COURSE DESCRIPTION CARD - SYLLABUS

Course name
FEM

Course

Field of study
Mechatronics
Year/Semester
3/5
Area of study (specialization)
-
Profile of study
general academic
Level of study
First-cycle studies
Course offered in
English
Form of study
full-time
Requirements
compulsory

Number of hours

Lecture
15
Laboratory classes
15
Other (e.g. online)
0
Tutorials
0
Projects/seminars
0

Number of credit points

2

Lecturers

Responsible for the course/lecturer:
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Faculty of Mechanical Engineegin
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Responsible for the course/lecturer:

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:

Lecture – two colloquiums during the semester, about 40 min. each, covering the knowledge presented in lectures; the condition to get credit are positive grades from both colloquiums (at least 60 % of points).

Laboratory – one colloquium at the end of the semester; reports prepared at the end of each classes.

Programme content

LECTURE

Introduction: description of methods used in structural analysis; idea of the finite element method (FEM); FEM in design process; applications of FEM

Description and classification of finite elements

Preparation of FE model: transition from an actual structure to a discrete model; analysis of support and load conditions; simplifying models; errors in FEM analysis

Mesh preparation: choice of the finite element; determining the mesh density – solution convergency analysis; mesh quality analysis; improving the mesh quality

Description of basic types of analyses: analysis of stress and displacements (linear and non-linear analysis, sources of nonlinearity); stability analysis (determining buckling loads and buckling shapes, post-buckling analysis – equilibrim path); modal analysis (determining natural frequencies and corresponding modes of vibrations); thermal analysis (heat flow)

Examples of analyses of a selected structural elements; modelling of selected machine elements

Contact problems: self-contact; bonded connections

Presenting of the results of FEM analyses – preparation of a report

LABORATORY

The use of the finite element methods do solve practical engineering problems; learning the proper modelling of supports and loads as well as the choice of a proper finite element. Solving of exemplary tasks: calculation of stresses and displacements in a beam under bending load and in a pressure vessel; stability analysis of a welded truss structure; calculation of thermal stress in a plate; optimization of stress distribution in a punch of a press tool.

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	50	2,0
Classes requiring direct contact with the teacher	30	1,0
Student's own work (literature studies, preparation for laboratory classes, preparation for tests) [1]	20	1,0

[1] delete or add other activities as appropriate