STUDY COURSE DESCRIPTION FORM

Name of the course	Code
Numerical methods of electromagnetic field analysis	
Name of the doctoral school	Year /Semester
Poznan University of Technology Doctoral School	**….**
Specialty/Discipline	Type (obligatory, elective):
Automation, electronic and electrical engineering	**elective**
No. of hours	No. of credits
Lectures: **4** Classes: **-** Laboratories: **-** Seminars: **-**	**1**

Cycle of study:	**Form of study:**	**Assessment:** (written exam, presentation, etc.)
Third-cycle studies (Polish Qualifications Framework level eight)	Full-time	Written exam

Responsible for the course/lecturer:

prof. dr hab. inż. Wojciech Szeląg / dr hab. inż. Cezary Jędryczka
e-mail: wojciech.szelag@put.poznan.pl / cezary.jedryczka@put.poznan.pl
phone : +48 61 665 2116/2396
Faculty of Control, Robotics, and Electrical Engineering
Poznan University of Technology
Piotrowo street 3a, 60-965 Poznan, Poland

Prerequisites in terms of knowledge, skills and social competencies:

1	**Knowledge:** The student has knowledge about methods describing systems with electromagnetic field and knowledge about numerical methods for solving partial differential equations in electromagnetism.
2	**Skills:** The student is able to describe electromagnetic field and to form numerical, finite difference schemes for electromagnetic field equations.
3	**Social competencies:** The student is aware that in conducting research he/she must abide by the code of ethics for electric al engineering and information engineering.

Objectives of the course:

Acquiring knowledge of models to describe devices and systems with electromagnetic field, mainly the models using numerical schemes, as well as mastering the principles of finite element method and the analogy between the methods of circuit analysis and the discrete methods of electric and magnetic field analysis. Background knowledge about professional FEM packages, Ansys, MagNet and Comsol.

Educational results (Study outcomes)

Knowledge:

P8S_WG	The student knows the views and opinions presented in the literature on electrical engineering and on numerical method and models used in the analysis and designing the devices with electromagnetic field of low frequency.	**SzD_W01**
P8S_WG	The student has advanced knowledge about development trends in the area of electrical engineering and can elaborate the numerical methods of electromagnetic field description in electromagnetic devices.	**SzD_W03**

Skills:

P8S_UW	The student is able to properly match numerical methods for the analysis of electromagnetic field in the systems that are studied in the PhD thesis.	**SzD_U02**
P8S_UK	The student can make use, in advanced way, of databases containing commercial software for electromagnetic field calculation as well as to evaluate the available results of electromagnetic field calculation and application of finite element method.	**SzD_U04**
P8S_UK	The student is able to present a paper at technical/scientific conference in his/her native language and in at least one foreign language, in the area of computer methods of electromagnetic field analysis.	**SzD_W08**
Social competencies:		
P8S_KK	The student is able to popularize, in accessible way, scientific and technical achievements in electrical engineering and information engineering.	**SzD_K03**

Compulsory literature:

1. K.J. Binns, P.J. Lawrenson, C.W. Trowbridge, The Analytical and Numerical Solution of Electric and Magnetic Fields, John Wiley & Sons 1992.
2. Jin, Jianming,: The Finite Element Method in Electromagnetics, 3rd edition, Wiley-IEEE Press, 2014.
3. Zienkiewicz O., Taylor R., Zhu J.: The Finite Element Method: Its Basis and Fundamentals. In: The Finite Element Method: its Basis and Fundamentals (Seventh Edition), Butterworth-Heinemann, Oxford, seventh edition ed., 2013, ISBN 978-1-85617-633-0.

Additional literature:

1. Meunier G. (editor), The Finite Element Method for Electromagnetic Modeling, ISBN: 978-1-848-21030-1 November 2008 Wiley-ISTE, 832 pages.
2. Polycarpou, A. Introduction to the finite element method in electromagnetics, Publisher: Morgan and Claypool Publishers (July 1, 2006), ISBN-10: 1598290460, 126 pages.

COURSE DESCRIPTION

	General issues	Specific issues	No. of hours
1	Electromagnetic field equations	• Understanding the Maxwell equations, differential integral and circuit representation of electromagnetic field equations using scalar and vector potentials formulations.	1
2	Fundamentals of finite element method (FEM)	• Understanding the FEM. Base functions, interpretation, example for 1D and 2D problems. Sources description, features of FEM equations, solving methods.	1
3	Time dependent field	• Differences between magnetostatic and transient problems. Solver types applied in professional FEM packages Ansys Maxwell, MagNet, Comsol.	1
4	Finite element analysis (FEA) state of art	• Process of FEA: Preprocessor, solver, post processor - example problems. Understanding the key risks in FEA and assessment of it results.	1

Assessment methods of educational results

Evaluation of students' knowledge and skills by a written exam/test and also evaluation of students' activities during the lessons - rewarding activity of the students by extra points for discussion and solving case study problems (students can use of notebooks during the exam).

STUDENT'S WORKLOAD	
Activity	**Hours**
Participation in lectures, classes, seminars and laboratories	4
Contact hours with lecturers (including consultations)	5
Self-study	5
Exam	1
TOTAL	**15**
TOTAL NUMBER OF ECTS POINTS FOR THE COURSE	1