RTU Course "Aerohydromechanics"

31000 Faculty of Civil and Mechanical Engineering

General data

Code	TAS208
Course title	Aerohydromechanics
Course status in the programme	Compulsory/Courses of Limited Choice
Responsible instructor	Igors Pavelko
Academic staff	Sergejs Kuzņecovs
Volume of the course: parts and credits points	2 parts, 7.5 credits
Language of instruction	LV, EN
Annotation	1. Fluid and gas properties: specific gravity and density, viscosity. Boundary layer, laminar and turbulent flow, vortices, and stagnation. The effect of fluid compressibility. Laws of hydrostatics. International standard atmosphere (ISA), application to aerodynamics. Fluid and gas kinematics and dynamics. Static, dynamic and total pressure. Bernoulli's theorem. Continuum equation. Measurement of fluid consumption and pressure in pipes. Flow through pipes and hydraulic losses. Classification and characteristics of the pumps. Hydraulic calculation of the pipes. 2. Fluid and gas vortices. Speed circulation. Stocks' theorem. Fundamentals and applications of theory of potential flows. Airflow around a body. Aerodynamics terms and definitions. Fundamentals and applications of dimensional analysis and similarity. Basic principles of supersonic aerodynamics. Fundamentals of a theory of the boundary layer.
Goals and objectives of the course in terms of competences and skills	To receive knowledge about purpose and contents of aerohydromechanics. To understand the regularities that underpin hydraulic systems. To acquire background knowledge for aircraft aerodynamics course.
Structure and tasks of independent studies	Preparation of reports of laboratory works: •determination of hydraulic losses in smooth tubes (2 h); •experimental determination of coefficients of local hydraulic drags (2 h); •pressure-flow rate relation of a centrifugal pump (2 h); •pressure-flow rate relation of a plunger pump (2 h); •determination of aerodynamic forces on an airplane by means of the similarity theory (2 h). Preparation of reports of calculation-graphic works: •hydraulic analysis of a pipe of airplane fuel system (4 h); •air flow around a rotating cylindrical object (4 h). Working with the literature (22 h).
Recommended literature	1. Pavelko I. Aerohidromehānika/Lekciju konspekts. – Rīga: RTU Izdevniecība, 2009. – 94 lpp. 2. I. Pavelko, V. Pavelko. Aerohidromehānika / Metodiskie norādījumi laboratorijas un aprēķinu - grafiskajiem darbiem. - Rīga: RTU Izdevniecība, 2006. - 31 lpp. 3. J. F. Douglas, J. M. Gasiorek, J. A. Swaffield and Lynne B. Jack. Fluid Mechanics: Pearson Education Ltd., England, Harlow, 2005. - 958 pp. 4. Ķirsis T., Lielpēteris P. Fluidu mehānika. Rīga, 1999. -84 lpp. 5. P. Lielpēteris, R. Dorošenko, Ē. Geriņš. Fluidtehnika. Rīga, 2005. -183 lpp. 6. А. М. Мхитарян, В. В. Ушаков, А. Г. Баскакова, В. Д. Трубенюк. Аэрогидромеханика. – М.: «Машиностроение», 1984. 352 с.
Course prerequisites	Material point velocity and acceleration. Substance law of conservation of mass. Movement of inventory change law. External and internal forces. Newton's Laws. Work and energy. Energy Conservation Law. Differential and integrated computing basics.

Course contents

Content	Full- and part-time intramural studies		Part time extramural studies	
	Contact Hours	Indep. work	Contact Hours	Indep. work
Fluid and gas properties. Internal forces in fluid and gas. Internal friction and viscosity. Types of fluid flow.	4	0	0	0
Thermodynamic processes. Equation of gas state. First law of thermodynamics. Notions of enthalpy and entropy.	4	0	0	0
Hydrostatic pressure and its main property. Main equation of hydrostatics. Equilibrium of a fluid under gravitation.	4	0	0	0
Notion of a center of pressure. Archimedean law. Equilibrium of a gas. International standard of atmosphere.	4	0	0	0
Flow continuity equation. Bernoulli’s law. Peculiarities of the Bernoulli’s law for a compressible gas.	4	0	0	0
Hydraulic losses in friction on a tube length. Local hydraulic losses.	4	0	0	0
Purpose, parameters and classification of pumps. Pressure and flow rate relations of centrifugal and of plunger pumps.	4	0	0	0
Experimental determination of hydraulic losses in smooth tubes.	2	0	0	0
Experimental determination of coefficients of local hydraulic drags.	2	0	0	0

Experimental determination of pressure and flow rate relation of a centrifugal pump.	2	0	0	0
Experimental determination of a pressure and flow rate relation of a plunger pump.	2	0	0	0
Fluid flow through orifices and nozzles. Hydraulic impact. Hydrodynamic cavitation.	4	0	0	0
Hydraulic analysis of a pipe of the airplane fuel system.	8	0	0	0
Differential equations of a vortex flow. Helmholtz theorem. Velocity circulation. Stokes theorem. Biot-Savart formula.	3	0	0	0
Potential flow. Two-dimensional parallel flow. Flow function. Potential parallel flow. Cauchy – Riemann conditions.	3	0	0	0
Uniform rectilinear flow. Fountain. Runoff. Dipole. Irrotational flow circulation.	3	0	0	0
Air flow around a rotating cylindrical object.	4	0	0	0
Aerodynamic forces, moments. Aerodynamic quality. Flow similarity criteria. P- theorem of a dimension theory.	4	0	0	0
Experimental determination of aerodynamic forces acting on an airplane by means of a similarity theory.	2	0	0	0
Propagation of small perturbations in gas. Influence of Mach number on parameters of gas flow. Supersonic flow patterns.	2	0	0	0
Stagnation and critical parameters of flow. Direct pressure jump patterns.	3	0	0	0
Stagnation pressure in a critical point after pressure jump. Oblique pressure jump peculiarities.	3	0	0	0
Notion of a boundary layer. Characteristics of a laminar boundary layer and drag calculation.	2	0	0	0
Characteristics of a turbulent boundary layer and drag calculation. Boundary layer separation.	3	0	0	0
Total:	80	0	0	0

Learning outcomes and assessment

Learning outcomes	Assessment methods
Able to use the laws of hydraulics for theoretical and experimental determination of hydraulic losses.	Laboratory works: Determination of hydraulic losses in smooth tubes. Experimental determination of coefficients of local hydraulic drags.
Able to do a particular hydraulic system suitable pressure source selection.	Laboratory works: Determination of a pressure and flow rate relation of a centrifugal pump. Determination of a pressure and flow rate relation of a plunger pump.
Able to do a hydraulic analysis of a pipe.	Calculation-graphic work: Hydraulic analysis of a pipe of an airplane fuel system
Able to use a potential flow theory to solve an initial problem of aerohydromechanics for typical phenomena.	Calculation-graphic work: Air flow around a rotating cylindrical object.
Able to use a similarity theory to determine aerodynamic forces acting on an aircraft.	Laboratory work: Determination of aerodynamic forces on an airplane by means of a similarity theory.
Able to demonstrate theoretical knowledge of main patterns and research methods of aerohydromechanics.	Exams.

Study subject structure

Part	CP	Hours			Tests		
		Lectures	Practical	Lab.	Test	Exam	Work
1.	4.5	1.5	0.5	1.0		*	
2.	3.0	1.0	0.5	0.5		*	