COURSE DESCRIPTION CARD - SYLLABUS

Course name

Fluid Mechanics

Course

Field of study

Environmental Engineering

Area of study (specialization)

Level of study

First-cycle studies

Form of study

full-time

Year/Semester

1 / 2

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	
30		

Number of credit points

6

Lecturers

Responsible for the course/lecturer:

prof. dr hab. inż. Janusz Wojtkowiak

email: janusz.wojtkowiak@put.poznan.pl

tel. (61) 6652442

Faculty of Environmental Engineering and Energy

ul. Berdychowo 4, 61-131 Poznań

Responsible for the course/lecturer:

Dr inż. Ilona Rzeźnik (tutorials)

email: ilona.rzeznik@put.poznan.pl

tel. (61) 6652524

Faculty of Environmental Engineering and Energy

ul. Berdychowo 4, 61-131 Poznań

Prerequisites

1. Knowledge:

Mathematics: algebra - functions, equations and inequalities, plane and space geometry, trigonometry, analytic geometry, basic probability theory, equations and systems of equations, elements of differential and integral calculus of functions of one variable

Physics: fundamental lows of physics, rules of mass momentum and energy conservation in classical mechanics, statics, kinematics, dynamics, and hydraulics

2. Skills:

Solving algebraic equations and systems of algebraic equations, formulating physical problems in the language of mathematics, solving simple differential equations, the use of integral calculus to calculate the geometrical quantities (eg, surface areas) and physical quantities (eg, average values of velocity, momentum of inertia), solving typical problems in classical mechanics - statics, kinematics, dynamics and hydraulics.

3. Social competencies:

Awareness of the need to constantly update and supplement knowledge and skills

Course objective

Purchase by the students basic knowledge and skills in fluid mechanics necessary to solve common tasks of fluid flows occurring in the build and natural environment.

Course-related learning outcomes

Knowledge

1. The students knows physical quantities characterizing fluids, understands their physical meaning and knows their units (achieved during lectures, tutorials and laboratory exercises) - [KIS_W02; KIS_W03; KIS_W04]

2. The student has knowledge of hydrostatic force on plane and curved surfaces (achieved during lectures and tutorials) - [KIS_W02; KIS_W03; KIS_W04]

3. Student knows and understands equations describing force and torque by the flow on the walls (achieved during lectures and tutorials) - [KIS_W02; KIS_W03; KIS_W04]

4. The student has an elementary knowledge of the laws governing the operation of turbomachinery (pumps, funs, blowers and compressors) (achieved during lectures and tutorials) - [KIS_W02; KIS_W03; KIS_W04]

5. The student has ordered knowledge of the phenomena responsible for the loss of pressure in the pipes and fittings and knows the equations used to describe them (achieved during lectures, tutorials and laboratory exercises) - [KIS_W02; KIS_W03; KIS_W04]

6. The student has a basic knowledge necessary for modeling the flow of water in the soil (achieved during lectures, tutorials and laboratory exercises) - [KIS_W02; KIS_W03; KIS_W04]

7. The student understands the causes of water hammer and cavitation phenomena in hydraulic systems, and knows the laws used to describe them (achieved during lectures and tutorials) - [KIS_W02; KIS_W03; KIS_W04]

8. The student knows and understands the phenomena occurring during the flow in open channels (free surface flow) and knows equations describing these phenomena (achieved during lectures, tutorials and laboratory exercises) - [KIS_W02; KIS_W03; KIS_W04]

9. The student knows and understand the laws describing liquid flows from the tanks (achieved during lectures and tutorials) - [KIS_W02; KIS_W03; KIS_W04]

Skills

1. The student can apply and convert units of physical quantities used in fluid mechanics - [KIS_U03; KIS_U-04]

2. The students can calculate: hydrostatic forces on plane and curved surfaces of the tanks, the forces of dynamic interactions between flowing fluid and pipe walls and immersed bodies, the power and efficiency of turbomachines (achieved during lectures and tutorials) - [KIS_U03; KIS_U-04]

3. The student can calculate: pressure losses in straight pipes and fittings, the pressure differences that cause a chimney effect and natural ventilation, the pressure increase and velocity of pressure wave in water hammer phenomenon (achieved during lectures, tutorials and laboratory exercises) - [KIS_U03; KIS_U-04]

4. The student can calculate: hazard of cavitation in hydraulic systems, flow rates in free surface flows, optimal shapes of channels in free surface flows, discharge time of tanks and vessels (achieved during lectures and tutorials) - [KIS_U03; KIS_U-04]

