COURSE DESCRIPTION CARD - SYLLABUS

Course name

NUMERICAL METHODS OF ELECTROMAGNETIC FIELD ANALYSIS

Course

Proposed by Discipline

Automation, electronic and electrical engineering

Year/Semester

II/3, III/5

Type of studies

Doctoral School

Course offered in

English

Form of study

full-time

Requirements

elective

Number of hours

Lecture	Tutorials	Projects/seminars
4		

Number of credit points

1

Lecturers

Responsible for the course/lecturer:

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Faculty of Control, Robotics, and Electrical Engineering

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Responsible for the course/lecturer:

Prerequisites

Knowledge: the student has knowledge about methods describing systems with electromagnetic field and knowledge about numerical methods for solving partial differential equations in electromagnetism.

Skills: the student is able to describe electromagnetic field and to form numerical, finite difference schemes for electromagnetic field equations.

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.

Course objective

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.

Course-related learning outcomes

Knowledge

A PhD student who graduated from doctoral school knows and understands:

1) 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, [P8S_WG/SzD_W01]

2) advanced knowledge about development trends in the area of electrical engineering and can elaborate the numerical methods of electromagnetic field description in electromagnetic devices. [P8S_WG/SzD_W03]

Skills

A PhD student who graduated from doctoral school can:

1) able to properly match numerical methods for the analysis of electromagnetic field in the systems that are studied in the PhD thesis, [P8S_UW/SzD_U02]

2) 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, [P8S_UK/SzD_U04]

3) 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. [P8S_UK/SzD_U08]

Social competences

A PhD student who graduated from doctoral school is ready to:

1) able to popularize, in accessible way, scientific and technical achievements in electrical engineering and information engineering. [P8S_KK/SzD_K03]

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

PQF code	Methods for verification of learning outcomes	Assessment criteria
W01, W03	Written/oral exam graded on the basis of a points system (0-100 points)	3.0: 50.1 -70.0 points 4.0: 70.1 -90.0 points 5.0: 90.1 -100 points
U02, U04, U08	Continuous assessment during the lecture based on discussion and solving the stated problems	evaluation of activities
K03	Continuous assessment during the lecture based on discussion and solving the stated problems	evaluation of activities

Programme content

1. Electromagnetic field equations (Understanding the Maxwell equations, differential integral and circuit representation of electromagnetic field equations using scalar and vector potentials formulations).
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).
3. Time dependent field (Differences between magnetostatic and transient problems. Solver types applied in professional FEM packages Ansys Maxwell, MagNet, Comsol).
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).

Teaching methods

Lecture: multimedia presentation including illustrations and examples.

Bibliography

Basic

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

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.

Breakdown of average student's workload

	Hours	ECTS
Total workload	14	1.0
Classes requiring direct contact with the teacher	9	0.5
Student's own work (literature studies, preparation for tutorials, project preparation) [1]	5	0.5

[1] delete or add other activities as appropriate