COURSE DESCRIPTION CARD - SYLLABUS

Course name
Fluid Mechanics [N1IŚrod1>MP]

Course

Field of study
Environmental Engineering

Year/Semester
2/3

Area of study (specialization)
–

Profile of study
general academic

Level of study
first-cycle

Course offered in
polish

Form of study
part-time

Requirements
compulsory

Number of hours

Lecture
20

Laboratory classes
20

Other (e.g. online)
0

Tutorials
20

Projects/seminars
0

Number of credit points

7,00

Coordinators

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Lecturers

Prerequisites

Mathematics: functions, equations and inequalities, plane and surface geometry, trigonometry, analytical geometry, algebraic equations and systems of equations, basics of differential and integral calculus of functions of one variable. Physics: basic laws and principles of behavior in classical mechanics, statics, kinematics, dynamics and hydraulics. Solving algebraic equations and systems of equations, formulating physical problems in the language of mathematics, solving simple differential equations, using integral calculus to calculate geometric (e.g., area) and physical quantities (e.g., averages, moments of inertia), solving tasks in classical mechanics, kinematics, dynamics and hydraulics. Awareness of the need to constantly update and supplement knowledge and skills.

Course objective

Acquisition by students of basic knowledge and skills in fluid mechanics necessary to solve typical tasks occurring in environmental engineering and HVAC systems.

Course-related learning outcomes

Knowledge:
1. The student knows the quantities that characterize the fluid, understands their physical sense and

knows the units
2. Knows the knowledge of laws describing the action of a stationary fluid on the walls of tanks
3. Knows and understands the phenomena occurring during the action of a fluid stream on the walls of conduits and obstacles
4. Has elementary knowledge of the flow characteristics of pumps and fans
5. Has a structured knowledge of the phenomena responsible for pressure losses in pressurized closed conduits and armature and knows the equations for their description
6. Has basic knowledge of fluid flow in porous medium and filtration
7. Knows and understands the phenomena occurring during flows in open pipes and knows the equations to describe these phenomena
8. Knows the basics of mathematical description of fluid outflow from reservoirs.

Skills:
1. The student is able to apply and convert units of physical quantities used in fluid mechanics
2. Is able to calculate: thrust forces of stationary liquid on the walls of tanks, forces of liquid streams on pipes and obstacles, powers of flow machines, energy losses in pipes and fittings
3. Is able to calculate the flow of liquid in open channels, the velocity of the reach and the shape of the streams, as well as calculate and select the conduit in the flow with free surface and for the flow of fluid under pressure
4. Is able to measure: pressures and velocities of fluids, fluxes of fluids in closed and open ducts, pressure loss in a closed duct, pressure loss in any component of a fitting, power of a pump and a fan.

Social competences:
1. The student understands the need for teamwork in solving theoretical and practical problems
2. Is aware of the necessity of repeated measurement activities and evaluation of uncertainty of measurement results and calculations
3. Sees the necessity of systematic deepening and expansion of his/her competence.

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Lectures:
Exam in the form of questions (and/or): open, calculation, drawing, test questions of various types.
Grading scale: 0-50% = 2,0; 51-60% = 3,0; 61-70% = 3,5; 71-80% = 4,0; 81-90% = 4,5; 91-100% = 5,0.
Bonus lecture attendance: +0.5 grade for attendance at 10 lectures, +1.0 grade for attendance at 14 lectures (condition: minimum exam score of 40%).
Tutorials:
Two written credit colloquia with calculation tasks.
Grading scale: 0-50% = 2,0; 51-60% = 3,0; 61-70% = 3,5; 71-80% = 4,0; 81-90% = 4,5; 91-100% = 5,0.
Laboratories:
Credit in the form of questions (and/or): open-ended, computational, drawing, test questions of various types at the end of the exercise cycle.
Grading scale: 0-50%: 2,0; 51-60%: 3,0; 61-70%: 3,5; 71-80%: 4,0; 81-90%: 4,5; 91-100%: 5,0.

Programme content

Lectures:
1 The concept of a fluid. Basic quantities characterizing a fluid. Classification of fluids, Newton's hypothesis, shear stresses in a fluid, perfect fluid, real fluid, basic thermophysical quantities characterizing fluids, effect of temperature and pressure on thermophysical parameters of fluids.
2 Fluid Statics. Basic equation of fluid statics, special form of equilibrium equation, hydrostatic pressure, absolute pressure, positive and negative pressure. Pressure measuring devices.
3. Pressure distribution in a stationary fluid, liquid pressure on flat and curved walls, general equations for calculating the force of pressure and the coordinates of its point of application, graph of pressure. Flow of bodies, Archimedes' law, surface tension, wetting angle, meniscus, rise and fall of capillaries.
4. flow of liquids in open conduits. Chezy's equation. Hydraulic gradient. Velocity coefficient. Manning's formula. Manning's coefficient of roughness. Froud's number, sub- and supercritical flow. Optimal cross sections of open pipes. Hydraulic bounce. Threshold flow. Overflows. Measurement of fluid flow in open conduits.
5. Fluid flow in a porous medium. Flow of water in soil. Darcy's law (filtration coefficient). Capacity of

