Module/Subject Syllabus Summary
[Mechanical Engineering]
Master Degree Studies

Subject:	Numerical modeling of engineering problems *(MES)*
Subject type:	*Compulsory*
Subject code:	
Year:	I
Semester:	2
Form of studies:	*Full-time course*
Type of classes and hours per semester:	*60*
Lecture	*30*
Exercise	*-*
Laboratory practice	*30*
Project	*-*
ECTS points:	*4*
Form of credit:	*Assessment*
Lecture language:	*English*

Subject objective	
C1	Understanding the principles of modelling engineering problems using the finite element method.
C2	Acquisition of skills in conducting numerical simulations and interpret the results of calculations in problems of engineering.

Prerequisites in knowledge, skills and other competencies	
1	Knowledge of general mechanics, strength of materials and numerical calculation methods at the level of competence of the first degree studies (W).
2	Ability to use CAD software for the design of spatial elements and assemblies of machines and mechanisms in engineering applications (U) .

Educational effects	
	Knowledge:
EK 1	Upon completion of the course the student knows in an advanced stage modelling techniques of machine parts and assemblies using CAD and FEM.
EK 2	Upon completion of the course the student is familiar with the numerical simulation using the finite element method in the field of stress and dynamic analysis.
	Skills:
EK 3	The student is able to perform the models and assemblies of machine parts and mechanisms using the principles of computer-aided design.
EK 4	Student is able to import geometric objects from CAD programs and carry out proper discretization of a geometric model using the methods of repairing a

	defective geometry. He knows how to prepare discrete model of the structure to the numerical simulation
EK 5	The student is able to define a suitable model material and the type and parameters of numerical analysis for static and dynamic issues using geometrically and physically nonlinear issues.
EK 6	Student is able to achieve a complete numerical simulation in terms of static and dynamic analysis, and carry out the correct interpretation of the results of calculations.
	Social competence:
EK 7	The student is aware of the responsibility for their own work and the need to act in a professional manner and respect the rules of professional ethics.

Curriculum content of Subject	
Form of classes - Lecture	
	Curriculum content
W1	Finite element method in applications of engineering.
W2	Basic equations of FEM.
W3	FEM calculation methods (Implicit, Explicit).
W4	Basic principles of discretization of continuous object - classification and characteristics of finite elements.
W5	Interaction in the discrete model: modelling of assemblies, the principle of combining elements, contact problems.
W6	Classification of engineering material models used in numerical modelling. Issues physically linear and nonlinear.
W7	Issues geometrically linear and nonlinear - calculation methods.
W8	Modelling of proper issues: buckling of the structure, natural vibrations.
W9	Evaluation and interpretation of the results of numerical analyzes FEM
Class form: laboratory practice	
	Curriculum content
L1	Practical rules for the conduct of discrete models and numerical simulations.
L2	Importing geometry from CAD programs, methods of repair the loaded geometry.
L3	Modelling of geometrically nonlinear issues.
L4	Physically linear and nonlinear issues - comparative analyzes.
L5	The multi-steps numerical analysis.
L6	Interactions in assemblies of machine, parts – connecting of finite element mesh, modelling of contact problems.
L7	Modelling of thin-walled structures.
L8	Modelling of proper issues: buckling, natural vibrations.
L9	Strength analysis of basic mechanical parts and systems.
L10	Explicit dynamic analysis type – impact modelling.
L11	Editing methods of calculation results - contour maps, charts, photos.

Teaching methodology	
1	*Lecture problem*

2	Lecture and multimedia presentation.
3	Test (45 minutes) conducted in a lecture hall covering several thematic blocks.
4	Practical simulation activities using software *CAE.*
5	Multimedia projections of numerical simulations samples.
6	Laboratory self-solving computational task with the situation defined by verbal description or verbal description and drawing.
7	Individual interpretation of the correctness of the results of calculations in relation to the modelled engineering issues.
8	Self-modifying parameters of a numerical model in order to obtain correct results of calculations.

Student workload	
Form of activity	Average hours to complete activity
Teacher contact hours, including:	*65*
Participation in lectures	*30*
Participation in laboratory classes	*30*
Participation in the consultation	5
Total student work time, including:	35
Self-studying of lectures topics	10
Individual preparation and participation in the colloquium crediting lecture	5
Substantive preparation for laboratory classes	20
Total student work time	100
Total ECTS for the subject:	4
Total of ECTS for practical classes (exercise, laboratory practice, projects)	2

Basic reference literature	
1	Rusiński E., Czmochowski J., Smolnicki T.: Zaawansowana metoda elementów skończonych w konstrukcjach nośnych, Oficyna Wydawnicza Politechniki Wrocławskiej, Wrocław 2000.
2	Rakowski G., Kacprzyk Z.: Metoda Elementów Skończonych w mechanice konstrukcji, Oficyna Wydawnicza PW., Warszawa 2005.
3	Bąk R., Burczyński T. – "Wytrzymałość materiałów z elementami ujęcia komputerowego". WNT, Warszawa 2001.
Complementary reference literature	
1	Niezgoda T. – „Analizy numeryczne wybranych zagadnień mechaniki". WAT, Warszawa 2007.
2	Osiński J.: Obliczenia wytrzymałościowe elementów maszyn z zastosowaniem metody elementów skończonych, Oficyna Wydawnicza PW., Warszawa 1997.
3	Dyląg Z., Jakubowicz A., Orłoś Z.; Wytrzymałość materiałów. WNT, Warszawa 2003.

Educational effect matrix					
Educational effect	Specific educational effect reference to curriculum-wide effects (PEK)	Subject objective	Curriculum content	Teaching methodology	Evaluation methods
EK 1	*MBM1A_W05 +*	*[C1, C2]*	*[W1,W4, L1,L2]*	*[1, 2, 3, 4, 6]*	*[O1, O2, O3]*
EK 2	*MBM1A_W11 +++*	*[C1, C2]*	*[W2,W3,W4,L3, L4,L5, L8,L9, L10]*	*[1, 2, 3, 6, 7]*	*[O1, O2, O3]*
EK 3	*MBM1A_W09 ++*	*[C1]*	*[L1, L2]*	*[4, 5, 6]*	*[O2, O3]*
EK 4	*MBM1A_U12 +*	*[C1]*	*[W1,W4, W7, W8, L2, L3, L4,L5]*	*[1, 2, 4, 6]*	*[O1, O2, O3]*
EK 5	*MBM1A_W06 +++*	*[C1]*	*[W4,W5,W6, W7, W8, L3, L4, L8, L10]*	*[1, 2, 3, 4, 5, 6]*	*[O1, O2, O3]*
EK 6	*MBM1A_U19 +++*	*[C1, C2]*	*[W1,W7, W8, W9, L5,L6, L7, L8,L9,L10, L11]*	*[1, 2, 4, 5, 6, 7, 8]*	*[O1, O2, O3]*
EK 7	*MBM1A_K04 + MBM1A_K03 ++*	*[C2]*	*[W9,L9, L11]*	*[1, 2, 3, 7, 8]*	*[O1, O2, O3]*

Evaluation methods and criteria		
Evaluation method symbol	Evaluation method description	Pass threshold
O1	Written lecture credit	*50%*
O2	Participation in laboratory classes	*75%*
O3	*Practical credit* in the form of numerical analysis of the example	*50%*

Curriculum author:	Hubert Dębski PhD (hab.) Eng.
E-mail:	h.debski@pollub.pl
Unit:	Department of Machine Design and Mechatronics, Faculty on Mechanical Engineering

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