POZNAN UNIVERSITY OF TECHNOLOGY

EUROPEAN CREDIT TRANSFER AND ACCUMULATION SYSTEM (ECTS)

COURSE DESCRIPTION CARD - SYLLABUS

Course name
Technical Electrodynamics [N1Eltech1>ET]

Course

Field of study
Electrical Engineering

Year/Semester
4/8

Area of study (specialization)
–

Profile of study
general academic

Level of study
first-cycle

Course offered in
Polish

Form of study
part-time

Requirements
compulsory

Number of hours

Lecture
10

Laboratory classes
20

Other
0

Tutorials
0

Projects/seminars
0

Number of credit points

3,00

Coordinators

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Lecturers

Prerequisites

Knowledge - Elementary knowledge of electrical engineering, electromagnetic field theory, electrical machines and numerical methods. Skills - The skill of effective self-education in a field related to the chosen major of studies, the skill to make a right decisions to solve simple problems related to the theory of the electromagnetic field, the ability to use Windows OS. Competences - Student is aware of the widening his competence, demonstrate a willingness to work in a team, the ability to comply with the rules in force on the lecture and laboratory.

Course objective

The student should obtain knowledge of the description and analysis of electromagnetic phenomena in electrical devices as well as knowledge of finite element method in electromagnetism.

Course-related learning outcomes

Knowledge:

1. The student has a basic knowledge of technical electrodynamics
2. The student has structured knowledge of numerical methods and software for the numerical calculation of electromagnetic transducers.

Skills:
1. The student will be able to use known methods and models for field analysis and synthesis of simple systems with the electromagnetic field
2. The student will be able to prepare a report on the numerical calculations of electromechanical transducers and systems with the electromagnetic field using professional software.

Social competences:
1. The student is aware of the value of his work, respect the principles of teamwork, takes responsibility for collaborative work.
2. The student is able to identify the problem and choose the correct way to solve the subject of electrodynamics.

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 lecture (rewarding activity and quality of the expression).

Laboratory:
- end 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

Lecture:
1. Basic laws of electromagnetism
2. Models of electromagnetic devices
3. Computer methods for solving circuit models
4. Electromagnetic field
5. Two-dimensional electromagnetic field
6. Methods of solving field equations
7. Finite Element Method (FEM)
8. Commercial software

Lab:
1. Simulation of the operating states of an alternating current electromagnet,
2. Simulation of dynamic states of an electromagnetic transducer with rotational motion,
3. Testing of material parameters in the solenoid - conductive core system,
4. Testing the characteristics of the eddy current torque transmission system
5. Construction of numerical models of electromechanical transducers in the following programs: (to choose from) Maxwell, FEMM, Magnet, CST Studio Suite
6. Simulation of the influence of material parameters and dimensions on the field distribution electromagnetic choke with air gap,
7. Simulation tests of electromagnetic screens.

Course topics

Lecture:
1. Basic laws of electromagnetism:
- review of the basics of electromagnetism and electric machines,
- Ampere's law,
- Gauss's law,
- Faraday's law,
- Lorenz force,
- equations describing the electromagnetic field: differential, integral and differential forms of field equations.

2. Models of electromagnetic devices:
- peripheral models,
- peripheral and field models,
- field and peripheral models,
- field models.

3. Computer methods for solving circuit models:
- explicit and implicit numerical schemes,
- forward/reverse Euler diagram
- Crank-Nicholson diagram,
- example.

4. Electromagnetic field - field models:
- field methods of describing electromagnetic phenomena,
- boundary conditions in the electric and magnetic field,
- methods of analyzing systems with electromagnetic fields,
- formulations using potentials.

5. Two-dimensional electromagnetic field:
- methods of analyzing two-dimensional electro- and magnetostatic fields,
- two-dimensional equations of a time-varying field,
- systems with induced (eddy) currents,
- integral methods,
- boundary element method,
- finite difference method,
- finite element method,
- mesh models of systems with electric and magnetic fields.

6. Methods for solving field equations:
- analytical methods (accurate),
- iterative methods.
- method: LLT, Cholewski, SOR, ICCG,
- methods of solving singular and non-singular field equations.

7. Finite Element Method (FEM):
- energy functional,
- formulating FEM equations,
- space discretization,
- definition of field sources,
- calculation of the flux associated with the winding,
- calculation of electromagnetic forces and moments.

8. Commercial software (selected):
- CST Studio Suite,
-Maxwell,
- FEMM.

Teaching methods

Lectures - presentation of issues using multimedia, illustrated with examples given on a board, discussion of problem issues.

Laboratory - implementation of simulation and laboratory tests of electromagnetic fields in electrical devices.

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	85	3,00
Classes requiring direct contact with the teacher	35	1,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	50	2,00