wells. Depression funnel.
6. Dynamic pressure of a fluid stream on flat and curved, moving and non-moving walls. Outflow of fluid from a reservoir (Torricelli's formula). Attachments. Coefficient of velocity, contraction and outflow. Submerged and non-submerged stream. Velocity distribution and range.
7 Introduction to laboratory tests. Principles of conducting experiments.
8. flow in pressure pipes. Equation of continuity of flow. Local velocity, average velocity. Velocity distribution and coefficient of friction for developed Newtonian fluid flow in a pipe. Fluid momentum. Mean mass and mean momentum fluid velocity, Coriolis coefficient. Laminar and turbulent flow. Reynolds number.
9. Bernoulli's equation. Static pressure, dynamic pressure and localized pressure. Linear and local pressure losses in the flow of fluid in closed conduits under pressure.
10. Devices for measuring the flux of flowing fluid in closed conduits.
11. Introduction to flow characteristics of pumps and fans and pumping and ventilation systems. Power calculation of flow machines.
Tutorials:
Topics selected from the following.
1. description of thermophysical properties of fluids.
2. elements of fluid statics part 1. pressure induced by a fluid.
3. Elements of fluid statics part 2. Chimney thrust, atmospheric statics, buoyancy of bodies, wetting, surface tension.
4. The pressure of a stationary fluid on the walls of containers.
5. Fluid flow through openings and attachments.
6 Groundwater flow.
7 Fixed fluid flow in open conduits.
5 Flows in closed conduits (Bernoulli's equation) part 1. Calculation of linear and local pressure losses.
6 Flows in closed conduits (Bernoulli's equation) part 2. Calculation of power of pumps and fans.
7. selected other issues supporting calculations in environmental engineering.
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Laboratories:
6 experiments selected by the instructors from the following will be carried out:
1. flow in a water leveller. Measurement of under- and overpressure.
2. flow in an open pipe. Measuring overflow.
3. determination of filtration coefficient.
4. measurement of fluid flow in a closed conduit.
5. Measurement of fluid pressure and local fluid velocity. Fluid velocity profile.
6. measurement of linear and local pressure losses.
7. Determination of the charcteristics of fans connected in series and parallel.
8. study of the characteristics of a centrifugal pump.
9. selected other experiments to support calculations in environmental engineering.

Teaching methods

Lectures:
Informative lecture with elements of a conversational lecture; Multimedia presentation; Exercise elements
Tutorials:
Problem method; Solving tasks
Laboratories:
Experiment method; Practical exercises

Bibliography

Basic:
[1] Amanowicz Ł., Schiller T.: Mechanika płynów w inżynierii środowiska - wybrane zagadnienia w eksperymentach. Wydawnictwo Politechniki Poznańskiej, Poznań 2022
[2] Mitosek M., Mechanika płynów w inżynierii i ochronie środowiska. Warszawa, PWN 2001
[3] Orzechowski Z., Prywer J., Zarzycki R., Mechanika płynów w inżynierii środowiska. Wyd. 2 zmienione. Warszawa, WNT 2001
[4] Jeżowiecka-Kabsch K., Szewczyk H., Mechanika płynów. Oficyna Wydawnicza Politechniki Wrocławskiej, Wrocław 2001

[5] Mitosek M., Matlak M., Kodura A., Zbiór zadań z hydrauliki dla inżynierii i ochrony środowiska. Oficyna wydawnicza Politechniki Warszawskiej, Warszawa 2004[
[6] Orzechowski Z., Prywer J., Zarzycki R., Zadania z mechanika płynów w inżynierii środowiska. Warszawa, WNT 2001
[7] Bogusławski L. (Red.), Ćwiczenia laboratoryjne z mechaniki płynów. Wydawnictwo Politechniki Poznańskiej, Poznań 1999
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[9] Bartosik A., Laboratorium z mechaniki płynów. Wydawnictwo Politechniki Świętokrzyskiej, Kielce 1996
[10]. Sawicki J., Szpakowski W., Weinerowska K., Wołoszyn E., Zima P. Laboratorium z mechaniki płynów i hydrauliki. Wydawnictwo Politechniki Gdańskiej, Gdańsk 2004

Additional:
[1] Munson B.R., Young D.F., Okiishi T.H., Fundamentals of Fluid Mechanics (4rd. Ed.). John Wiley and Sons Inc., New York 2002
[2] White F.M., Fluid Mechanics. McGrawHill Book Company. 5th Int. Ed. Boston 2003

Breakdown of average student's workload

	Hours	ECTS
Total workload	175	7,00
Classes requiring direct contact with the teacher	60	2,50
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	115	4,50