COURSE DESCRIPTION CARD - SYLLABUS

Course name

Fluid Mechanics II

Course

Field of study	Year/Semester
Environmental Engineering Second-cycle Studies	1/1
Area of study (specialization)	Profile of study
Heating, Air Conditioning and Air Protection	general academic
Level of study	Course offered in
Second-cycle studies	polish
Form of study	Requirements
full-time	compulsory

Number of hours

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

Number of credit points

4

Lecturers

Responsible for the course/lecturer:	Responsible for the course/lecturer:
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Prerequisites

1.Knowledge

Mathematics: differential and integral calculus, ordinary and partial differential equations, combinatorics and calculus of probability, basic numerical methods. Classical physics: foundations of fluid mechanics and heat engineering.

2.Skills

Mathematics: the use of differential and integral calculus to calculate physical phenomena, solving ordinary differential equations and simple partial differential equations, solving differential equations by means of numerical methods

Fluid mechanics and heat engineering: solving fluid statics, kinematics and dynamics problems and making fluid mechanics measurements, solving heat engeenering problems at the first-cycle level.

3.Social competencies

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

Course objective

Assumptions and objectives of the course:

Extending and deepening the knowledge and skills in fluid mechanics required to solve complex fluid flow problems appear both in built and natural environment

Course-related learning outcomes

Knowledge

1. The student has structured and theoretically extended knowledge of the kinematics of turbomachinery blading systems and necessary for the simplifying the equations of conservation of mass momentum and energy in fluid mechanics and understands the consequences of these simplifications and classification of non-Newtonian fluids.

2. The student knows the basic laws and equations of compressible fluid flows.

3. The student knows the concept of fluid momentum-flux and understands the equations describing the operation of water and wind turbines.

4. The student knows the causes of water hammer and is able to limit their effects.

5. The student knows and understands the origin and structure of differential equations expressing conservation of mass, momentum and energy in fluid mechanics and the phenomenon of turbulence, and knows the mathematical basis of its modeling (computational fluid dynamics equations).

6. The student knows the phenomena responsible for the loss of energy in fluid flows, and has in-depth knowledge of the ways to reduce these losses.

7. The student knows foundations of computer fluid dynamics (CFD), is aware both of advantages and limitations of CFD methods, knows and understands the need to verify and validate the results of CFD calculations.

Skills

1. Student is able to introduce simplification in differential equations describing complex fluid flows and predict consequences of the simplifications.

2. Student can calculate theoretically flow characteristics of complex engineering systems both for incompressible and compressible fluids.

3. The student is able to determine the critical parameters of the compressible fluid - density, pressure and temperature.

4. The student is able to calculate the parameters of the fluid during the water hammer - pressure jump, speed of the pressure wave.

5. Student is able to determine by means of experimental methods the flow characteristics of pumps, fans, control valves and fittings.

6. The student has the ability to examine using PIV technique the structures of complex fluid flows.

7. The student is able to determine experimentally the flow characteristics of complex engineering systems.

Social competences

1. The student understands the need for teamwork in solving theoretical and practical problems.

2. The student is aware of the need to evaluate the uncertainty of measurement and calculation results.

3. The student sees the need for systematic increasing his professional skills and competences.

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 of the students 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:

One short written test in the middle of semester and one written final test at the end of semester

Continuous assessment of the students (rewarding students activity).

Laboratory exercises

Assessment of prepared reports

Continuous assessment of the students during laboratory exercises

Programme content

Compressible fluid flows. Adiabatic gas flow in the duct with constant cross-section. Static, dynamic and total enthalpy. Mach number. Critical gas pressure, temperature and density. Kinematics of turbomachinery blading systems. Velocity triangles of blading systems. Basic equation of turbomachinery. Power calculation of water and wind turbines. Hydraulic hammer. Basics of mathematical description. Reasons for joining and limiting the effects. The differential equations of mass, momentum and energy conservation.Derivation of the equations of conservation of mass, momentum and energy. The general and simplified forms of the conservation equations. Introduction to turbulence. Average velocity, velocity fluctuations. Scale of turbulence. Turbulence intensity. Turbulent viscosity. Kinetic energy of turbulence. Dissipation of turbulence kinetic energy. Foundations of Computational Fluid Dynamics (CFD).

Teaching methods

Classical lecture with elements of conversation

Tutorials: solving problems

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	100	4,0
Classes requiring direct contact with the teacher	60	2,5
Student's own work (literature studies, preparation for laboratory classes/tutorials, preparation for tests/exam) [1]	40	1,5

[1] delete or add other activities as appropriate