RTU Course "Automatization of Calculation of Construction Durability"

15325 Teorēt.mehānikas un materiālu pretestības katedra

General data

Code	MMP534
Course title	Automatization of Calculation of Construction Durability
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	Januševskis Aleksandrs
Academic staff	Januševskis Jānis
Volume of the course: parts and credits points	1 part, 4.0 Credit Points, 6.0 ECTS credits
Language of instruction	LV, EN, RU
Possibility of distance learning	Not planned
Maximum auditorium capacity	24
Maximum number of students per semester	50
Abstract	Calculations of design strength as the integral part of computer aided design and analysis (CAD/CAE). An overview of numerical techniques for CAE: matrices, eigenvalue problems, differentiation, integration, linear algebraic equations. Finite element method (FEM). Applying FEM for solution of the elasticity theory problems. Geometric modelling. Discretization of the real structures. Review of general purpose FEM programs. Capabilities of the strength analysis programs. FE libraries, solution methods and commands. Preprocessing, postprocessing and other special capabilities. Optimization of statically loaded constructions of mechanical engineering.
Goals and objectives of the course in terms of competences and skills	Systematic learning of construction strength calculation problems and mathematical basics, understanding of theoretical concepts of CAE and practical skills of CAE software application for broad class of mechanical engineering objects.
Structure and tasks of independent studies	Each student independently carries out practical exercises and develops the coursework. The basic task of the coursework is to provide the basis required for the creation of 3D model for calculation of mechanical engineering object and implementation of appropriate calculations (strength, buckling, fatigue, frequency, thermo, optimization etc.) by CAE software as well as interpretation of obtained results.
Recommended literature	1. R. Rikards, A. Čate. Galīgo elementu metode. Rīga. 2002. -130 2. J. Auziņš, A. Januševskis. Eksperimentu plānošana un analīze. Rīga. 2007. -256. 3.E.Lavendelis. Materiālu pretestība. Rīga.Zvaigzne.1986., 4. O. Zienkiewicz , R. Taylor. The Finite Element Method. Vol.1: The Basis. 5th edition. Oxford, Auckland, Boston, Johannesburg, Melbourne, New Delhi: Butterworth-Heinemann. 2000. -689 5. O. Zienkiewicz , R. Taylor. The Finite Element Method. Vol.2: Solid Mechanics. 5th edition. Oxford, Auckland, Boston, Johannesburg, Melbourne, New Delhi: Butterworth-Heinemann. 2000. -459. 6.ANSYS User's Manual.Volumes I,II,III,IV.Swanson Analysis Systems,Inc., Houston, PA, USA,1994. 7.K.J.Bathe. Finite Element Procedures. Prentice Hall. 1996.-1050.
Course prerequisites	Computer skills, mathematics, mechanics (statics), strength of materials

Course outline

Theme	Hours
Classification of calculations of the objects of mechanical engineering and typical examples. Calculations of Construction resistance as the integral part of CAD	4
Main functions and structure of CAE software, preprocessors, processors and postprocessors. Commercial FEM software.	4
Finite element method (FEM) and development tendencies. Finding boundaries of model ("Sledge hammer" approach).	4
Types of matrices, operations and properties. Systems of linear algebraic equations, solution methods and algorithms.	4
Strength calculations of the real mechanical engineering constructions by CosmosWorks. Failure criteria.	4
Principle of potential energy minimum. Ritz method. CosmosWorks processors.	4
Basics of FEM, finding of beam stiffness matrix. Nonlinear analysis.	4
Total stiffness matrix of construction consisting of beams and rods. Symmetric problems.	4
Accuracy of calculations and adaptive meshing methods. Sensitivity analysis.	4
Optimization tasks of mechanical engineering constructions and its classical solution methods. Response surface method.	4
Simplification of calculation schemes. Types of connectors available in CosmosWorks. Contact problems.	4
Comparison of element libraries of Cosmos, Ansys and Nastran. Fatigue problems.	4
Discretization of objects for calculations, types of possible distortions and methods to overcome this situation. Dirty	4
Methods of fluid flow calculations. Finite volume method. FloWorks preprocessor, processor un post processor	4
Models for calculation by Cosmos FloWorks. Internal and external flow analysis.	4

State of the art methods: meshless method, smooth particle method, hydrocodes.	4

Learning outcomes and assessment

Learning outcomes	Assessment methods
The student must know how to create the virtual 3D models for computations as well as perform strength, buckling, fatigue, frequency, thermo and optimization analysis by SolidWorks Simulation software	Corresponding models and documentation with the results of computations obtained in practical works and coursework as well as student answers on assessment test questions.
The student must be familiar with the problems to be solved by CAE and the mathematical foundations of solution methods, the basic concepts of CAD/CAE as well as have practical skills to perform static and optimization calculations for the mechanical engineering objects applying CAE software.	Question at the examination. Development quality and observance of the submission deadline of the coursework, student attendance rate, as well as participation in students scientific conferences are considered additionally

Study subject structure

Part	CP	ECTS	Hours per Week			Tests		
			Lectures	Practical	Lab.	Test	Exam	Work
1.	4.0	6.0	1.0	3.0	0.0		*	