



## RTU Course "Finite Element Method and its Applications"

15E03 Lidaparātu teorijas un konstrukcijas katedra

### General data

Code	TAD545
Course title	Finite Element Method and its Applications
Course status in the programme	Compulsory/Courses of Limited Choice
Course level	Post-graduate Studies
Course type	Academic
Field of study	Mechanics, Mechanical Engineering, Machine Building
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	The main concept of the finite element method (FEM). Classification of FE. Idea and characteristics of the shape functions. Interpolation of vector quantities. Local coordinate systems. Conditions of convergence and continuity of FEM solution. Methodology of calculation of nodal values of unknown quantity. Acquaintance with principles of formation and application of computer programs based on FEM. Learning of computer programs ELCUT, FRANC and "Mechanical Desktop". Calculation of some elements of aircraft engines by FEM programs. (JAR-66, mod.1.2.a, 1.3.b, 11.2, 12.5).
Goals and objectives of the course in terms of competences and skills	To get knowledge on a concept of the finite element method and common ways of solution of specific problems. To learn practical application of specific computer programs based on the finite element method.
Structure and tasks of independent studies	Calculation of thermal state of GTE turbine disk (2h). Calculation of state of stress of GTE turbine disk (2h). Calculation of state of stress of a flat plate (2h). Calculation of state of stress near a tip of crack (1h). Research of crack propagation and development of the Paris model (1h). PD crankshaft strength analysis (8h).
Recommended literature	1. Yijun Liu. Lecture Notes: Introduction to Finite Element Method// University of Cincinnati. 1998. 2. Kug Weon Kim. Hyo-Chol Sin. Finite Element Method and Thermo-Viscoplastic Cutting Model in Manufacturing Systems// COMPUTER-AIDED DESIGN, ENGINEERING, AND MANUFACTURING Systems Techniques And Applications. 2001 by CRC Press LLC. 3. Hughes, T.J.R. 1987. The Finite Element Method: Linear Static and Dynamic Finite Element Analysis. Prentice-Hall, Englewood Cliffs, NJ. 4. L. Segerlind. Primenenie metoda konečnyh elementov - M.:Mir, 1979. 5. Rikards R., Čate A. Galīgo elementu metode. RTU, Rīga, 2002. 6. Barkanovs J. Ievads galīgo elementu metodē. 1. Sēj. RTU, Rīga, 2010.
Course prerequisites	Differential and integrated computing basics. Calculation of tension, compression, bending, and torsion. Permissible stress and factor of safety. Thermal conductivity and convection. Thermal conductivity equation. Elasticity of material. Energy of deformation and elastic potential.

### Course outline

Theme	Hours
The main concept of the finite element method. Sequence of model development. Rules of splitting.	1
Notions of a finite element and a node. Numeration of nodes. Classification of the finite elements.	1
Interpolation of unknown quantities. Form functions.	2
Local coordinate systems: st-coordinates; L-coordinates.	2
Convergence and continuity of FE solution.	1
Determination of values of the unknown quantity in the nodes.	3
Introduction to ELCUT. ELCUT aided calculation of the thermal state of structural elements.	3
Introduction to ELCUT. ELCUT aided calculation of the state of stress of structural elements.	3
Introduction to FRANC. FRANC aided calculation of the state of stress of a flat plate.	4
FRANC aided calculation of the state of stress near a tip of crack.	2
FRANC aided research of crack propagation and development of Paris model.	2
Introduction to Mechanical Desktop. Splitting of 3D object into the finite elements. Boundary conditions.	2
Mechanical Desktop aided strength calculation of a structural element. Analysis of results.	6

### Learning outcomes and assessment

Learning outcomes	Assessment methods
Able to solve plane and axially symmetrical tasks of thermal conductivity and the ones of theory of elasticity with the help of ELCUT.	Test on GTE turbine disk strength calculation.

Able to solve plane tasks of theory of elasticity and the ones of fracture mechanics with the help of FRANC.	Test. Calculation of the state of stress and fatigue strength of a flat plate with stress concentrators.
Able to execute an analysis of strength of a specific 3D object with the help of Mechanical Desktop.	Test. PD crankshaft strength analysis by the finite element method.
To be proficient in general questions of theory of the finite element method.	Exam.

***Study subject structure***

Part	CP	ECTS	Hours per Week			Tests		
			Lectures	Practical	Lab.	Test	Exam	Work
1.	2.0	3.0	0.5	1.5	0.0		*	