



## RTU Course "Fundamentals of Aerodynamics"

15E03 Lidaparātu teorijas un konstrukcijas katedra

### General data

Code	TAS100
Course title	Fundamentals of Aerodynamics
Course status in the programme	Compulsory/Courses of Limited Choice
Course level	Undergraduate Studies
Course type	Professional
Field of study	Transport
Responsible instructor	Kuzņecovs Sergejs
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	<p>Aerodynamic problems. Fluid and gas properties. Specific gravity and density. Viscosity, fluid resistance. Internal forces in fluid (gas). International Standard Atmosphere (ISA). Streamline and streamtube. Continuum equation. Vortices. Bernoulli's integral, venturi. Static, dynamic and total pressure. Concept of similarity. Experimental aerodynamics formulas.</p> <p>The airfoil, its geometric characteristics: camber, chord. Airfoil aerodynamic coefficients and their connection with the pressure coefficient. Airfoil lift and drag coefficients versus angle of attack. Boundary layer stall. Airfoil centre of pressure and aerodynamic centre (focus). Concept of boundary layer. Laminar layer and turbulent boundary layer.</p> <p>Wing form, aspect ratio. Wrapping. Generation of lift and drag: angle of attack, aerodynamic coefficients. Induced drag. Polar curve of airplane and L/D ratio. Lift forcing devices of a wing: slat, flap, flap-aileron. Drag forcing devices of a wing: spoiler, air brake. Vortex generator. Speed of sound. Sound propagation. Subsonic, transonic, and supersonic flight. Compressibility effect. Mach number, critical Mach number, shock waves, heating, areas law. Sweep-back wing critical Mach number. Control devices: elevator, rudder, aileron. Trim tab, antiservo tab, spring servo tab. Elementary flight theory: level flight, climbing, descending, take off, landing, manures. Four forces of flight. Concepts of stability and control.</p>
Goals and objectives of the course in terms of competences and skills	<p>Global objectives</p> <p>Aim of the given subject is the methods analysis of aerodynamics and their application for building of aircraft aerodynamics.</p> <p>Specific objectives</p> <ul style="list-style-type: none"> <li>•To understand the essence of theoretical and experimental aerodynamics</li> <li>•To obtain theoretical knowledge about fundamentals of aerodynamics, analytical and experimental methods of aerodynamic force and moments.</li> </ul>
Structure and tasks of independent studies	<p>Home work for testing: • Test 1: Physics of atmosphere. International Standard Atmosphere (ISA).(2h); • Test 2: Basis of airflow. (2h); • Test 3: Slat, flap etc. (2h); • Test 4: Control of flight (2h); • Test 5: Level flight, climbing, descending (2h); • Test 6: Take off, landing (2h); • Test 7: Constant altitude turn. Left-turning tendencies of one-engine airplane (2h); • Test 8: Stability and dynamics of flight (2h).</p>
Recommended literature	<ol style="list-style-type: none"> <li>1. V. Pavelko. Gaisakuģu aerodinamika // Mācību līdzeklis. - Rīga: RTU, 2009.- 258 lpp.</li> <li>2. I. Pavelko. Aerohidromehānika/Lekciju konspekts. – Rīga: RTU Izdevniecība, 2009. – 94 lpp.</li> <li>3. JAR CPL Course: 08000- Principles of Flight, 08100- Subsonic Aerodynamics). 1998.- 250 pp.</li> <li>4. Lešinskis A. Aerodinamika, Mācību līdzeklis, Rīga, RAU, 1997. - 120 lpp.</li> <li>5. I. Pavelko, V. Pavelko. Metodiskie norādījumi laboratorijas un aprēķinu-grafiskajiem darbiem „Aerohidromehānika”. – Rīga, RTU Izdevniecība, 2006 – 31 lpp.</li> <li>6. Мхитарян А.М. и др. Аэродинамика. 1976. - 448 с.</li> <li>7. Airframe and Powerplant Mechanics Handbook: US Department of Transportation. FAA, 1991. - 500 pp.</li> <li>8. Anderson, J.D. 1991. Fundamentals of Aerodynamics, 2nd ed. McGraw-Hill, New York.</li> <li>9. Л. Ф. Николаев. Аэродинамика и динамика полета транспортных самолетов// - Москва: Транспорт, 1990. -256 с.</li> <li>10. Гаухман Я. Н. и др. Аэродинамика и динамика полета летательных аппаратов. Часть 1. Аэродинамика. – Рига: РКИИГА, 1976.</li> <li>11. Aerodynamics, Aeronautics, and Flight Mechanics, 2/e Barnes W. McCormick// John Wiley &amp; Sons, Inc., 1995 672 pages.</li> </ol>
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.

### Course outline

Theme	Hours
Aerodynamics problems. Fluid and gas properties.	1
International Standard Atmosphere (ISA).	1
Streamline and streamtube. Continuum equation. Vortices.	2
Bernoulli's integral, venturi. Static, dynamic and total pressure.	2

Concept of similarity. Experimental aerodynamics formulas.	2
Airfoil aerodynamic coefficients and their connection with the pressure coefficient. Airfoil lift and drag coefficients	2
Airfoil centre of pressure and aerodynamic centre (focus).	1
Concept of boundary layer. Laminar and turbulent boundary layer.	1
Wing form, aspect ratio, and aerodynamic properties.	2
Induced drag. Polar curve of airplane and L/D ratio.	2
Lift and drag forcing devices.	2
Speed of sound. Mach number, critical Mach number.	2
Control devices.	2
Flight theory: level flight.	2
Flight theory: climbing, descending.	2
Flight theory: take off, landing.	2
Flight theory: manures.	2
Concepts of stability and control.	2

### ***Learning outcomes and assessment***

Learning outcomes	Assessment methods
Able to determine the quantities of parameters of a gas state at different heights.	Test 1: Physics of atmosphere. International Standard Atmosphere (ISA).
Able to estimate different typical phenomena in airflow.	2. test: Basis of airflow.
Able to identify the lift forcing devices of a wing and understand their purpose and operation principle.	3. test: Slat, flap ect.
Able to identify the flight control devices and understand their purpose and operation principle.	4. test: Control of flight.
Able to determine the characteristics of main conditions of flight.	5. test: Level flight, climbing, descending. 6. test: Take off, landing. 7. test: Constant altitude turn. Left-turning tendencies of one-engine airplane
Able to estimate stability of an aircraft in flight and understand conditions of stability.	Test No 8: Stability and dynamics of flight.

### ***Study subject structure***

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