STUDY MODULE DESCRIPTION FORM

Name of the module/subject		Code
Technical Electrodynamics		**1010311361010304777**

Field of study	Profile of study (general academic, practical)	Year /Semester
Electrical Engineering	**general academic**	**3 / 6**

Elective path/specialty	Subject offered in:	Course (compulsory, elective)
Electric Power Systems	**Polish**	**obligatory**

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

No. of hours	No. of credits
Lecture: **15** Classes: **-** Laboratory: **30** Project/seminars: **-**	**3**

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

Dr inż. Rafał M. Wojciechowski
email: rafal.wojcieiechowski@put.poznan.pl
tel. 48 061 665 23 96
Electrical Engineering
ul. Piotrowo 3a, 60-965 Poznań

Responsible for subject / lecturer:

Prof. dr hab inż. Andrzej Demenko
email: andrzej.demenko@put.poznan.pl
tel. 48 061 665 21 26
Electrical Engineering
ul. Piotrowo 3a, 60-965 Poznań

Prerequisites in terms of knowledge, skills and social competencies:

1	**Knowledge**	Elementary knowledge of electrical engineering, electromagnetic field theory, electrical machines and numerical methods.
2	**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.
3	**Social competencies**	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.

Assumptions and objectives of the course:

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.

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

Knowledge:

1. The student has a basic knowledge of technical electrodynamics - [K_W02++; K_W06+++]
2. The student has structured knowledge of numerical methods and software for the numerical calculation of electromagnetic transducers - [K_W02+++; K_W06+++; K_W12+]

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 - [K_U10++; K_U11+++]
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 - [K_U08++]

Social competencies:

1. The student is aware of the value of his work, respect the principles of teamwork, takes responsibility for collaborative work - [K_K03++]
2. The student is able to identify the problem and choose the correct way to solve the subject of electrodynamics - [K_K06++]

Assessment methods of study outcomes

Lecture:
-assessment of knowledge and skills by the completion of a written test (solving problem),
-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 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.

Course description

The field approach in the description of electromagnetic phenomena. Differential, integral and circuit forms of electromagnetic field equations. Boundary conditions. Two dimensional (2D) fields. Methods of electromagnetic field analysis, field and potential formulations. Integral and finite difference methods of 2D electro and magnetostatic field analysis. Finite element method. Network models of systems with magnetic and electric field. Inducted currents. Electromagnetic shields. Field method of electromagnetic torques and forces calculation. Updated 2017: Methods describing the filamentary winding electrical machines using the electric potential vector T0. Electromagnetic levitation. Equations of 2D transient field. Numerical methods of solving diffusion equation. Implicit and explicit schemes, Crank-Nicholson method. Professional software for electromagnetic field analysis in electrical devices. 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. Michalski W., Podstawy teorii pola elektromagnetycznego. Statyczne pola elektryczne i magnetyczne, Oficyna Wydawnicza Politechniki Wrocławskiej, 2013
3. Feynman L. S., Feynmana wykłady z fizyki. Elektrodynamika, fizyka ośrodków ciągłych, t. 2.2, PWN Warszawa 2012
4. Brzezowska J., Gajewski A., Wprowadzenie do elektrodynamiki klasycznej, WPK, Kraków, 2010
5. Demenko A., Obwodowe modele układów z polem elektromagnetycznym, WPP, Poznań, 2004
6. Bastos J., Sadowski J., Electromagnetic Modeling by Finite Element Methods, Marsel Dekker Inc., 2003
7. Nowak L., Modele polowe przetworników elektromechanicznych w stanach nieustalonych, WPP, Poznań, 1999
8. Bossavit A., Computational electromagnetism, variational formulations, complementarity, edge element method, Academic Press Limited, London, 1998
9. Demenko A., Symulacja dynamicznych stanów pracy maszyn elektrycznych w ujęciu polowym, WPP, Poznań, 1997
10. Turowski J., Elektrodynamika techniczna, Wyd.II, WNT, Warszawa, 1993

Additional bibliography:

1. Jian-Ming J., Theory and Computation of Electromagnetic Fields, John Wiley and Sons, 2010
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
4. Binns K., Lawrenson P., Trowbridge C., The analytical and numerical solution of electric and magnetic fields, John Wiley and Sons, 1992

Result of average student's workload

Activity	Time (working hours)
1. Lectures	15
2. Laboratories	30
3. Participate in the consultations on the lecture	3
4. Participate in the consultations on the laboratories	5
5. Preparation for laboratory	15
6. Homework preparation	20

Student’s workload

Source of workload	hours	ECTS
Total workload	88	3
Contact hours	53	2
Practical activities	65	2