Mechanical Engineering
Master Degree Studies

Subject:	Advanced methods applied in mechanics and strength of materials
Subject type:	
Subject code:	
Year:	I
Semester:	2
Form of studies:	*Full-time course*
Type of classes and hours per semester:	*Lecture + Laboratory practice=60*
Lecture	*30*
Exercise	
Laboratory practice	*30*
Project	
ECTS points:	
Form of credit:	*Lecture examination + Assessment of laboratory practice*
Lecture language:	*English*

Subject objectives	
C1	Familiarize students with advanced methods used in mechanics and strength of materials.
C2	Familiarize students with the methods of modelling of mechanical systems.

Prerequisites in knowledge, skills and other competencies	
1	The student knows basic problems and computational methods of mechanics and strength of materials
2	The student has basic knowledge of the following areas: general mechanics, strength of materials and mathematics

Educational effects	
	Knowledge:
EK 1	The student has knowledge of the subject of mechanical and strength analysis of mechanical systems/structures
EK 2	The student has an advanced knowledge of mechanics of materials and engineering structures
	Skills:
EK3	The student is able to perform experimental studies to determine the strength properties of complex engineering structures
EK 4	The student is able to prepare and solve the physical model of the mechanical system
	Social competencies:
EK 5	Student is able to work in a team

Curriculum of the Subject	
Class form: lecture	
	Curriculum content
W1	Introduction. Basic concepts. Types of modelling. Parameters and variables in the modelling. Physical, mathematical and numerical modelling. Classification of models. Linear and nonlinear models. Examples.
W2	Creating a physical model of the mechanical system. Simplifying assumptions used in the modelling. Formulation of a mathematical model. Identification of system parameters.
W3	Analytical methods in modelling. Analytical solving of simple mathematical models.
W4	Physical modelling of simple and complex systems in the Adams environment
W5	Numerical methods of analysis of a mathematical model. Examples of software for numerical simulation.
W6	Numerical simulations in Matlab and Simulink environment. Writing user procedures, as well as the use of built-in packages.
W7	Analysis, interpretation and visualization of the results. Time series, phase portraits. Impact of initial conditions on the simulation result.
W8	Introduction to modelling of elements and structures using mechanical energy methods.
W9	Application of the Maxwell-Mohr method for structure modelling.
W10	Special cases and simplifications used in the Maxwell-Mohr method.
W11	Approximate methods of solving differential equations on the example of a differential equation of the deflection line.
W12	Approximate methods in the case of stability loss of structural elements.
W13	Introduction to the Finite Element Method (FEM) on the example of bar-beam structures.
W14	Direct method of the FEM linear models solution on the example of a truss.
W15	Application of the Finite Element Method for beam structures.
Class form: laboratory practice	
	Curriculum content
L1	Laboratory and 'Health and Safety' regulations. Analytical studies of a mechanical system with one degree of freedom.
L2	Physical modelling of the one-degree-of-freedom system with the Adams software.
L3	Numerical modelling of the mechanical system with one degree of freedom.
L4	Physical modelling of a system with two degrees of freedom with the Adams software.
L5	Analytical studies of the mechanical system with two degrees of freedom.
L6	Numerical investigations of the mechanical system with two degrees of freedom. Verification of the analytical model.
L7	Data analysis examples: time series, phase portraits, FFT. Impact of initial conditions and the size of time integration step.

KAPITAŁ LUDZKI
NARODOWA STRATEGIA SPÓJNOŚCI
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Projekt współfinansowany ze środków Unii Europejskiej w ramach
Europejskiego Funduszu Społecznego

L8	Modelling of the vehicle suspension system in the Matlab and the Simulik software environment.
L9	Analytical testing of stress and strain of the ring using the Maxwell-Mohr's method. Verification of the results in the experiment.
L10	Application of mechanical energy methods in modelling of a bar-beam structures.
L11	The use of approximate methods to determine the deflection of a selected bar-beam structure. Comparison with the experimental measurements.
L12	The use of approximate methods to determine the critical force for selected elements of a structure.
L13	FEM modeling of bar-beam structures using the direct method. Derivation of the stiffness matrix and solving of large systems of linear equations.
L14	Verification of the results obtained by the direct FEM with experimental measurements.
L15	Comparison of analytical solution for a truss with the FEM and the Maxwell-Mohr method's outcomes.

Teaching methodology	
1	*Lecture z with multimedia presentation*
2	*Laboratory practice*

Student workload	
Form of activity	Average hours to complete activity
Teacher contact hours, including:	
• *Attendance at lectures* • *Attendance at laboratory practice* • *Attendance at examination and consultation*	• *30* • *30* • *7*
Total student work time, including:	
• *Preparation for laboratory practice* • *Preparation for examination*	•
Total student work time	
Total ECTS for the subject:	
Total of ECTS for practical classes (exercise, laboratory practice, projects)	

Basic reference literature	
1	*Beer, F. et al.: Mechanics of Materials, McGraw-Hill, 2014*
2	*Hibbeler, R.C.: Mechanics of Materials, Prentice Hall, 2013*
3	*Gere, J.M., Goodno, B.J.: Mechanics of Materials, Cengage Learning, 2012*
4	*Craig, R.R.: Mechanics of Materials, Wiley, 2011*
Complementary reference literature	
1	*Allen, J.H.: Mechanics of Materials for Dummies, For Dummies, 2011*
2	*Gere, J.M., Timoshenko, S.P.: Mechanics of Materials, PWS Pub Co., 1997*

Educational effect matrix					
Educational effect	Specific educational effect reference to curriculum-wide effects (PEK)	Subject objective	Curriculum content	Teaching methodology	Evaluation methods
EK 1, EK 2	MBM1A_W02, MBM1A_W04, MBM1A_W05, MBM1A_W09, MBM1A_W10, MBM1A_W14, MBM1A_W18	*C1, C2*	*W1-W15*	*1*	*O1*
EK 3, EK 4	MBM1A_U08, MBM1A_U21, MBM1A_U23, MBM1A_U24	*C1, C2*	*L1-L15*	*2*	*O2*
EK 5	MBM1A_K03	*C1, C2*	*L1-L15*	*2*	*O2*

Evaluation methods and criteria		
Evaluation method symbol	Evaluation method description	Pass threshold
O1	*Examination*	*60%*
O2	*Reports of laboratory experiments*	*100%*

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