POZNAN UNIVERSITY OF TECHNOLOGY

EUROPEAN CREDIT TRANSFER AND ACCUMULATION SYSTEM (ECTS)

COURSE DESCRIPTION CARD - SYLLABUS

Course name
The multi-stage element method in technique [S2MwT1>MEWwT]

Course

Field of study
Mathematics in Technology

Year/Semester
2/3

Area of study (specialization)
Programming in Technology

Profile of study
general academic

Level of study
second-cycle

Course offered in
polish

Form of study
full-time

Requirements
compulsory

Number of hours

Lecture
30

Laboratory classes
30

Other (e.g. online)
0

Tutorials
0

Projects/seminars
0

Number of credit points

4,00

Coordinators

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Lecturers

Prerequisites

Knowledge - Basic knowledge of: variation calculus, ordinary differential equations, descriptive and spatial geometry, field theory equations (scalar field, vector field, vortex field), methods of solving large systems of equations, numerical methods in technique. Skills - The ability to program in C / C ++, Matlabie or Scilabie at the basic level, the ability to effectively self-study in a field related to the chosen field of study. Competences - Skills in team work and verbal communication, awareness of the need to expand one"s competences and knowledge, readiness to cooperate as part of a team.

Course objective

Getting to know contemporary methods of description and analysis of field phenomena occurring in technical systems and devices, including a multi-stage approach to the finite element method in relation to systems with electric, magnetic and thermal fields.

Course-related learning outcomes

Knowledge:
1. The student will have structured knowledge of numerical methods and software enabling the calculation of technical systems with the electromagnetic field.

2. The student will have knowledge in the field of analysis and synthesis of systems with electromagnetic and thermal fields.

Skills:
1. Student will be able to use known methods and field models to analyze and synthesize simple technical systems, in particular systems with electromagnetic field and heat field.
2. Student will be able to prepare a study on the numerical calculations of transducers and technical systems using professional software.

Social competences:
1. The student will be aware of the value of their own work, is able to comply with the principles of teamwork, bears responsibility for the jointly implemented task.
2. The student will be able to identify a given problem and indicate the correct way to solve it in the subject.

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Learning outcomes presented above are verified as follows:
Lecture:
-assessment of knowledge and skills by the completion of a written test (solving problem),
-continuous evaluation for each course (rewarding activity and quality of the expression).
Laboratory:
- test and rewarding of knowledge necessary to carry out subsequent tasks in class,
- continuous assessment of the student"s activity and the increase of his knowledge and skills, as well as social competences related to team work,
- assessment of knowledge and skills related to the implementation of tasks, assessment of reports on the completed task.
Extra points for the activity in the classroom, and in particular for:
-discussion and proposition of additional aspects of the subjects,
-effectiveness of the application of the knowledge gained during solving the given problem,
-ability to work within a team, which performs the task detailed at the laboratory,
-quality and diligence of the developed reports.

Programme content

Field methods for describing phenomena in technology. The equations describing the electromagnetic and thermal fields: differential, integral and differential forms of notation of field equations. Methods for analyzing systems with electric, magnetic and thermal fields, wording using potentials. Two-dimensional field (2D). Three-dimensional field (3D). Finite Element Method - multi-stage approach: Types of finite elements: triangular, quadrangular, tetrahedral, pentagonal, hexagonal. Interpolating functions of node, edge, wall and volume element. Relations between interpolation functions of a multistage element. Boundary conditions for electromagnetic and thermal fields. Numerical methods for solving the FEM equation: (singular matrices, regular matrices, Coulomb calibration condition). Graphs and mesh models of finite element and system divided into finite elements, Mesh representation of FEM equations, Professional software for electromagnetic field analysis in electrical devices

Teaching methods

Lectures - presentation of issues using multimedia, illustrated with examples given on a board, discussion of problem issues.
Laboratory - calculating the value of interpolation functions of finite elements, simulation tests of systems with the field: electric, magnetic and thermal - using computer hardware and Matlab software (optional Scilab)

Bibliography

Basic
1. Mazur D., Gołębiowski M., Rudy M., Modelowanie i analiza układów elektromechanicznych metodą elementów skończonych, Oficyna Wydawnicza Politechniki Rzeszowskiej, 2016
2. Balderes T. Finite element method, AccessScience, 2014.

3. Zienkiewicz O., Taylor R, Zhu J., The Finite Element Method: Its Basis and Fundamentals, Butterworth-Heinemann, 2013.
4. Michalski W., Podstawy teorii pola elektromagnetycznego. Statyczne pola elektryczne i magnetyczne, Oficyna Wydawnicza Politechniki Wrocławskiej, 2013.
5. Meunier G., The Finite Element Method for Electromagnetic Modeling, London - WILEY, 2008.
6. Demenko A., Obwodowe modele układów z polem elektromagnetycznym, WPP, Poznań, 2004.
7. Bossavit A., Computational electromagnetism, variational formulations, complementarity, edge element method, Academic Press Limited, London, 1998
Additional
1. Feynman L. S., Feynmana wykłady z fizyki. Elektrodynamika, fizyka ośrodków ciągłych, t. 2.2, PWN Warszawa 2012
2. Sikora J., Numeryczne metody rozwiązywania zagadnień brzegowych, WUPL., Lublin 2009
3. Dolezel I., Karban P., Solin P., Integral methods in low-frequency electromagnetics, Wiley and Son, New Jersey, 2009

Breakdown of average student's workload

	Hours	ECTS
Total workload	105	4,00
Classes requiring direct contact with the teacher	60	2,50
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	45	1,50