Cracow University of Technology

Course syllabus

binding for the doctoral students of the CUT Doctoral School commencing their studies in the academic year 2022/2023

Information on the course

Name of the course in Polish	MES z zastosowaniami w mechanice i inżynierii
Name of the course in English	FEM with applications in mechanics and engineering
Number of the ECTS points	2
Language of instruction	Polish
Category of the course	Choosable
Field of education	Engineering and Technology
Discipline of education	Civil Engineering and Transport
Person responsible for the course Contact	Prof. Jerzy Pamin PhD Eng. jerzy.pamin@pk.edu.pl

Type of course, number of hours in the study programme curriculum

Semester	Credit type (G / NG)*	Lecture	Practical classes	Laboratory	Computer Lab	Project Class	Seminar
2, 3, 4, 5	G	20	0	0	10	0	0

*G – graded credit, NG – non-graded credit

Course objectives

Code	Objective description
Objective 1	Consolidation and broadening of knowledge about FEM modelling
Objective 2	Getting to know selected nonlinear models of materials and structures
Objective 3	Acquiring the ability to simulate deformation and effort of a simple structure with various FEM models

Learning Outcomes

Code	Description of the learning outcome adjusted to the specific characteristics of the discipline	Learning outcome symbol in the CUT SD	Methods of verification
OUTCOMES RELATED TO KNOWLEDGE			
EUW1	A PhD student knows and understands FEM phrases and algorithms for mechanics and thermo-mechanics as well as selected models of engineering materials	E_W01, E_W02	Involvement in class activities, a presentation of a project, a final test
EUW2	A PhD student knows and understands the methodology of calculating nonlinear FEM models of selected materials and engineering structures	E_W01, E_W02	Involvement in class activities, a presentation of a project, a final test

OUTCOMES RELATED TO SKILLS			
EUU1	A PhD student is able to calculate deformation and stress of a structural element in the linear and nonlinear range	E_U01	Involvement in class activities, a presentation of a project
EUU2	A PhD student is able to prepare and present a presentation of his project work	E_U01	Involvement in class activities, a presentation of a project
OUTCOMES RELATED TO SOCIAL COMPETENCES			
EUK1	A PhD student is ready to critically evaluate the results of numerical simulations of selected engineering issues	E_K01, E_K03	Involvement in class activities, a presentation of a project

Course outline

No.	Contents	Learning outcomes for the course	No. of hours
LECTURE			
W1	FEM modelling. To formulate local and global dynamics.	EUW1, EUW2, EUU1	2
W2	FEM for thermo-mechanics of structures. FEM failures.	EUW1, EUW2, EUK1	2
W3	FEM algorithms for nonlinear problems.	EUW2, EUU2, EUU1	2
W4	Computational plasticity.	EUW1, EUW2, EUU1	2
W5	Modelling of scratching of quasi-brittle materials.	EUW1, EUW2, EUU1	2
W6	Modelling of damage and fracture.	EUW1, EUW2, EUU1	2
W7	Thermodynamic foundations of constitutive models.	EUW1, EUW2, EUU1	2
W8	Variation rules and multi-field FEM formulations.	EUW1, EUW2, EUU1	2
W9	Modelling of buckling problems.	EUW1, EUW2, EUU1	2
W10	Analysis of deformation localization issues.	EUW1, EUW2, EUK1	2

No.	Contents	Learning outcomes for the course	No. of hours
COMPUTER LAB			
LK1	An introduction to a design exercise. An example of an elasto-plastic FEM analysis.	EUW2, EUU1, EUU2	2
LK2	Project realization.	EUW2, EUU1, EUU2	6
LK3	Presentation of projects.	EUW2, EUU2, EUK1	2

The ECTS points statement

WORKING HOURS SETTLEMENT	
Type of activity	Average number of hours (45 min.) dedicated to the completion of an activity type
SCHEDULED CONTACT HOURS WITH AN ACADEMIC TEACHER	
Hours allotted in the syllabus	30
Consultations	1

Examination / course credit assignment	1
HOURS WITHOUT THE PARTICIPATION OF AN ACADEMIC TEACHER	
Independent study of the course contents	10
Preparation of a paper, report, project, presentation, discussion	13
ECTS POINTS STATEMENT	
Total number of hours	55
The ECTS points number	2

Preliminary requirements

No.	Requirements
1	Knowledge of mathematical analysis, basics of computational methods and FEM.
2	Knowledge of the basics of strength of materials and building mechanics.

Course credit assignment conditions / method of the final grade calculation

No.	Description
COURSE CREDIT ASSIGNMENT CONDITIONS	
1	80% attendance in class. Presentation of the developed project.
METHOD OF THE FINAL GRADE CALCULATION	
Weighted average of test marks and presentation marks, including attendance.	

Additional information

Not specified

The course reading list

1	T. Belytschko, W.K. Liu and B. Moran, *Nonlinear Finite Elements for Continua and Structures*, John Wiley & Sons, 2000.
2	R. de Borst, M.A. Crisfield, J.J.C. Remmers and C.V. Verhoosel, *Non-linear Finite Element Analysis of Solids and Structures*, Second Edition, J. Wiley & Sons, Chichester, 2012.
3	U. Haussler-Combe, *Computational Methods for Reinforced Concrete Structures*, Ernst & Sohn, Berlin, 2015.
4	M. Kleiber, P. Kowalczyk, *Wprowadzenie do nieliniowej termomechaniki ciał odkształcalnych*, IPPT PAN, Warszawa, 2011.
5	M. Radwańska, A. Stankiewicz, A. Wosatko, J. Pamin, *Plate and Shell Structures. Selected Analytical and Finite Element Solutions*, J. Wiley & Sons, 2017.
6	G. Rakowski, Z. Kacprzyk, *Metoda elementów skończonych w mechanice konstrukcji*, Oficyna Wydawnicza Politechniki Warszawskiej, Warszawa, 2005.
7	E. de Souza Neto, D. Peric, D. Owen, *Computational methods for plasticity - theory & applications,* J. Wiley & Sons, 2008.
8	O.C. Zienkiewicz, R.L.Taylor and J.Z. Zhu, *The Finite Element Method*, Sixth Edition, Elsevier Butterworth-Heinemann, Oxford, 2005.