balances, momentum balance for steady processes, fluid interaction on the walls, angular momentum balance and stress tensor symmetry);

ideal fluid (definition of ideal fluid, Euler equations, Bernoulli equation, static pressure, dynamic pressure, hydrostatic pressure, pressure height, velocity height, position height (leveling), B. equation for a narrow stream, Coriolis coefficient);

dynamics of real fluids (generalized hypothesis of Newton viscosity, Navier - Stokes equations);

similarity of flows and dimensional analysis (geometric, kinematic and dynamic similarity, conditions of similarity, criterion numbers of Strouhal, Euler, Newton, Reynolds, Froude, Mach, Weber, dimensional and dimensionless parameters, I and II Buckingham theorem, dimensional base, power form (Rayleigh) in dimensional analysis);

laminar and turbulent flows (Reynolds experiment, critical velocities and Reynolds numbers, turbulent motion characteristics, turbulence intensity, turbulent viscosity);

fixed laminar flows (Couette, Poiseuille, film flow, Hagen - Poiseuille flows);

external flow of bodies (drag, lift, drag and lift coefficients);

hydrodynamic boundary layer (laminar, transitional and turbulent part of the boundary layer, shift thickness and momentum loss thickness, boundary layer detachment, resistance factor);

flows in closed ducts (Darcy - Weisbach equation, friction coefficient, Blasius, Krajenka, Prandtl - Karman, Nikuradze, Colebrooke - White formulas, local resistance, local loss factor, modified Bernoulli equation, hydraulic calculations of pipelines, Ancone chart , long pipelines);

open channels (uniform and variable motion, hydraulic fall, bottom fall, Chézy's formula, hydraulic radius, isotaches, critical bottom fall, calm and rapid flow, overflows);

pumps (pump division, pump capacity, lifting height, power, pump characteristics, pipeline characteristics, pump selection);

two-phase flows (continuous phase, dispersed phase, aerosols, dusts, fumes, mists, hydrosols, emulsions, foam, multi-fraction systems, particle quantitative curve, two-phase flow structures, structure maps);

compressible fluid flows (propagation of small disturbances, wave equations, sound velocity).

Teaching methods

lecture, laboratory, design exercises

Bibliography

Basic

1. Z. Orzechowski, J. Prywer, R. Zarzycki, Mechanika płynów w inżynierii środowiska, WNT Warszawa 2001, wyd. 2;

2. R. Gryboś, Podstawy mechaniki płynów, PWN, Warszawa, 1998;

3. R. Gryboś, Mechanika płynów z hydrauliką, Wyd. Politechniki Śląskiej, 1999, wyd. 10;

4. J. Bukowski, Mechanika płynów, PWN Warszawa, 1970, wyd. 3;

5. Z. Orzechowski, J. Prywer, R. Zarzycki, Zadania z mechaniki płynów w inżynierii środowiska, WNT Warszawa 2001;

6. R. Gryboś, Zbiór zadań z technicznej mechaniki płynów, PWN, Warszawa 2002 1. E. Tuliszka, Mechanika płynów, Wyd. Politechniki Poznańskiej, 1969;

2. J.A. Kołodziej, Podstawy mechaniki płynów, Wyd. Politechniki Poznańskiej, 1982;

3. Błasiński H., Młodziński B., Aparatura przemysłu chemicznego, WNT Warszawa 1983;

4. Płanowski A.N., Ramm W.M., Kagan S.Z. Procesy i aparaty w technologii chemicznej. Seria wydawnicza: Inżynieria chemiczna, WNT Warszawa 1974;

5. J.E. Elsner, Turbulencja przepływów, PWN Warszawa 1987;

6. Podstawowe procesy inżynierii chemicznej. Przenoszenie pędu, ciepła i masy, praca zbiorowa pod red. Z. Ziołkowskiego, PWN Warszawa 1982;

7. K.F. Pawłow, P.G. Romankow, A.A. Noskow, Przykłady i zadania z zakresu aparatury i inżynierii chemicznej, WNT Warszawa, wyd. 5

Additional

Breakdown of average student's workload

	Hours	ECTS
Total workload	130	5,0
Classes requiring direct contact with the teacher	95	3,6
Student's own work (literature studies, preparation for laboratory classes/tutorials, preparation for tests/exam, project preparation) [1]	35	1,4

[1] delete or add other activities as appropriate