Field of study (Kierunek):

Civil Engineering (Budownictwo)

Subject Description Card (Karta Opisu Przedmiotu)

ISCED 2013-F Field of study: Building and civil engineering (code: 0732)

Name of the subject						Subject code	Semester
FEM in Structural Engineering *Metoda elementów skończonych w konstrukcjach inżynierskich*							**Autumn**
Subject		**Profile**				**Level of education**	
Facultative		**General academic**				**Full-time**	
Type of classes							**ECTS**
Lecture	**Practice**	**Laboratory**	**Project**	**Seminar**	**Exam**		
15	**15**	**-**	**30**	**-**	**NO**		**6**
Faculty conducting subject:	***Faculty of Civil Engineering*** ***Tel: +48 (34) 325 02 06***						
Teachers conducting subject:	***DSc. Piotr Lacki*** mail: piotr.lacki@pcz.pl						

I. Card subject	
PURPOSE OF THE SUBJECT	
C01	Understanding the course of proceedings in the construction of a numerical model in the finite element method
C02	Acquiring the skills of proper selection of a numerical model based on a physical model.
C03	Acquiring the ability to interpret the results of numerical simulations using the finite element method.
PRELIMINARY REQUIREMENTS FOR KNOWLEDGE, SKILLS AND OTHER COMPETENCES	
1	Basic knowledge of Civil Engineering.
2	Basic knowledge of the theoretical mechanics and the strength of materials and the skill to calculate the sections strength parameters.
3	Knowledge of the structural mechanics and the ability to solve the static equilibrium systems.
4	Ability to construct the building dividing walls.
5	Ability to use the standards of the construction loads.
6	Knowledge of the preparing principles of the technical drawings and the ability to read and apply them.
LEARNING OUTCOMES:	
Knowledge: the graduate knows and understands	
EK1	the rules of conducting the analysis using MES.
Skills: the graduate can	
EK2	explain the workflow using the finite element method, build a FEM model and optimize the MES model.
Social competence: the student is ready to	
EK3	work in a group and make his/her own decisions related with design metal structures.

PROGRAM CONTENT		
Type of classes - Lecture		**Number of hours**
L1	Construction of the FEM program. An algorithm for the construction of the FEM model.	1
L2	Numerical model of a truss. One-dimensional elements (1D) of the "truss" type.	1

L3	Numerical model of a truss. Concentrated loads.	1
L4	Numerical model of a truss. Implementation of boundary conditions for a truss	1
L5	Numerical model of a truss. Analysis of results for a truss	1
L6	Numerical model of the beam. One-dimensional (1D) "beam" elements	1
L7	Numerical model of the beam. Types of beam loads	1
L8	Numerical model of the beam. Types of boundary conditions for beams	1
L9	Numerical model of the beam. Analysis of results for beams	1
L10	Discussion of the scope of the implemented own project	1
L11	Two-dimensional "shell" elements	1
L12	Analysis of results using elements of the "shell" type	1
L13	Three-dimensional elements (3D Solid).	1
L14	Analysis of results using 3D Solid elements.	1
L15	Final test.	1
	TOTAL:	**15**

PROGRAM CONTENT		
Type of classes - Practice		**Number of hours**
PT1	Discussion of the procedure for modeling MES using an example	1
PT2	An example of using truss elements for truss modeling	1
PT3	Discussion of a truss load with concentrated forces on the example	1
PT4	Discussion of defining complex boundary conditions for a truss example	1
PT5	Discussion of the analysis of the calculation results for the truss on an example	1
PT6	The use of beam-like elements for frame modeling.	1
PT7	Loading of the frames with the examples	1
PT8	Discussion of defining complex boundary conditions for frames on an example	1
PT9	Discussion of the analysis of the calculation results for the frames on the example	1
PT10	Discussing project tasks	1
PT11	An example of using a two-dimensional "shell" element	1
PT12	Analysis of the results of the FEM model with the use of "shell" type elements	1
PT13	An example of using a three-dimensional element "3D Solid"	1
PT14	Analysis of the results of the FEM model with the use of “3D Solid” elements	1
PT15	Final assignment.	1
	TOTAL:	**15**

PROGRAM CONTENT		
Type of classes - Project		**Number of hours**
P1	The assumptions of project.	2
P2	Creating geometry	5
P3	Loads	1
P4	Boundary conditions	1
P5	Building a FEM model	5
P6	Optimizing the FEM model	5
P7	Analysis of calculation results	5
P8	Creation of the project documentation	6
	TOTAL:	**30**

BASIC AND ADDITIONAL LITERATURE	
Basic literature:	
1.	Zienkiewicz O. C.: Metoda elementów skończonych, Arkady, Warszawa 1972.
2.	Klaus-Jürgen Bathe: Finite element procedures Prentice Hall, 1996.
3.	Beer F. P., Johnston E. R. Jr., Mazurek D. F., Cornwell P. J., Eisenberg E. R.: *Vector mechanics for engineers. Statics and dynamics.* McGraw-Hill, New York 2010.
4.	Rakowski G., Kacprzyk Z.: Metoda elementów skończonych w mechanice konstrukcji, Oficyna Wydawnicza

	Politechniki Warszawskiej, Warszawa 2005.
5.	Szmelter J., Dacko M., Dobrociński S., Wieczorek M.: Metoda elementów skończonych w statyce konstrukcji, Arkady, Warszawa 1979
6.	Sieczkowski J.M.: Podstawy komputerowego modelowania konstrukcji budowlanych, Oficyna wydawnicza Politechniki Wrocławskiej, Wrocław 2001
7.	Starosolski W.: Wybrane zagadnienia z komputerowego modelowania konstrukcji inżynierskich, Wydawnictwo Politechniki Śląskiej, Gliwice 2001
Additional literature:	
1.	Bogucki W., Żyburtowicz M.: Tablice do projektowania konstrukcji metalowych, Arkady, Warszawa 2008
2.	PN-EN 1993-1-1:2006 Eurokod 3. Projektowanie konstrukcji stalowych. Część 1-1: Reguły ogólne i reguły dotyczące budynków.
3.	PN-EN 1993-1-5:2008 Eurokod 3. Projektowanie konstrukcji stalowych. Część 1-5: Blachownice.
4.	PN-EN 1993-1-3:2008 Eurokod 3. Projektowanie konstrukcji stalowych. Część 1-3: Reguły ogólne - reguły uzupełniające dla konstrukcji z kształtowników i blach profilowanych na zimno.