COURSE DESCRIPTION CARD - SYLLABUS

Course name
Modeling of coupled phenomena [S2Elmob1>MZS]

Course

Field of study
Electromobility

Year/Semester
1/1

Area of study (specialization)
–

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
15

Other (e.g. online)
0

Tutorials
0

Projects/seminars
0

Number of credit points

3,00

Coordinators

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Lecturers

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Prerequisites

Knowledge - Basic knowledge in the field of electrical engineering, electronics, electromagnetic field theory, electrodynamics, electrical machines, mechanics, thermodynamics 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 circuit theory, electrical machines, mechanics and thermodynamics. 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.

Course objective

Getting to know the methods of description and analysis of electrodynamic, electromagnetic, thermal and mechanical phenomena in devices and systems used in electromobility, including finite element methods in relation to systems with a magnetic field

Course-related learning outcomes

Knowledge:
1. The student has extended and deepened knowledge in the field of field theory: electric, magnetic, thermal and mechanics.
2. The student has a structured and in-depth knowledge of numerical methods and software for calculating transducers and devices used in electromobility.

Skills:
1. The student was able to use the acquired knowledge about the latest technical achievements in the design of devices and systems in the field of electromobility.
2. The student was able to prepare a study on numerical calculations of electromechanical converters and systems with electromagnetic, thermal and mechanical fields using professional software.
3. The student was able to plan and carry out an experiment involving computer simulations and measurements in systems used in electromobility.

Social competences:
1. Student ma świadomość wartości własnej pracy, potrafi podporządkować się zasadom pracy w zespole, ponosi odpowiedzialność za wspólnie realizowane zadanie
2. Student potrafi zidentyfikować dany problem i wskazać prawidłowy sposób jego rozwiązania w zakresie przedmiotu.

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Lecture:
-assessment of knowledge and skills demonstrated in a problem-based written test,
- continuous assessment during each class (rewarding activity and quality of speech).
Lab:
- test and rewarding of knowledge necessary to carry out subsequent laboratory exercises,
- continuous assessment of the student's activity during classes and the increase of his knowledge and skills, as well as social competences related to working in a team,
-assessment of knowledge and skills related to the implementation of laboratory tasks, evaluation of the report on the exercise performed.
Obtaining additional points for activity during classes, in particular for:
- preparing answers to questions and problem tasks given by the lecturer,
- the effectiveness of applying the acquired knowledge when solving a given research problem,
- the ability to cooperate within a team practically implementing a detailed task in the laboratory

Programme content

Field methods of describing phenomena in technology. Equations describing the electromagnetic, thermal and structural fields. Methods of analysis of systems with electric, magnetic, thermal and mechanical fields. Phrases using potentials. Two-dimensional (2D) field. Three-dimensional (3D) field. Finite Element Method - multi-stage approach. Interpolation functions and their relationships between interpolation functions of a multi-stage element. Boundary conditions. Numerical methods of solving FEM equation: (singular matrices, regular matrices, Coulomb calibration condition). Graphs and mesh models of a finite element and a system divided into finite elements. Grid representation of FEM equations. Professional software for the analysis of coupled phenomena in devices and systems.

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 electromagnetic, thermal and mechanical fields

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. Lewis R. W., Morgan K.,Thomas H., Seetharamu S., The Finite Element Method in Heat Transfer Analysis, Wiley Publisher, 1996.
11. 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.

Breakdown of average student's workload

	Hours	ECTS
Total workload	77	3,00
Classes requiring direct contact with the teacher	47	2,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	30	1,00