RTU Course "Aerohydromechanics"

15E03 Lidaparātu teorijas un konstrukcijas katedra

General data

Code	TAS219
Course title	Aerohydromechanics
Course status in the programme	Compulsory/Courses of Limited Choice
Course level	Undergraduate Studies
Course type	Professional
Field of study	Mechanics, Mechanical Engineering, Machine Building
Responsible instructor	Kuzņecovs Sergejs
Academic staff	Pavelko Vitālijs
Volume of the course: parts and credits points	1 part, 3.0 Credit Points, 4.5 ECTS credits
Language of instruction	LV, EN, RU
Possibility of distance learning	Not planned
Abstract	Laws of hydrostatics. Fluid and gas kinematics. Continuum equation. Bernoulli's law. Peculiarities of Bernoulli's law for a gas. Flow through orifices and nozzles. Fluid consumption equation. Pumps. Classification and characteristics of the pumps. Special phenomena in the fluid flow in the pipes. Hydraulic calculation of the pipes. Fluid vortices. Fundamentals of the theory of potential flows. Fundamentals of dimensional analysis and similarity. Small perturbations and pressure shocks in the air flow. Fundamentals of the boundary layer theory.
Goals and objectives of the course in terms of competences and skills	To receive knowledge about the purpose and contents of aerohydromechanics. To understand the regularities that underpin the hydraulic systems. To acquire the aircraft aerodynamics course in the required grounding.
Structure and tasks of independent studies	Preparation of reports on the laboratory works: •determination of hydraulic losses in the smooth tubes (1 h); •experimental determination of coefficients of the local hydraulic drags (1 h); •pressure-flow rate relation of a centrifugal pump (1 h); •pressure-flow rate relation of a plunger pump (1 h); •determination of aerodynamic forces on the airplane by means of the similarity theory (1h). Preparation of reports on the calculation-graphic works: •hydraulic analysis of a pipe of the airplane fuel system (2 h); •air flow around a rotating cylindrical object (2 h). Work with the literature (15 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 the inventory change law. External and internal forces. Newton's Laws. Work and energy. Energy Conservation Law. Differential and integrated computing basics.

Course outline

Theme	Hours
Fluid and gas properties. Internal forces in fluid and gas. Internal friction and viscosity. Types of fluid flow.	2
Thermodynamic processes. Equation of gas state. First law of thermodynamics. Notions of enthalpy and entropy.	2
Hydrostatic pressure and its main property. Main equation of hydrostatics. Equilibrium of a fluid when gravitation.	2
Notion of a centre of pressure. Archimedean law. Equilibrium of a gas. International standard atmosphere.	2
Flow continuity equation. Bernoulli’s law. Peculiarities of the Bernoulli’s law for a compressible gas.	2
Hydraulic losses in friction on a tube length. Local hydraulic losses.	2
Purpose, parameters and classification of pumps. Pressure-flow rate relations of centrifugal and of plunger pumps.	2
Experimental determination of hydraulic losses in the smooth tubes.	2
Experimental determination of coefficients of the local hydraulic drags.	2
Experimental determination of a pressure-flow rate relation of a centrifugal pump.	2
Experimental determination of a pressure-flow rate relation of a plunger pump.	2
Fluid flow through the orifices and nozzles. Hydraulic impact. Hydrodynamic cavitation.	2
Hydraulic analysis of a pipe of the airplane fuel system.	2
Differential equations of a vortex flow. Helmholtz theorem. Velocity circulation. Stokes theorem. Biot-Savart formula.	2
A potential flow. Two-dimensional parallel flow. Flow function. A potential parallel flow. Cauchy – Riemann conditions.	2

Uniform rectilinear flow. Fountain. Runoff. Dipole. Irrotational flow circulation.	2
Air flow around a rotating cylindrical object.	2
Aerodynamic forces, moments. Aerodynamic quality. Flow similarity criterions. p- theorem of a dimension theory.	2
Experimental determination of aerodynamic forces on the airplane by means of a similarity theory.	2
Propagation of small perturbations in gas. Influence of Mach number on parameters of gas flow. Supersonic flow patterns.	2
Stagnation and critical parameters of flow. Direct pressure jump patterns.	2
Stagnation pressure in a critical point after pressure jump. Oblique pressure jump peculiarities.	2
Notion of a boundary layer. Characteristics of a laminar boundary layer and drag calculation.	2
Characteristics of a turbulent boundary layer and drag calculation. Boundary layer separation.	2

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 the smooth tubes. Experimental determination of coefficients of the local hydraulic drags.
Able to do a particular hydraulic system suitable pressure source selection.	Laboratory works: Determination of a pressure-flow rate relation of a centrifugal pump. Determination of a pressure-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 the 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 the similarity theory to determine aerodynamic forces on the aircraft.	Laboratory work: Determination of aerodynamic forces on the airplane by means of the similarity theory.
Able to show theoretical knowledge of main patterns and research methods of aerohidromechanics.	Exam.

Study subject structure

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