POZNAN UNIVERSITY OF TECHNOLOGY
EUROPEAN CREDIT TRANSFER AND ACCUMULATION SYSTEM (ECTS)

COURSE DESCRIPTION CARD - SYLLABUS

Course name
Fundamentals of chemical engineering [S1IFar2>PIC1]

Course

Field of study
Pharmaceutical Engineering

Year/Semester
2/4

Area of study (specialization)
–

Profile of study
general academic

Level of study
first-cycle

Course offered in
Polish

Form of study
full-time

Requirements
compulsory

Number of hours

Lecture
30

Laboratory classes
0

Other (e.g. online)
0

Tutorials
0

Projects/seminars
15

Number of credit points
3,00

Coordinators

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Lecturers

Prerequisites

The student should have knowledge of mathematics in the field of differential and integral calculus (K_W2). The student should have knowledge of physics, in particular mechanics and thermodynamics (K_W3). The student should be able to use specialist literature and draw conclusions on its basis (K_U1). The student should be able to implement self-education (K_U24). The student should understand the need for further training and raising their professional competences (K_K1).

Course objective

Teaching knowledge in the field of momentum and heat exchange (in particular statics, kinematics and dynamics of fluid as well as steady heat exchange issues). The use of this knowledge to calculate the forces interacting between a fluid and solids, to calculate the hydraulic systems, hydraulic measurements, pump selection, to formulate heat exchange problems and to solve the problems of steady heat conduction in solids of different geometry and boundary conditions.

Course-related learning outcomes

Knowledge:
1. knowledge of fluid statics and static forces [K_W10, K_W12]

2. knowledge of fluid kinematics [K_W10, K_W12]
3. knowledge of fluid dynamics [K_W10, K_W12]
4. knowledge of heat transport mechanisms [K_W10]
5. knowledge of the heat transport equation [K_W10]
6. knowledge of ways to increase the intensity of heat exchange [K_W10]

Skills:
1. ability to identify and analyze basic processes of chemical engineering [K_U14, K_U15]
2. ability to calculate the forces interacting between a fluid and a solid [K_U13]
3. ability to calculate and design simple hydraulic systems [K_U13, K_U17]
4. ability to select pumps for hydraulic systems [K_U13, K_U16]
5. ability to formulate and solve a simple heat transfer problem [K_U13, K_U14]
7. ability to use specialist literature on chemical and process engineering [KU_1]
8. self-study skills [K_U24]

Social competences:
1. The student understands the need for self-education and raising their professional competences [K_K1]
2. The student is aware of compliance with ethics in a broad sense [K_K3, K_K8]

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Completing project exercises based on the assessment of the ability to solve project tasks.
Passing the lectures in the form of a test consisting of 25 closed questions. The maximum number of points for completing the test is 27. The number of points obtained is rounded down to the integer value. The final grade 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.

Programme content

The course presents momentum transport processes (fluid mechanics with hydraulics) in the field related to pharmaceutical 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 statics equation, connected vessels, Pascal law, chimney draft principle, absolute and relative equilibrium of liquids, fluid 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);
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 of flows (geometrical, kinematic and dynamic similarity, similarity conditions, 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);
fixed laminar flows (Couette, Poiseuille flows, film flow, Hagen - Poiseuille flow);
external flow (drag force, lift force, 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 pipes (Darcy - Weisbach equation, friction coefficient, Blasius, Krajenka, Prandtl - Karman, Nicuraga, Colebrooke - White formulas, local resistance, local loss factor, modified Bernoulli equation, hydraulic calculations of pipelines, Ancone chart , long pipelines);
pumps (pump division, pump capacity, lifting height, power, pump characteristics, pipeline characteristics, pump selection).
Heat transport processes are also being introduced that include:
simple heat transfer mechanisms (conduction, convection, radiation) with laws describing them;
differential equation of heat conduction in solids (general form, special forms, uniqueness of the solution);
solution of the heat conduction equation in the process of steady heat transport through a flat wall and hollow cylinder and sphere.

Course topics

none

Teaching methods

lecture and computational 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;
7. T. Hobler, Ruch ciepła i wymienniki, wyd. 4, Warszawa, PWN 1971;
8. S. Wiśniewski, T. Wiśniewski, Wymiana ciepła, WNT Warszawa 2000, Wyd. V.

Additional:
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. Zadania projektowe z inżynierii procesowej, praca zbiorowa pod red. M. Kozłowskiego, Wyd. Politechniki Warszawskiej 2002, wyd. 2;
8. K.F. Pawłow, P.G. Romankow, A.A. Noskow, Przykłady i zadania z zakresu aparatury i inżynierii chemicznej, WNT Warszawa, wyd. 5;
9. Kowalski S.J., Teoria procesów przepływowych cieplnych i dyfuzyjnych, Wydawnictwo Politechniki Poznańskiej, Wyd. 1999 oraz 2008.

Breakdown of average student's workload

	Hours	ECTS
Total workload	75	3,00
Classes requiring direct contact with the teacher	50	2,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	25	1,00