POZNAN UNIVERSITY OF TECHNOLOGY

EUROPEAN CREDIT TRANSFER AND ACCUMULATION SYSTEM (ECTS)

COURSE DESCRIPTION CARD - SYLLABUS

Course name
FEM systems [S1ETI1>SMES]

Course

Field of study
Education in Technology and Informatics

Year/Semester
3/6

Area of study (specialization)
–

Profile of study
general academic

Level of study
first-cycle

Course offered in
Polish

Form of study
full-time

Requirements
compulsory

Number of hours

Lecture
15

Laboratory classes
15

Other (e.g. online)
0

Tutorials
0

Projects/seminars
15

Number of credit points

5,00

Coordinators

dr inż. Piotr Kędzia
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Lecturers

Prerequisites

Studend starting the course should has the knowledge in the field of mathimatics, mechanics of materials, mechanical engineering design, engineering graphics and material science. Should be able to solve simple tasks related to mechanics of materials, understand general rules of the machine design, be able to model physical phenomena as well as simple machine elements. Should be able to use efficiently the software for 3D modelling of solids. Should know how to find and how to use a proper catalogs and standards related to engineering materilas and machine parts.

Course objective

Presenting the principles of operation and capabilities of modern computer systems allowing to perform numerical calculations based on the finite element method. Learning the proper use of the finite element method in order to solve, correctly and effectively, complex engineering problems. Description of basic types of numerical analyses.

Course-related learning outcomes

Knowledge:
1. has basic knowledge how the fe systems works and how to use them.

2. has knowledge related to numerical modelling of structural elements and simple assemblies of these elements.
3. knows the rules of preparation of numerical models of structural elements by simplification of the actual objects.
4. has knowledge to select the type of analysis and properties of the numerical model adequate for the given engineering problem.

Skills:
1. is able to carry out the strength analysis of machine elements under simple cases of load using numerical methods.
2. is able to prepare a correct and effective numerical model of the structural elements and machine parts.
3. is able to interpret the results of numerical analyses and to draw the conclusions allowing to make a design decision.
4. is able to prepare a correct and comprehensible report from numerical investigation and present it to occupational environment using modern it techniques.

Social competences:
1. understands the importance of computer systems and the latest technical achievements in the engineering work.
2. understand the necessity of cooperation of experts in many different fields of engineering during the design process.
3. is aware of the influence of the design engineer"s work on shaping the public space and the environment.

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

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Learning outcome Verification metnod Assessment criteria
(all mentioned above) colloquium 3.0 – 50.1%-60.0%;
3.5– 60.1%-70.0%;
4.0– 70.1%-80.0%;
4.5– 80.1%-90.0%;
5.0– 90.1%-100.0%;

Programme content

Discussion of construction analysis methods, presentation of the idea of the finite element method (FEM); FEM in the design process, application of FEM.
Overview of finite elements: finite element characteristics; classification of elements
Preparation of the FE model: transition from the real structure to the discrete model, analysis of support and load conditions, ways of simplifying the model, errors in FE analysis
Preparation of a finite element mesh: element selection, mesh density - solution convergence analysis, mesh quality analysis; improving mesh quality
Discussion of basic types of analyses: stress and strain analysis (distinction between linear and nonlinear analysis; sources of nonlinearity); stability analysis (determination of critical loads and buckling modes, post-critical analysis - equilibrium path); modal analysis (determination of natural frequencies and corresponding vibration modes); thermal analysis (heat flow)
Examples of analyzes of selected structural elements; modeling of selected elements of machine parts
Contact issues
Presenting the results of the FEM analysis - preparing a report

Course topics

Lecture:
- FEM applications,
- FEM modeling in the design process,
- Finite elements and their classification, types of boundary conditions, fastenings and loads,
- preparation of the FEM model for calculations

- Basic FEM analyzes (static analysis, buckling, modal analysis, thermal analysis)
- Material models,
- Contact issues

Lab:
- cantilever beam (FEA basics, model construction, material definition, boundary conditions, solid mesh of finite elements, analysis of numerical results)
- stub pipe (related contact issues)
- thin-walled tank (FEM surface modeling)
- truss (FEM beam modeling)
- stamp (2D simplifications)
- Parametric optimization in FEM
- thermal issue

Design:
- solving the problem in various ways (3D, 2D, 1D, simplification)
- rack pole (determination of substitute parameters)
- Lame's problem (shrink contact)
- pin connections (connectors)
- welded I-beam (static analysis and buckling)
- the influence of mesh elements on the analysis results
- buckling of a slender bar (different types of support conditions)
- the influence of the notch on the stresses in the flat bar
- welded connections

Teaching methods

Lecture:
- lecture with multimedia presentation containing figures and pictures supported with examples presented on the blackboard; real time presentation of the possibilities of the FE system
- application of theoretical knowledge presented on the lecture to solve simple ingeneering problems
- during the lecture the discussion with students is initiated

Laboratory:
- solving exemplary engineering problems with the use of computer using FE system
- the presented examples and and solutions are discussedt with the students

Bibliography

Basic
1. Rakowski G., Kacprzyk Z. Metoda elementów skończonych w mechanice konstrukcji, Oficyna Wydawnicza Politechniki Warszawskiej, 2005.
2. Kurowski P.M. Finite element analysis for design engineers (2nd ed.), SAE International, Warrendale, Pa., 2017.
3. Steele J.M. Applied finite element modeling, Marcel Dekker, Inc. New York, 1989

Additional
1. Łodygowski T., Kąkol W., Metoda elementów skończonych w wybranych zagadnieniach mechaniki konstrukcji inżynierskich. WPP, Poznań, 1991.
2. Bathe K.J. Finite element procedures, Prentice-Hall, Inc., New Jersey, 1996.
3. Zienkiewicz O.C., Taylor R.L., Zhu J.Z. The finite element method: its basics and fundamentals, Elsevier Butterworth-Heinemann, New York, 2005.
4. Singiresu S., The finite element method in engineering , Elsevier Butterworth-Heinemann, New York, 2014

Breakdown of average student's workload

	Hours	ECTS
Total workload	128	5,00
Classes requiring direct contact with the teacher	52	2,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	76	3,00