POZNAN UNIVERSITY OF TECHNOLOGY

EUROPEAN CREDIT TRANSFER AND ACCUMULATION SYSTEM (ECTS)

COURSE DESCRIPTION CARD - SYLLABUS

Course name

Modelling of coupled phenomena in electromagnetic transducers [S2Elmob1-SPE>MZSwPE]

Course

Field of study

Electromobility

Year/Semester

1/2

Area of study (specialization)

Energy Processing Systems

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

0

Laboratory classes

30

Other

0

Tutorials

0

Projects/seminars

0

Number of credit points

2,00

Coordinators

dr hab. inż. Rafał Wojciechowski prof. PP
rafal.wojciechowski@put.poznan.pl

dr hab. inż. Mariusz Barański
mariusz.baranski@put.poznan.pl

Lecturers

Prerequisites

Knowledge - the student starting this subject should have in-depth knowledge of computer science, physics, thermodynamics, principles of operation and methods of simulation of electromechanical transducers in particular electrical machines. The student should have knowledge of: differential and integral calculus at the general level, finite element methods and methods of analysis of systems with electric, magnetic, thermal and mechanical fields. Skills - the student starting this subject should have the ability to effectively self-educatein the field related to the chosen field of study; ability to make the right decisions when solving tasks and formulating problems in the field of creating models of electromagnetic transducers from the area of electromobility based on real data using professional FEM packages. Competences - the student is aware of expanding their competences demonstrates readiness to solve research and practical problems and, if necessary, with expert advice.

Course objective

Acquire knowledge on numerical modeling in 2D and 3D of coupled electric, magnetic, mechanical and thermal fields in the time domain and frequency domain using the finite element method and specialized FEM software. Planning and conducting experimental research on the measurement of electrical and non-electrical quantities of electromagnetic and electromechanical transducers in electric and hybrid vehicle systems.

Course-related learning outcomes

Knowledge:
1. The student has in-depth knowledge of magnetic and electro-insulating materials, as well as of phenomena coupled in systems with electric, magnetic, thermal and mechanical fields.
2. The student has knowledge of development trends, new developments in the field of electromobility and the dilemmas of contemporary civilisation, in particular with regard to the environmental impact of changes in vehicle fuelling.
3. The student has extended and deepened knowledge in the field of modelling, analysis and synthesis of elements and systems characteristic for hybrid and electric vehicles including traction vehicles.

Skills:
1. The student can use the knowledge of new technical and technological achievements in special devices and devices in the field of electromobility.
2. The student can plan and carry out computer experiments and measurements of electrical and non-electrical quantities in systems of electric and hybrid devices and their charging infrastructure.

Social competences:
1. The student is aware of the importance of the latest scientific and technical achievements in solving research and practical problems and, if necessary, supporting themselves with expert opinions.

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Laboratory exercises:
- rewarding the knowledge necessary to implement the problems in a given area of laboratory tasks,
- rewarding the increase in the ability to use the learned rules and methods when solving current problem tasks,
- assessment of knowledge and skills related to the implementation of the exercise task developed in the form of a report/report.
Obtaining additional points for activity during classes, in particular for:
- proposing to discuss additional aspects of the issue,
- the ability to cooperate within a team practically implementing a detailed task in the laboratory.

Programme content

Numerical modeling of attached electric, magnetic, mechanical and thermal fields in time and frequency domain using finite methods and attached packages FEM, Maxwell, Magnet.

Course topics

Field-circuit models of electromagnetic transducers in 2D and 3D. Planning and conducting experimental research, including measurements of electrical and non-electrical quantities in drive systems, electric and hybrid devices.
Systems and diagrams for determining electromagnetic forces and moments as well as magnetic field distributions; systems and equipped with a heating chamber up to 250 degC and resistance sensors and thermocouples, pyrometers and a infrared thermal imaging camera for measuring the temperature of electromechanical transducers. LabVIEW card and measurement environment. Create models based on real data with FEM packages included. Analysis and interpretation of obtained field distributions connected with electromagnetic transducers..

Teaching methods

Laboratories:

- multimedia presentation of instructions for performing exercises
- detailed review of reports by the instructor, discussion,
- demonstrations,
- work in teams.

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.
8. Nowak L., Modele polowe przetworników elektromechanicznych w stanach nieustalonych, WPP, Poznań, 1999.
9. Gasiak G., Metody numeryczne w mechanice, Metoda elementów skończonych. Wydaw. Politechniki Opolskiej, 1997.
10. Pełczewski W., Zagadnienia cieplne w maszynach elektrycznych, Warszawa : Państwowe Wydawnictwo Techniczne, 1956.

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.
5. Comparative analysis of the power parameters of a line-start permanent magnet synchronous motor using professional FEM packages and in-house software, Mariusz Barański, Archives of Electrical Engineering, 2023, vol. 72, no. 2, s. 585 -596
6. FE analysis of coupled electromagnetic-thermal phenomena in the squirrel cage motor working at high ambient temperature, Mariusz Barański, COMPEL - The International Journal for Computation and Mathematics in Electrical and Electronic Engineering, 2019, vol. 38, no. 4, s. 1120-113
7. Experimental and Simulation Studies of Partial Demagnetization Process of Permanent Magnets in Electric Motors, Mariusz Barański, Wojciech Szeląg , Wiesław Łyskawiński, IEEE Transactions on Energy Conversion - 2021, vol. 36, no. 4, s. 3137-3145
8. Coupled Field Analysis of Phenomena in Hybrid Excited Magnetorheological Fluid Brake, Wojciech Szeląg, Cezary Jędryczka, Adam Myszkowski, Rafał M. Wojciechowski, Sensors - 2023, vol. 23, iss. 1, s. 358-1-358-18
9. Analysis of the Distributions of Displacement and Eddy Currents in the Ferrite Core of an Electromagnetic Transducer Using the 2D Approach of the Edge Element Method and the Harmonic Balance Method, Wojciech Ludowicz, Rafał M. Wojciechowski, Energies - 2021, vol. 14, no. 13, s. 3980-1-3980-21

Breakdown of average student's workload

	Hours	ECTS
Total workload	55	2,00
Classes requiring direct contact with the teacher	30	1,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	25	1,00