COURSE DESCRIPTION CARD - SYLLABUS

Course name
Fluid mechanics [S2ZE1E>MP]

Course

Field of study
Green Energy

Year/Semester
1/1

Area of study (specialization)
–

Profile of study
general academic

Level of study
second-cycle

Course offered in
English

Form of study
full-time

Requirements
compulsory

Number of hours

Lecture
15

Laboratory classes
15

Other (e.g. online)
0

Tutorials
30

Projects/seminars
0

Number of credit points

4,00

Coordinators

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Lecturers

Prerequisites

1. Knowledge: Mathematics: algebra, trigonometry, analytical geometry, mathematical analysis of single and multivariable functions, differential and integral calculus, ordinary and partial differential equations, basics of numerical methods at the 6 PRK level Physics: solid state mechanics, kinematics and dynamics, basics of thermodynamics at the 5 PRK level, fluid mechanics at the 6 PRK level 2. Skills: Mathematics: mathematical analysis, application of differential and integral calculus to describe physical phenomena, solving ordinary differential equations, transforming partial differential equations Fluid physics and mechanics: solving tasks in solid state mechanics, kinematics, dynamics and thermodynamics at level 5 PRK, solving tasks in fluid mechanics at level 6 PRK 3. Social competences Awareness of the need to constantly update and supplement own knowledge and skills.

Course objective

Expanding and deepening the knowledge and skills in the field of fluid mechanics necessary to solve complex flow problems occurring in power engineering devices and energy systems

Course-related learning outcomes

Knowledge:

1. The student has an orderly and theoretically founded knowledge of the operation of fluid flow machines and fluid flows in complex pipe systems and fittings (obtained during lectures, auditorium and laboratory exercises)
2. The student knows the phenomena that generate energy losses in fluid flows and has in-depth knowledge of how to reduce these losses (obtained during lectures, auditorium and laboratory exercises)
3. The student knows and understands the basic equations describing the flow of liquids in open chanels
4. The student has in-depth theoretical and practical knowledge in the field of calculating the power of water and wind turbines, knows the rules of their efficient operation and knows how to improve the efficiency of these turbines (obtained during lectures, lecture and laboratory exercises)
5. The student knows and understands the structure of the system of differential equations expressing the laws of mass, momentum and energy conservation that are the basis of numerical fluid dynamics (CFD) (obtained during lectures and auditorium exercises)

Skills:
1. Student is able to determine theoretically and experimentally pressure losses in pipes and pipe systems of any geometry and in any fittings
2. The student knows how to determine the optimal cross-sections of open channels
3. The student is able to experimentally determine the flow characteristics of pumps, fans and control valves
4. The student has the ability to calculate the power of turbine machines and is able to quantify the factors affecting the efficiency of water and wind turbines
5. The student is able to plan and experimentally determine the characteristics of complex flow systems
6. The student is able to consciously apply simplifications in differential equations describing complex fluid flows (in CFD equations)

Social competences:
1. The student understands the need for teamwork in solving theoretical and practical problems
2. The student is aware of the necessity of accessible sharing of specialist knowledge in the field of fluid mechanics in the energy sector
3. The student sees the need to systematically deepen and expand his/her own competences

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Lectures:
45-minute written exam (written test) at the time specified at the beginning of the semester. The aim of the exam (test) is to check the students' knowledge. The exam (test) involves answering 4 questions. In doubtful cases, the exam (test) is extended by the oral part
Students' activity is assessed during each lecture.
Detailed evaluation criteria and the grading scale are presented in the first class in the semester and reminded before the exam (test).
Tutorials:
60-minute written test in the last week of the semester. The test is aimed at checking the students skills and consists in solving 2 tasks.
Assessing the correctness of independent solutions to tasks (student's home work).
Continuous assessment in every class (rewarding student activity).
Laboratory exercises:
Written (10-minute) checking of students' preparation before each of the laboratory exercises
Assessment of the written reports of each exercise.
Continuous assessment in every class (rewarding student activity).
The condition for passing the exam (passing the lectures) as well as to passing the tutorials is obtaining a minimum of 50% of the maximum number of points. The maximum number is 20.
Grading scale: 0-9 points = 2.0, 10-12 points = 3.0, 13-14 points = 3.5, 15-16 points = 4.0, 17-18 points = 4.5, 19-20 points = 5.0

Programme content

The module program covers the following topics:
1. internal (pressure) flows of the real fluid,

2. pressure losses in internal flows,
3. forces occurring between the fluid and the pipe in internal flows,
4. power and efficiency of turbomachinery,
5. forces occurring between the flowing fluid and flat and curved, movable and stationary walls,
6. flows with a free surface (in open channels),
7. elements of computational fluid dynamics (CFD).

Course topics

The lecture program covers the following topics:
1. the influence of temperature and pressure on the thermophysical parameters of fluids,
2. flow continuity equation,
3. local velocity, average velocity, velocity distribution for the developed Newtonian fluid flow in the pipe,
4. laminar and turbulent flow, critical Reynolds number, Bernoulli's equation for a real fluid,
5. friction pressure losses, minor pressure losses and developing pressure losses,
6. fluid momentum, average mass and average momentum velocity of the fluid,
7. flows in open channels, uniform flow, Chezy's equation, Manning's roughness coefficient, Froud's number,
8. optimal cross-sections of open channels, hydraulic jump,
9. general equation for the power of any turbomachinery,
10. efficiency of turbomachinery,
11. differential equations of conservation of mass, momentum and energy in fluid mechanics.

The tutorials program covers the following topics:
1. operation and applications of liquid manometers,
2. calculating the hydrostatic force on flat and curved walls,
3. calculation of pressure losses in pipes and fittings,
4. calculation of pump and fan power,
5. determining the efficiency of an ordinary well,
6. calculation of the efficiency of open channels,
7. calculating optimal shapes of open channels.

The laboratory program covers the following topics:
1. measurements of friction, minor and developing flow pressure losses in ducts,
2. determining the flow characteristics of the control valve,
3. determining the flow and energy characteristics of the fan/pump.

Teaching methods

Lectures: classical lecture with elements of conversation; multimedia presentation illustrated with examples
Tutorials: solving advanced problems in fluid mechanics
Laboratory exercises: teaching by experimentation

Bibliography

Basic:
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

Additional:
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

Breakdown of average student's workload

	Hours	ECTS
Total workload	100	4,00
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)	40	1,50