RTU Course "Experimental Aerodynamics and Aerodynamic Calculations"

15E03 Lidaparātu teorijas un konstrukcijas katedra

General data

Code	TAS210
Course title	Experimental Aerodynamics and Aerodynamic Calculations
Course status in the programme	Compulsory/Courses of Limited Choice
Course level	Undergraduate Studies
Course type	Professional
Field of study	Transport
Responsible instructor	Pavelko Igors
Academic staff	Pavelko Vitālijs
Volume of the course: parts and credits points	1 part, 2.0 Credit Points, 3.0 ECTS credits
Language of instruction	LV, EN, RU
Possibility of distance learning	Not planned
Abstract	Problems of aerodynamics. Theoretical and experimental aerodynamics. Equations system of theoretical aerodynamics. Ideal fluid. Viscous fluid. Potential airflow theory and its application for calculation of the airfoil aerodynamics properties. Thin airfoil theory. Panel method solution. Lifting line theory (3-D wing). Vortex lattice method (3-D wing). Dimensional analysis and introduction to the boundary layer. Lift and drag of a wing. Aircraft aerodynamics properties estimation. Problems of experimental aerodynamics and methods of their solution. Principles of construction of the wind tunnels. Wind tunnels of low subsonic and high velocities. Measuring of an air flow velocity. Aerodynamic spectrum. Theoretical and experimental estimation of a distribution of pressure on a surface of a body in the air flow. Operation principle of an aerodynamic balance. Experimental estimation of Reynolds number. Theoretical and experimental estimation of a polara of a profile. Theoretical and experimental estimation of thrust, power absorbed and efficiency of an air propeller. Choice of the aircraft propeller engine and estimation of the parameters of a rated mode. Ensuring of an aerodynamic similarity.
Goals and objectives of the course in terms of competences and skills	Experimental Aerodynamics and Aerodynamic Calculation is the applied version of Aerodynamics. It is a subject about general ideas and common principles of aircraft (or others objects) aerodynamic properties obtained by calculation or experimentally. The aim of the given subject is the methods of aircraft aerodynamics analysis and their application for different kinds of vehicles.
Structure and tasks of independent studies	Independent work with literature in accordance with the subject programme (6h.) Performing of control works: 1) Airfoil properties analysis, using the panel method solution (4h.); 2) Estimation of aircraft aerodynamics properties (4h). Performing of report on laboratory works: 1) Experimental investigation (by wind tunnel) of aircraft aerodynamics properties (1h); 2) Air propeller experimental investigation in wind tunnel (1h).
Recommended literature	1. Experiments in aerodynamics by S. P. Langley. Reston (Va.): American Institute of Aeronautics and Astronautics, 2006. - 115 pp. 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. Aerodynamics for students. 2008. (www.aerodynamics4 students.com)
Course prerequisites	Aerodynamic forces, moments and their coefficients. Liquid and gas vortices movement. Potential flow theory basics. Similarities and dimension theory. Theory of boundary layer. Supersonic flow regularities and pressure jumps.

Course outline

Theme	Hours
Problems of aerodynamics. Theoretical and experimental aerodynamics. Equations system of theoretical aerodynamics.	2
Ideal fluid. Viscous fluid.	1
Potential airflow theory and its application for calculation of the airfoil aerodynamics properties.	2
Thin airfoil theory.	2
Lifting line theory (3-D wing).	2
Vortex lattice method (3-D wing).	2
Panel method solution.	2
Dimensional analysis and introduction to boundary layer theory.	2
Theoretical estimation of a polara of a profile.	2
Lift and drag of a wing. Aircraft aerodynamics properties estimation.	2
Problems of experimental aerodynamics and methods of their solution. Ensuring of an aerodynamic similarity.	1
Principles of construction of the wind tunnels. Wind tunnels of low subsonic and high velocities.	1
Measuring of an air flow velocity. Experimental estimation of Reynolds number for an air.	2
Aerodynamic spectrum. Theoretical and experimental estimation of a pressure distribution on a body surface in air flow.	2

Experimental estimation of a polara of a profile.	2
Operation principle of an aerodynamic balance.	1
Theoretical and experimental estimation of thrust, power absorbed and efficiency of an air propeller.	2
Choice of the aircraft propeller engine and estimation of the parameters of a rated mode.	2

Learning outcomes and assessment

Learning outcomes	Assessment methods
Able to calculate coefficient of lift and one of longitudinal moment when different values of the angle of attack.	Control work: “Airfoil properties analysis, using panel method solution”.
Able to calculate a polara of the airplane.	Control work: “Aircraft aerodynamics properties estimation”.
Able to estimate aerodynamics properties of the aircraft by experiment with a model.	Laboratory work: “Experimental investigation (by wind tunnel) of aircraft aerodynamics properties”.
Able to estimate the thrust, power absorbed and efficiency of an air propeller when different velocity modes by experiment. On the basis of the results of the experiment able to determine an optimal operating condition for air propeller.	Laboratory work: “Air propeller experimental investigation in wind tunnel”.
Able to orientate in the methods of aircraft aerodynamics analysis and apply it for different kinds of vehicles.	Exam.

Study subject structure

Part	CP	ECTS	Hours per Week			Tests		
			Lectures	Practical	Lab.	Test	Exam	Work
1.	2.0	3.0	0.5	0.5	1.0		*	