COURSE DESCRIPTION CARD - SYLLABUS

Course name

Finite Element Method

Course

Field of study

Mechanical Engineering

Area of study (specialization)

Level of study

First-cycle studies

Form of study

full-time

Year/Semester

3/5

Profile of study

general academic

Course offered in

english

Requirements

compulsory

Number of hours

Lecture

15

Tutorials

0

Laboratory classes

15

Projects/seminars

0

Other (e.g. online)

0

Number of credit points

2

Lecturers

Responsible for the course/lecturer:

dr hab. Tomasz Stręk

Institute of Applied Mechanics

Faculty of Mechanical Enginneering

ul. Piotrowo 3, 60-965 Poznań

ul Jana Pawla II 24 (CMBiN - room 438)

email: tomasz.strek (at) put.poznan.pl

Responsible for the course/lecturer:

Prerequisites

Knowledge of mathematics, mechanics, fluid mechanics, strength of materials, heat transfer and differential equations, numerical methods. Skills of logical thinking, the use of information obtained from the library and the Internet. Social competencies of understanding the need for learning and acquiring new knowledge.

Course objective

The student should obtain knowledge of theoretical and computational fundamentals for solution of basic linear and non-linear partial differential equation problems modeling and governing technical, engineering and nature problems. Theoretical and practical knowledge of computing using finite element method/analysis to solve the basic problems of linear and nonlinear scientific and technical issues described by partial differential equations (stationary and non-stationary problems).

Course-related learning outcomes

Knowledge

Has structured, theoretically founded knowledge of technical mechanics and fluid mechanics, which allows you to calculate: elements of the theory of stress and strain, laminar and turbulent flow, flows through closed and open channels, Navier-Stokes equations, heat transfer and thermoelasticity. Has basic knowledge of computational methods in mechanics, fluid mechanics and strength (FEM). Has basic knowledge of information technology and computer science in the field of computer hardware and software to support engineering work in mechanics, machine construction and technology.

Skills

Is able to obtain information from literature, databases and other properly selected sources (also in English) in the field of mechanics and machine construction as well as other engineering and technical issues consistent with the field of study; is able to integrate obtained information, interpret it, as well as draw conclusions as well as formulate and substantiate opinions.

Is able to use a mathematical apparatus to describe mechanical issues, constructions and technological processes, is able to apply known methods and mathematical models, as well as computer simulations to analyze and evaluate the operation of elements and systems in devices.

Social competences

Is aware of the importance and understanding of non-technical aspects and effects of engineering activities, including its impact on the environment and the associated responsibility for decisions.

Can interact and work in a group, taking on different roles in it.

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Lecture: Credit in writing on the basis of general questions or scores (credit in the case of obtaining 51% of points:> 50% - 3.0,> 60% - 3.5,> 70% - 4.0,> 80% - 4.5,> 90 % of points - 5.0) carried out at the end of the semester. In the case of remote work, it may be implemented in the form of a technical problem developed and solved (using FEM) described in the selected scientific publication.

Laboratory / project: Assessment on the basis of the project of the developed problem / issues in the field of content of issues performed in the laboratory exercises. The form and quality of prepared materials is assessed (description of issues, theory, method, results, analysis and literature). The prepared data will allow calculations and graphical representation of the calculations.

Programme content

Lecture: Mathematical foundations of the finite element method. The essence of FEM. Calculation stages: "preprocessing-solving-postprocessing"; model analysis, solution and analysis of results. Generalized concept of finite elements method. Boundary issues for partial differential equations. Types of boundary conditions. Solving basic initial-boundary problems. Fundamentals of heat exchange. Basic mechanisms of heat exchange. Thermo-mechanical properties of materials. Modeling and simulation of heat transfer issues. Constitutive relationships of solids for 3D and 2D models. Modeling and simulation of the problem of solid state mechanics. Modeling and simulation of natural vibration forms. Modeling and simulation of thermal deformation issues. Modeling and simulation of fluid mechanics issues.

Laboratory: Solving engineering problems in the content of the lecture in a computer program (eg Comsol Multiphysics). Computer and mathematical models (equations with initial-boundary conditions) will be prepared for the contents of the lecture presented in the laboratory.

Teaching methods

Lecture: lecture / problem lecture / lecture with multimedia presentation.

The content of the lecture is presented in the form of a multimedia presentation in combination with a classic blackboard lecture enriched with shows related to the issues presented.

Computer laboratory: project method (research, implementation, practical project) / group work / task solving.

Bibliography

Basic

O.C. Zienkiewicz , R.L. Taylor , The Finite Element Method, Volume 1-3, 5th edition, Butterworth-Heinemann, Oxford, 2000. (7th edition - 2013: https://www.elsevier.com/books/the-finite-element-method-its-basis-and-fundamentals/zienkiewicz/978-1-85617-633-0)

William B. J. Zimmerman, Multiphysics Modeling With Finite Element Methods, Series on Stability Vibration and Control of Systems, Series A - Vol. 18, 2006.

Andriy Milenin, Podstawy metody elementów skończonych. Zagadnienia termomechaniczne, Wydawnictwo AGH, 2010.

Stefan Wiśniewski, Tomasz S. Wiśniewski, Wymiana ciepła (wyd 6), PWN, Warszawa, 2017.

Adrian Bejan, Allan D. Kraus, Heat Transfer Handbook, John Wiley & Sons, Inc., Hoboken, New Jersey, 2003.

Allan F. Bower, Applied Mechanics of Solids, http://solidmechanics.org/index.html

Introduction to Structural Mechanics: https://www.comsol.com/multiphysics/introduction-to-structural-mechanics

Additional

Taler J., Duda P.: Rozwiązywanie prostych i odwrotnych zagadnień przewodzenia ciepła, WNT, Warszawa 2003.

Mechanika techniczna. Komputerowe metody ciał stałych, pod red. M. Kleibera, PWN, Warszawa, 1995.

Wiesław Pudlik, Wymina i wymienniki ciepła, Politechnika Gdańska, Gdańsk 2012 (źródło: http://pbc.gda.pl/Content/4404/wymiana-i-wymienniki-final.pdf)

Breakdown of average student's workload

	Hours	ECTS
Total workload	60	2,0
Classes requiring direct contact with the teacher	30	1,0
Student's own work (literature studies, preparation for laboratory classes/tutorials, preparation for tests/exam, project preparation) [1]	30	1,0

[1] delete or add other activities as appropriate