STUDY MODULE DESCRIPTION FORM

Name of the module/subject		Code
Computer methods in electrodynamics		**1010322331010301539**

Field of study	Profile of study (general academic, practical)	Year /Semester
Electrical Engineering	**general academic**	**2 / 3**
Elective path/specialty	Subject offered in:	Course (compulsory, elective)
Electrical Systems in Mechatronics	**Polish**	**obligatory**

Cycle of study:	Form of study (full-time,part-time)
Second-cycle studies	**full-time**

No. of hours					No. of credits
Lecture: **15**	Classes: **-**	Laboratory: **-**	Project/seminars: **15**		**3**

Status of the course in the study program (Basic, major, other)	(university-wide, from another field)
major	**from field**

Education areas and fields of science and art	ECTS distribution (number and %)
technical sciences	**3 100%**
Technical sciences	**3 100%**

Responsible for subject / lecturer:

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Responsible for subject / lecturer:

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Prerequisites in terms of knowledge, skills and social competencies:

1	**Knowledge**	Knowledge of electromagnetic field theory, electrical engineering, and computer science electrodynamics. Basic knowledge of numerical methods for solving equations of the electromagnetic circuit and electromagnetic field problems.
2	**Skills**	Programming skills in C++ and Pascal at the basic level, familiarity with programs for numerical analysis of electromechanical transducers at the basic level, The skill of effective self-education in a field related to the chosen major of studies.
3	**Social competencies**	Skills in teamwork and proper verbal communication, the awareness of the need to broaden their skills and knowledge.

Assumptions and objectives of the course:

-Familiarization with the current knowledge of the recent methods used in electromagnetic field simulations of the nowadays electromechanical converters.

Study outcomes and reference to the educational results for a field of study

Knowledge:

1. The student has structurally organized knowledge of the numerical methods and software for the calculation of electromagnetic transducers using finite element method - [K_W01+++; K_W02+++]

2. The student has knowledge about computer methods for the analysis of systems with the electromagnetic field - [K_W02+++; K_W03+]

Skills:

1. The student will know how to use numerical methods for modeling phenomena in electromechanical transducers - [K_U03+; K_U07++]

2. The student will be able to prepare a study on the numerical calculations of electromechanical transducers and systems with electromagnetic field using professional software - [K_U09+++]

Social competencies:

1. The student is aware of the value of his work, respect the principles of teamwork, takes responsibility for collaborative work - [K_K02++]

Assessment methods of study outcomes

Lecture:
-assessment of knowledge and skills listed on the completion of a written,
-continuous evaluation for each course (rewarding activity and quality of the expression).

Laboratory:
- end test and favoring the knowledge necessary to complete tasks during laboratory,
- continuous evaluation for each course - rewarding gain skills,
- assessment of skills related to the practical implementation of lecture knowledge to solve laboratory tasks,
- evaluation of the reports from performed exercise.

Extra points for the activity in the classroom, and in particular for:
-discussion 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.

Course description

Electromagnetic field equations in regions with conducting and displacement currents. Differential and integral description of field equations. Circuit models of electromagnetic field. Plane wave. Penetration of an electromagnetic wave into a conducting region. Electromagnetic and magnetic shielding. Methods of field calculations. Field and potential formulations. Analogy between methods of circuit and field analysis. Numerical method of electromagnetic field analysis in electrical machines and apparatus. Finite element method - unified approach. Interpolation functions of nodal, edge, facet and volume element. Finite element graphs and circuit models of finite elements. Network representation of finite equations in the region with displacement and eddy currents. Finite element solution of eddy current problems. Simulation of the movement in the finite element analysis of electromagnetic converters. Updated 2017: Methods describing the filamentary winding electrical machines. The applied methods of education: lectures - presentation of issues using multimedia resources, discussion of problematic tasks; laboratory - implementation of simulation and laboratory tests of electromagnetic fields.

Basic bibliography:

1. Mazur D., Gołębiowski M., Rudy M., Modelowanie i analiza układów elektromechanicznych metodą elementów skończonych, Oficyna Wydawnicza Politechniki Rzeszowskiej, 2016
2. Feynman L. S., Feynmana wykłady z fizyki. Elektrodynamika, fizyka ośrodków ciągłych, t. 2.2, PWN Warszawa 2012
3. Sikora J., Numeryczne metody rozwiązywania zagadnień brzegowych, WUPL., Lublin 2009
4. Demenko A., Obwodowe modele układów z polem elektromagnetycznym, WPP, Poznań, 2003
5. Joao Bastos, Nelson Sadowski, Electromagnetic Modeling by Finite Element Methods, Marsel Dekker Inc., 2003
6. Nowak L., Modele polowe przetworników elektromechanicznych w stanach nieustalonych, WPP, Poznań, 1999
7. Bossavit A., Computational electromagnetism, variational formulations, complementarity, edge element method, Academic Press Limited, London, 1998

Additional bibliography:

1. Jian-Ming J., Theory and Computation of Electromagnetic Fields, John WileyandSons, 2010
2. Dolezel I., Karban P., Solin P., Integral methods in low-frequency electromagnetics, WileyandSon, New Jersey, 2009
3. Binns K., Lawrenson P., Trowbridge C., The analytical and numerical solution of electric and magnetic fields, John WileyandSons, 1992
4. Demenko A., Symulacja dynamicznych stanów pracy maszyn elektrycznych w ujęciu polowym, WPP, Poznań, 1997

Result of average student's workload

Activity	Time (working hours)
1. Lectures	15
2. Project classes	15
3. Participate in the consultations	20
4. Implementation of project tasks	18
5. Preparation for project classes	5

Student's workload

Source of workload	hours	ECTS
Total workload	73	3
Contact hours	50	2
Practical activities	38	1