POZNAN UNIVERSITY OF TECHNOLOGY

EUROPEAN CREDIT TRANSFER AND ACCUMULATION SYSTEM (ECTS)

COURSE DESCRIPTION CARD - SYLLABUS

Course name
Technical Electrodynamics [S1Eltech1P>ET]

Course

Field of study	Year/Semester
Electrical Engineering	3/6
Area of study (specialization)	Profile of study
–	practical
Level of study	Course offered in
first-cycle	Polish
Form of study	Requirements
full-time	compulsory

Number of hours

Lecture	Laboratory classes	Other (e.g. online)
15	30	0
Tutorials	Projects/seminars	
0	0	

Number of credit points

3,00

Coordinators

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Lecturers

Prerequisites

Knowledge - Basic knowledge in the field of electrical engineering, electromagnetic field theory and computer science. Skills - The ability to effectively self-educate in the field related to the chosen field of study; the ability to make the right decisions when solving simple tasks and problems in the field of electromagnetic field theory, the ability to use the system Windows operating system at a general level. Competences - The student is aware of expanding his competences, shows readiness to work in a team, the ability to comply with the rules in force during lectures and laboratory classes.

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

none

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Lectures - presentation of issues with the use of multimedia, illustrated with examples given on the board, discussion of problematic issues.

Laboratory - implementation of simulation and laboratory tests of systems with an electromagnetic field.

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

Lababoratory:
1. Testing the magnetic properties of materials,
2. Simulation of the operating states of an alternating current electromagnet,
3. Simulation of dynamic states of an electromagnetic transducer with rotational motion,
4. Simulation and testing of the operating states of a transformer with a toroidal core,
5. Testing of material parameters in the solenoid - conductive core system,
6. Testing the characteristics of the eddy current torque transmission system,
7. Testing the electromotive force of transformation and rotation.
8. Construction of numerical models of electromechanical transducers in the following programs (to choose): CST Studio Suite, Maxwell, FEMM, Magnet,
9. Simulation of the influence of material parameters and dimensions on the field distribution
10. Simulation studies of electromagnetic shields.

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,
-Maxwell

Teaching methods

Lectures - presentation of issues with the use of multimedia, illustrated with examples given on the board, discussion of problematic issues.

Laboratory - implementation of simulation and laboratory tests of systems with an electromagnetic field.

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, ButterworthHeinemann, 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
8. Nowak L., Modele polowe przetworników elektromechanicznych w stanach nieustalonych, WPP, Poznań, 1999.

Additional
1. Sikora J., Numeryczne metody rozwiązywania zagadnień brzegowych, WUPL., Lublin 2009,
2. Dolezel I., Karban P., Solin P., Integral methods in low-frequency electromagnetics, Wiley and Son, New Jersey, 2009,
3. Turowski J., Elektrodynamika techniczna, Wyd.II, WNT, Warszawa, 1993,
4. Binns K., Lawrenson P., Trowbridge C., The analytical and numerical solution of electric and magnetic fields, John Wiley and Sons, 1992.

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