5. The student can measure: pressure of fluid (static, dynamic and total), average velocity of fluid in internal and free surface flows, pressure losses in pipes and fittings, power and efficiency of pumps, fans and blowers (achieved during laboratory exercises) - [KIS_U03; KIS_U-04]

Social competences

1. The student understands the need for teamwork in solving theoretical and practical problems (achieved during lectures, tutorials and laboratory exercises) - [KIS_K02]

2. The student is aware of the need to repeat the measuring actions and to evaluate the uncertainty of measurement and calculation results (achieved during lectures, tutorials and laboratory exercises) - [KIS_K02]

3. The student sees the need for systematic increasing his skills and competences (achieved during lectures, tutorials and laboratory exercises) - [KIS_K02]

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Lectures:

Final exam consists of two parts. Part 1: knowledge test (4 questions to answer), Part. 2: test of skills (2 problems to solve),

Continuous assessment during lectures (rewarding activity of the students).

To pass each of the two parts of the exam (as well as to pass the tutorials) there is necessary to obtain at least 50% of the maximum points (max=20 points). The exam is passed if both part 1 and part 2 are passed. Corrected (Improved) is only this part which was failed.

Grading system:

0-9 points = 2,0 (failed); 10-12 points = 3,0 (sufficient); 13-14 points = 3,5 (sufficient plus); 15-16 points = 4,0 (good); 17-18 points = 4,5 (good plus); 19-20 points = 5,0 (very good)

Tutorials

Two short written tests during the semester - one in the middle and one at the end of the semester

Continuous assessment of the students (rewarding students activity).

Laboratory exercises:

Continuous assessment in every class.

Assessment during consultation of students reports (assessing students' own work).

Written test after completing the cycle of laboratory exercises.

Programme content

Classification of fluids. Newtonian and non-newtonian fluids. Shear stress in the fluid, the perfect fluid and viscous fluid. Basic physical properties of fluids. Effect of temperature and pressure on parameters of fluids. The basic equation of fluid statics. The hydrostatic pressure. Absolute pressure, over-and underpressure. Archimedes low. The pressure distribution in the Earth atmosphere. The surface tension. Hydrostatic force on plane and curved surfaces. The equation of continuity. Local velocity and average velocity of the fluid. The velocity distribution. Friction pressure losses. Laminar and turbulent flows. Critical Reynolds number. Bernoulli equation for inviscit and viscous fluids. Friction factor. Darcy-Weisbach formula. Hagen and Blasius formulas. Roughness of the pipe, Moody chart. Colebroock-White, Walden and Haaland formulas. Minor pressure loss. Calculation of pressure losses in complex hydraulic systems. Momentum of the fluid. Force and torque by the flow on the walls. Water hammer phenomenon. Orifice flow, tank discharge. Weirs. Open channel flows. Chezy formula. Manning roughness coefficient. Subcritical and supercritical free surface flows. Froude number. Optimal shape of open channel cross-section. Measurements of liquid flow in open channels. Underground water motion. Water inflow to traditional and artesian wells. Calculation of gas tank discharge and gas flow in pipes. Bernoulli equation for adiabatic gas flow.

Teaching methods

Classical lecture with elements of conversation

Tutorials: solving problems method

Laboratory exercises: teaching by experimentation

Bibliography

Basic

1. Mitosek M., Mechanika płynów w inżynierii i ochronie środowiska. Warszawa, PWN 2001

2. Orzechowski Z., Prywer J., Zarzycki R., Mechanika płynów w inżynierii środowiska. Wyd. 2 zmienione. Warszawa, WNT 2001

3. Jeżowiecka-Kabsch K., Szewczyk H., Mechanika płynów. Oficyna Wydawnicza Politechniki Wrocławskiej, Wrocław 2001

4. Mitosek M., Matlak M., Kodura A., Zbiór zadań z hydrauliki dla inżynierii i ochrony środowiska. Oficyna wydawnicza Politechniki Warszawskiej, Warszawa 2004

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

6. Bogusławski L. (Red.), Ćwiczenia laboratoryjne z mechaniki płynów. Wydawnictwo Politechniki Poznańskiej, Poznań 1999

7. Niełacny M., Ćwiczenia laboratoryjne z mechaniki płynów. Wydawnictwo Politechniki Poznańskiej, Poznań 1996

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	150	6,0
Classes requiring direct contact with the teacher	90	3,5
Student's own work (literature studies, preparation for laboratory classes/tutorials, preparation for tests/exam) [1]	60	2,5

[1] delete or add other activities as appropriate