COURSE DESCRIPTION CARD - SYLLABUS

Course name
Finite Element Method [S1MiBM2>MES]

Course

Field of study
Mechanical Engineering

Year/Semester
2/4

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
30

Other
0

Tutorials
0

Projects/seminars
0

Number of credit points

3,00

Coordinators

Lecturers

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.
Copmuter laboratory: 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: 1) Mathematical foundations of the finite element method. The essence of MES. Calculation steps: "preprocessing-solving-postprocessing"; model analysis, solving and analysis of results. 2) Generalized concept of finite elements. 3) Solving basic initial-boundary problems described by equations of partial differential equations. 4) Initial-boundary problems for partial differential equations. Types of boundary conditions. Solid mechanics - Navier's equation and constitutive relationship for 3D problems. Modeling and simulation of natural vibration modes and system's response to harmonic excitations. 5) Basics of heat transfer. Basic mechanisms of heat exchange. Thermo-mechanical properties of materials. Modeling and simulation of heat transfer problems. Modeling and simulation of thermal deformation problems. Modeling of heat exchangers using the finite element method. 6) Types of finite elements, methods of integration in the finite element method. 7) Modeling and applications of auxetic materials. 8) Pass.
Laboratory: Solving engineering problems in the content of the lecture in a computer program (or another in the case of remote work). Computer and mathematical models (equations with initial-boundary conditions) will be prepared for the contents of the lecture presented in the laboratory.

Course topics

none

Teaching methods

Lectures: lecture / problem lecture / lecture with multimedia presentation / FEM computer software
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 labs: solving exemplary and practical problems with the use of FEM software / group work / solving tasks.

Bibliography

Basic:
Jan Sikora, Numeryczne metody rozwiązywania zagadnień brzegowych. Podstawy metody elementów

skończonych i metody elementów brzegowych, Politechnika Lubelska, 2012.
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	75	3,00
Classes requiring direct contact with the teacher	45	2,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	30	1,00