DOCTORAL SCHOOL OF WROCŁAW UNIVERSITY OF SCIENCE AND TECHNOLOGY

SUPERVISOR/TEAM/ DECLARING/CONDUCTING COURSE: Prof. of WUST, Kazimierz Myślecki, PhD, Eng.
DEPARTMENT: Civil Engineering Department
SCIENTIFIC DISCIPLINE: Civil Engineering and Transport

COURSE CARD

Course name in Polish: Metoda elementów skończonych w mechanice ośrodków ciągłych
Course name in English: Finite element method in mechanics of continua
Course language: Polish / ~~English~~*
University-wide general course type*:
The course is intended for all PhD students: YES / NO
1) BASIC COURSE
~~2) SPECIALIST COURSE~~
~~3) SEMINAR~~
~~4) HUMANISTIC COURSE~~
~~5) LANGUAGE~~

Subject code: ILQ100022W

* delete as applicable

	Lecture	Foreign language course	Seminar	Mixed forms
Number of hours of organized classes in university (ZZU)	30			
Grading	Exam	Exam	Oral presentation	Exam, inspection, evaluation classes
Number of ECTS points	**0**			

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Has a basic practical knowledge regarding numeric, variational and tensor calculus.
2. Has a background in linear algebra, matrix calculus and mathematical analysis.
3. Has a basic knowledge regarding structural mechanics and theory of elasticity.
4. Has a basic practical skills of coding algorithms in mathematical computer system (Mathematica, Mathlab).

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COURSE OBJECTIVES

C1 Introduction to advance problems of mechanics of continua, especially – mechanics of solids.
C2 Overview of basic properties of solid materials – elasticity, plasticity and viscosity.
C3 Practical FEM modeling of beams and plates.
C4 Practical FEM algorithm formulation and coding it in Mathematica computer system.

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PROGRAM CONTENTS

Form of classes – lecture (Lec)		Number of hours
Lec1	Introduction to mechanics of continua.	1
Lec1-Lec2	Cartesian tensors. Algebra and analysis of tensors.	2
Lec2-Lec3	Displacements vector. Lagrange and Euler nonlinear tensors. Cauchy linear strain tensor.	2
Lec3-Lec4	Momentum, moment of momentum. Equilibrium equations of solids.	3
Lec5-Lec6	Constitutive models of solids – elasticity, plasticity viscosity.	3
Lec6-Lec7	Elastic models of rods (Euler, Timoshenko) and shells (Kirchhoff-Love, Reissner- Mindlin).	3
Lec8-Lec9	Principle of virtual work. Lagrange's functional. Hellinger's-Reissner's functional.	3
Lec9-Lec10	Introduction to FEM. Methods of Ritz and Galerkin.	2
Lec10-Lec11	Lagrange and Hermite polynomial interpolation. Families of element shape functions in 1D, 2D and 3D spaces. Triangle and tetrahedron element families.	3
Lec11-Lec12	Structure of FEM algorithm. Theorems of convergence in FEM. Compatible and incompatible plate and shell elements.	2
Lec13-Lec14	Introduction to nonlinear problems of FEM. Buckling of beams and plates.	3
Lec14-Lec15	Large displacements algorithm. Path of equilibrium. Elastic stability – energy interpretation. Methods of load and displacement incrementation. Newton-Raphson method.	3
	Total hours:	**30**

TEACHING TOOLS USED

N1. Traditional lecture.
N2. Working with Mathematica system on some example problems.
N3. Discussion.

ACHIEVED SUBJECT LEARNING OUTCOMES

Type of learning outcome	Code of learning outcome	Assessment of learning outcome
Knowledge	**P8U_W**	student competently quotes other authors in articles published and prepared for publication in peer-reviewed scientific journals, peer-reviewed materials from international scientific conferences, and in book editions preceding the preparation of a doctoral dissertation
Knowledge	**P8S_WG**	student has an advanced knowledge fundamental to

		a field relevant to his/her research, including the most advanced methods of research and verification of results achieved
Skills	**P8S_UO**	student is able to establish and undertake scientific cooperation in research teams, including international research teams, is able to initiate and conduct discussions on research topics, results obtained and their interpretation

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Mase G.T., Smelser R.E., Mase G.E. Continuum mechanics for engineers, CRC Press, 2010
[2] Rymarz Cz.: Mechanika ośrodków ciągłych. PWN, Warszawa 1993
[3] Zienkiewicz O.C., Taylor R.L.: The finite elements method, 6th edition, 2006
[4] Crisfield M.A.: Non-Linear finite element analysis solid and structures. John Wiley & Sons. 2000

SECONDARY LITERATURE:

[1] Eringen A.C.: Nonlinear theory of continuous media. McGraw-Hill BC, New York, 1962
[2] Skrzypczyk J.: Plastyczność i pełzanie. PWN, Warszawa 1986
[3] Rakowski G. Kacprzyk Z.: Metoda elementów skończonych w mechanice konstrukcji. Oficyna Wyd. Pol. Warszawskiej, Warszawa 1993
[4] Waszczyszyn Z., Cichoń Cz., Radwańska M., Metoda elementów skończonych w stateczności konstrukcji, Arkady, 1990

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

Prof. of WUST, Kazimierz Myślecki, PhD, Eng., kazimierz.myslecki@pwr.edu.pl