STUDY MODULE DESCRIPTION FORM

Name of the module/subject **Technical Electrodynamics**			Code **1010314381010324777**
Field of study **Electrical Engineering**	Profile of study (general academic, practical) **(brak)**		Year /Semester **4 / 8**
Elective path/specialty **Networks and Electric Power Systems**	Subject offered in: **Polish**		Course (compulsory, elective) **obligatory**
Cycle of study: **First-cycle studies**	Form of study (full-time,part-time) **part-time**		
No. of hours Lecture: **8** Classes: **-** Laboratory: **13** Project/seminars: **-**			No. of credits **3**
Status of the course in the study program (Basic, major, other) **(brak)**	(university-wide, from another field) **(brak)**		
Education areas and fields of science and art **technical sciences** **Technical sciences**			ECTS distribution (number and %) **3 100%** **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. 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.

Basic bibliography:

1. Feynman L. S., Feynmana wykłady z fizyki. Elektrodynamika, fizyka ośrodków ciągłych, t. 2.2, PWN Warszawa 2012
2. Brzezowska J., Gajewski A., Wprowadzenie do elektrodynamiki klasycznej, WPK, Kraków, 2010
3. Demenko A., Obwodowe modele układów z polem elektromagnetycznym, WPP, Poznań, 2004
4. Bastos J., Sadowski J., Electromagnetic Modeling by Finite Element Methods, Marsel Dekker Inc., 2003
5. Nowak L., Modele polowe przetworników elektromechanicznych w stanach nieustalonych, WPP, Poznań, 1999
6. Bossavit A., Computational electromagnetism, variational formulations, complementarity, edge element method, Academic Press Limited, London, 1998
7. Demenko A., Symulacja dynamicznych stanów pracy maszyn elektrycznych w ujęciu polowym, WPP, Poznań, 1997
8. Turowski J., Elektrodynamika techniczna, Wyd.II, WNT, Warszawa, 1993
9. Feynman L. S., Feynmana wykłady z fizyki. Elektrodynamika, fizyka ośrodków ciągłych, t. 2.2, PWN Warszawa 2012
10. Brzezowska J., Gajewski A., Wprowadzenie do elektrodynamiki klasycznej, WPK, Kraków, 2010
11. Demenko A., Obwodowe modele układów z polem elektromagnetycznym, WPP, Poznań, 2004
12. Bastos J., Sadowski J., Electromagnetic Modeling by Finite Element Methods, Marsel Dekker Inc., 2003
13. Nowak L., Modele polowe przetworników elektromechanicznych w stanach nieustalonych, WPP, Poznań, 1999
14. Bossavit A., Computational electromagnetism, variational formulations, complementarity, edge element method, Academic Press Limited, London, 1998
15. Demenko A., Symulacja dynamicznych stanów pracy maszyn elektrycznych w ujęciu polowym, WPP, Poznań, 1997
16. 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
5. Jian-Ming J., Theory and Computation of Electromagnetic Fields, John Wiley and Sons, 2010
6. Sikora J., Numeryczne metody rozwiązywania zagadnień brzegowych, WUPL., Lublin 2009
7. Dolezel I., Karban P., Solin P., Integral methods in low-frequency electromagnetics, Wiley and Son, New Jersey, 2009
8. 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 2. Laboratories 3. Participate in the consultations on the lecture 4. Participate in the consultations on the laboratories 5. Preparation for laboratory 6. Homework preparation	8 13 5 12 8 22

Student's workload

Source of workload	hours	ECTS
Total workload	68	3
Contact hours	38	1
Practical activities	43	1