RTU Course "Computer-Aided Analysis of Mechanical Systems of Machines (Basic Course)"

15325 Teorēt.mehānikas un materiālu pretestības katedra

General data

Code	MTH304
Course title	Computer-Aided Analysis of Mechanical Systems of Machines (Basic Course)
Course status in the programme	Compulsory/Courses of Limited Choice
Course level	Undergraduate Studies
Course type	Academic
Field of study	Mechanics, Mechanical Engineering, Machine Building
Responsible instructor	Januševskis Aleksandrs
Academic staff	Auziņš Jānis Kovaļska Agrita
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
Maximum auditorium capacity	24
Maximum number of students per semester	50
Abstract	Role of mechanical system analysis in the designing process. Specifics of the static, kinemtaic and dynamic calculations. Development of Mathematical Models for Real Machines and Identification Problem. Basics of Machine Dynamics Analysis. Review of General - Purpose Analysis Programs (Imita, Working Model, Mikrostation, Autocad etc.)
Goals and objectives of the course in terms of competences and skills	Systematic learning of dynamics calculation problems and mathematical basics, understanding of theoretical concepts of CAE and practical skills of CAE software using for designing of 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 dynamics calculations by CAE software as well as interpretation of obtained results.
Recommended literature	1. D.Marghitu. Kinematic chains and machine components design. Elsevier, 2005. -790. 2. R.L.Norton. Design of machinery: an introduction to the synthesis and analysis of mechanisms and machines. McGraw-Hill. 1999. -924. 3. E.W. Nelson, C.L. Best, W.G. McLEAN. Theory and problems of engineering mechanics statics and dynamics McGraw-Hill. 1999. -526 4. T. Hsu, D.K. Sinha. Computer – Aided Design: An Integrated Approach. New York, Los Angeles, San Francisco. West Publishing Company. 1992. –487. 5. J. Auziņš, A. Januševskis. Eksperimentu plānošana un analīze. Rīga. 2007. -255. 6. CosmosWorks Professional. StructuralResearch and Analysis Corporation. 2005.-156. 7. ADAMS User's Manual. 2005. 8. ANSYS/ED Workbook. Swanson Analysis Systems, Inc., Houston, PA, USA, 1994. 9. ANSYS User's Manual. Volumes I, II, III, IV. Swanson Analysis Systems, Inc., Houston, PA, USA, 1994. 10. Atskaite par ZPD. Tēma Nr.207. Dinamiski slogotu mašīnu un mehānismu automatizētās funkcionālās projektēšanas un vadības algoritmu un programmlīdzekļu izstrādāšana. ZP reģ. Nr. 90.143, Rīga, 1993, -166. 11. Working Model:Demonstration Guide and Tutorial.1997.
Course prerequisites	Computer skills, mathematics, theoretical mechanics (dynamics)

Course outline

Theme	Hours
Analysis of mechanical parts of machines and its place in the design projects. Vibration calculations by Imita.	3
Review of universal purpose computer programs (ADAMS, CosmosMotion, Imita, LMS, Medyna, Working Model etc.)	3
Matrix form of the differential equations of motion of mechanical systems. Linear models, superposition.	3
Koshi problem for linear differential equations and analytical solution for multi DOF systems.	3
Obtaining the solution for linear differential equations in case of excited vibrations.	3
Static, kinematic and dynamic calculations of mechanical systems and its specific. Possibilities of ADAMS and CosmosMoti	3
Problem of nonlinear programming and software for optimization. Spatial model of the car power unit.	3
Eigenvalue problem for systems with nonclassical distribution of dissipation, physical meaning of eigenvalues for analysis	3
Structure of ADAMS simulation system and area of solved problems.	3
Searching for the optimal solution by the means of design of experiments.	3
Design of experiments and ADAMS/Insight	3
Stochastic global optimization methods. Tabu search, simulated annealing, genetic algorithms.	3
Review of optimization software (VisualDoc, EDAOpt)	3
Using of response surface metthod in ADAMS/Insight and EDAOpt environments	3

Description of dynamic behaviour of real mechanical systems by mathematical models, identification problem.	3
High velocity impact calculation methods. Hydrocodes.	3

Learning outcomes and assessment

Learning outcomes	Assessment methods
The student must know how to create the virtual 3D computational models and perform kinematic and dynamic analysis applying SolidWorks Motion and ADAMS 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 dynamics calculations for the mechanical engineering objects by help of CAE software.	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.	3.0	4.5	1.0	2.0	0.0		*	