Code	IV.5.
Course Title (English)	Engineering Physics - Fluid Mechanics
Course Title (Polish)	Fizyka techniczna – Mechanika płynów
Credits	5 ECTS

Language of instruction English

Compulsory for Profile: Computer Modelling and Simulation (CMS), Intelligent Energy (IE), Biotechnology for Environmental Protection (BI), Business and Technology (BT)

Type of studies BSc studies

Unit running the programme Institute of Thermal Machinery

***Course coordinator** and academic teachers* **Stanisław Drobniak, Prof.,** Stanisław Drobniak, Prof., Andrzej Bogusławski, Assoc**.** Prof., Dariusz Asendrych, Dr

Form of classes and number of hours

Semester	Lec.	Tut.	Lab.	Proj.	Sem.	Credit points
IV	30	15	15			5

Learning outcomes The outcome of the course is the ability of the student to understand the flow physics and to be able to solve practical problems involving the fluid mechanics applications. The objective of the first part of the course is to familiarize students with basic physical properties of fluids, the most important being the Newton's law and its relation with molecular structure of fluids. The course on statics enables students to understand scalar nature of pressure and to calculate hydrostatic pressure in various configurations, as well as hydrostatic pressure on plane and curved surfaces. The second part is devoted to kinematics of fluid motion, with special reference to flow-analysing techniques. The streamline equation and Helmholtz theorem create the basis for flow description. The Euler's equation for inviscid fluid and continuity equation are analysed and Bernoulli equation is derived for inviscid and viscous flow. The flow losses in ducts are analysed and simplified semi – empirical methods are introduced. The Navier-Stokes equation is derived to familiarize students with analytical treatment of continuous media, then Hagen-Poiseuille integral is analysed to familiarize students with laminar flow properties. Dimensional analysis of flows is derived from N-S equation and the applicability of Re, Fr, Ma and St similarity criteria for flow modelling are discussed. The influence of streamline curvature is analysed with help of Bernoulli equation. Idea of boundary layer is derived from N-S equation and the Prandtl's approximation is introduced, basic physical properties and integral characteristics are discussed, the separation of boundary layer is discussed and the idea of viscous and form drag is analyzed.

Prerequisites (courses) Engineering Physics – Mechanics I, II, III

Mathematics I, II

Prerequisites (mathematical tools)	Basic knowledge of differential and integration calculus, fundamentals of vector calculus, basic knowledge of ordinary and partial differential equations

Course description

LECTURE

Fluid properties: concept of the fluid, fluid as a continuum and the limitations due to molecular fluid structure, the Newton's and Hook's laws and their relation to molecular structure, basic thermodynamic properties of fluids.
Fluid statics: pressure properties, equilibrium of fluid element, irrotational nature of gravity field, hydrostatic pressure and its applications to manometry, hydrostatic forces on plane and curved surfaces, equilibrium of floating and immersed bodies.
Fluid kinematics: Lagrange and Euler analysis of fluid motion, equation of streamline and its application to flow analysis, idea of steady and unsteady fluid motion, the Helmholtz theorem on fluid motion.
Dynamics of inviscid flow: Euler's differential equation, continuity equation, the solvability of Euler's equation for inviscid flows. Bernoulli equation as a 1D integral of Euler's differential equation, basic properties of inviscid 1D flow
Dynamics of viscous flow: Reynolds experiment, basic properties of laminar and turbulent flow, Bernoulli equation for viscous flow, friction and minor losses in pipe systems, empirical and semi-empirical correlations for flow losses, energy and pressure distributions along ducts with friction and minor losses, flow and velocity profile in circular pipe, derivation of Navier-Stokes equation, simplifications of N-S equations, Hagen-Poiseuille integral for viscous flow in thin pipe and application for viscometers, dimensional analysis of flows derived from N-S equation and the applicability of Re, Fr, Ma and St similarity criteria for flow modelling, the influence of streamline curvature upon the flow pattern, secondary flows due to streamline curvature in open channels and ducts.
Boundary layer: Prandtl's approximation, boundary layer description from N-S equation, basic physical properties and integral characteristics of boundary layer, separation of boundary layer, viscous and form drag in flows around streamlined and bluff bodies.

TUTORIALS:

Calculation of basic thermodynamic properties of fluids, hydrostatic pressure and its applications to manometry, hydrostatic forces on plane and curved surfaces, calculation of streamlines and flow trajectories, calculation of inviscid fluid flow in ducts, determination of pressure losses due to friction and minor losses, calculation of external forces from momentum conservation principle.

LABORATORY

Measurement of pressure, flow around the circular cylinder, determination of drag of streamlined and bluff bodies, determination of drag from momentum conservation principle, determination of velocity distribution and Coriolis coefficient for axi-symmetric flow, pressure distribution in 2D diffuser, determination of discharge coefficient of a nozzle, determination of jet reaction force on a flat plate, determination of critical Reynolds number for pipe flow.

PROJECT: Not applicable

SEMINAR: Not applicable

Form of assessment Exam

Basic reference materials	1.	E.J. Shaughnessy, I.M. Katz, J.P. Schaffer, Introduction to Fluid Mechanics, Oxford University Press, 2005
	2.	F.M. White, fluid Mechanics, McGraw-Hill, 2003
	3.	J.B. Evett, C. Liu, Fundamentals of Fluid Mechanics, , McGraw-Hill, 1987
	4.	Durst F.: Fluid Mechanics. An introduction to the theory of fluid flows. Springer-Verlag, Berlin, 2008
Other reference materials		For Polish-speaking students:
	1.	R. A. Duckworth, Mechanika Płynów, WNT, 1983
	2.	R. Puzyrewski, J. Sawicki, Podstawy mechaniki płynów i hydrauliki, PWN, 1998
	3.	Z. Kazimierski, Podstawy mechaniki płynów i metod komputerowej symulacji przepływów, Wyd. Pol. Łódzkiej, 2004
	4.	A. Tarnogrodzki, Dynamika Gazów, WKŁ, 2003

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Average student workload (teaching hours + individ.)	4 teaching hours +3 hours of individual work per week
Remarks:	
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