RTU Course "Construction Mechanics"

15E03 Lidaparātu teorijas un konstrukcijas katedra

General data

Code	TAS304
Course title	Construction Mechanics
Course status in the programme	Compulsory/Courses of Limited Choice; Courses of Free Choice
Course level	Undergraduate Studies
Course type	Academic
Field of study	Mechanics, Mechanical Engineering, Machine Building
Responsible instructor	Pavelko Vitālijs
Academic staff	Pavelko Igors
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	Introduction. The problems of structural analysis. Analysis of the supporting system. Fastening of the material point to the base. Fastening of the disc to the base. Statically determinative problem. Statically non-determinative problem. Method of forces. Beam system analysis by the finite elements method. Fundamentals of the finite elements method. Transformation of finite displacements and forces. Stiffness matrix of a finite element. Principle of virtual displacements and the basic system of equations. Boundary conditions and the algorithm of problem solving. Cross-ply bending and stability of rectangular plates. Cross and longitudinal bend of rectangular plates. Equations of equilibrium and deformation. Bi-harmonic equations, boundary conditions and method of solution. Stability of equilibrium of plates and thin-walled beam. Analysis of the thin-walled panel. Combine the thin-walled beam complete loading. Direct stresses in cross-section of beam and the method of reducing coefficients. Basic equation for the shear flow determination. Bending centre and the angle of torsion. Analysis of the thin-walled beam with the open and closed cross-section. Analysis of the thin-walled beam with the multiply closed cross-section. Beam system analysis by finite elements method. Fundamentals of finite elements method. Transformation of finite displacements and forces. Stiffness matrix of a finite element. Principle of virtual displacements and basic system of equations. Boundary conditions and the algorithm of problem solving. Cross-ply bending and stability of rectangular plates. Cross and longitudinal bend of rectangular plates. Equations of equilibrium and deformation. Bi-harmonic equations, boundary conditions and method of solution. Stability of equilibrium of plates and thin-walled beam. Analysis of thin-walled panel. Combine thin-walled beam complete loading. Direct stresses in cross-section of beam and the method of reducing coefficients. Basic equation for the shear flow determination. Bending center and the angle of torsion. Analysis of thin-walled beam with opened and closed cross-section Analysis of thin-walled beam with multiply closed cross-section.
Goals and objectives of the course in terms of competences and skills	To be able to analyze the elastic system of rods and thin-walled elements (plate, shell) of the aircraft structure, to select the rational methods of stress and strain analysis and stability properties. To be able to solve the rods systems problem by the classical and finite element methods. To be able to solve the problem of thin-walled rod bending and torsion. To be able to solve the rods systems problem by classical and finite element method. To To be able to solve the problem of thin-walled rod bending and torsion.
Structure and tasks of independent studies	Preparation of reports on homework and lab work: • Homework 1: Fastening of a block to the base (2 h); • Homework 2: 3D frame system analysis by FEM (2h); • Homework 3: Bending and torsion of the thin-walled beam (2 h); • Lab work 1: Experimental evaluation of the bending centre of the thin-walled beam; • Lab work 2: Experimental investigation of the complete bending of combine thin-walled beam; • Work with the literature (14 h).
Recommended literature	1. V. Pavelko. Būvmehānika. Lekciju konspekts – Rīga: RTU, 2003. – 85 lpp. 2. V. Pavelko. Būvmehānika. Kursa darba uzdevumi, to izpildīšanas piemēri un metodiskie norādījumi – Rīga: RAU, 1996. – 74 lpp. 3. Melderis I., Teters G. Būvmehānika: Mācību grāmata augstskolu studentiem. – Rīga: Zvaigzne, 1977. – 560 lpp. 4. Juriksons V., Melderis I. Būvmehānika: Uzdevumi ar atrisinājumiem. – Rīga: Zvaigzne, 1977. – 368 lpp. 5. Aircraft Structures for engineering students//Fourth Edition by T.H.G.Megson.-Oxford: Butterworth Heinemann, 2005.-590 pp. 6. E.Lavendelis, A.Valdmanis. Materialu pretestība. -Rīga: Zvaigzne, 1970.- 455 lpp.
Course prerequisites	Strength of materials

Course outline

Theme	Hours
Analysis of the supporting system.	2
Fastening of the disc and the block to the base. Statically determinative problem.	4
Beam system analysis by the finite elements method.	2

Transformation of finite displacements and forces. Stiffness matrix of a finite element.	4
Principle of virtual displacements and the basic system of equations. Boundary conditions and the algorithm of problem s	2
Cross-ply bending and stability of rectangular plates. Cross and longitudinal bend of rectangular plates.	6
Bi-harmonic equations, boundary conditions and method of solution.	2
Stability of equilibrium of plates and thin-walled beam.	4
Analysis of thin-walled panel.	2
Complex thin-walled beam. Direct stresses of beam and the method of reducing coefficients	2
Basic equation for the shear flow determination. Bending centre and the angle of torsion.	4
Analysis of thin-walled beam with open and closed cross-section. Multiply closed cross-section.	4
Warping displacement of thin-walled beam. Basic equation of torsion of thin-walled beam	4
Shell. Shells without bending	2
Bending of cylindrical shell	2
Stability of cylindrical shell	2

Learning outcomes and assessment

Learning outcomes	Assessment methods
Analysis of the supporting system. Statically non-determinative problem.	Homework 1: Fastening of a block to the base.
Beam system analysis by the finite elements method.	Homework 2: 3D frame system analysis by FEM
Combine thin-walled beam complete loading.	Homework 3: Bending and torsion of the thin-walled beam
Bending centre and the angle of torsion.	Lab work 1: Experimental evaluation of the bending centre of the thin-walled beam
Direct stresses in cross-section of beam and the method of reducing coefficients. Analysis of thin-walled beam with open and closed cross-section.	Lab work 2: Experimental investigation of the complete bending of the combined thin-walled beam
Problems of the structural analysis.	Final exam
Analysis of supporting system. Statically non-determinative problem	1st homework: Fastening of a block to the base.
Beam system analysis by finite elements method.	2nd homework: 3D frame system analysis by FEM
Combine thin-walled beam complete loading.	3rd homework: Bending and torsion of the thin-walled beam
Bending center and the angle of torsion.	1st lab-work: Experimental evaluation of the bending center of a thin-walled beam
Direct stresses in cross-section of beam and the method of reducing coefficients.Analysis of thin-walled beam with opened and closed cross-section	2nd lab-work: Experimental investigation of the complete bending of combine thin-walled beam
The problems of structural analysis	Final exam

Study subject structure

Part	CP	ECTS	Hours per Week			Tests			Tests (free choice)		
			Lectures	Practical	Lab.	Test	Exam	Work	Test	Exam	Work
1.	3.0	4.5	1.5	1.5	0.0		*				