

FACULTY OF ELECTRICAL
ENGINEERING**SUBJECT CARD**

Name in Polish: **Modelowanie maszyn elektrycznych**
 Name in English: **Modelling of Electrical Machines**
 Main field of study (if applicable): **Electrical Engineering**
 Specialization (if applicable): **Renewable Energy Systems**
 Level and form of studies: **2nd level, full-time**
 Kind of subject: **obligatory**
 Subject code: **ELR053110**
 Group of courses: **NO**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU):	15			30	
Number of hours of total student workload (CNPS):	30			60	
Form of crediting:	crediting with grade			crediting with grade	
For group of courses mark (X) final course:					
Number of ECTS points:	1			2	
including number of ECTS points for practical (P) classes :				2	
including number of ECTS points for direct teacher-student contact (BK) classes:	0.70			1.40	

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Knowledge of Electrical Engineering Fundamentals
2. Knowledge of Electrical Machines Fundamentals

SUBJECT OBJECTIVES

- C1. The achievement of grounds of field-circuit modeling of electrical machines
 C2. Knowledge of possibility application of modern numerical techniques for modeling of induction machines

SUBJECT LEARNING OUTCOMES*relating to knowledge:*

- PEU_W01 Student is able to formulate two-dimensional magnetic field problem in regions containing current sources by Maxwell's equations
 PEU_W02 Student is able to formulate two-dimensional field-circuit model of an induction machine

relating to skills:

- PEU_U01 Student is able to create two-dimensional model of an induction machine using Flux 2D software
 PEU_U02 Student is able to determine performance characteristics of the induction machine in motoring and generating mode of operation using Flux2D software

relating to social competences:

- PEU_K01 Acquirement of active attitude and skills of systematic study and work while doing project tasks

PROGRAMME CONTENT

Form of classes - lecture		Number of hours:
Lec 1	Course schedule and requirements. Mathematical basics of field modeling of electrical machines. The basic electromagnetic field quantities and equations.	2
Lec 2	Electrostatic, magnetostatic and magnetodynamic fields.	2
Lec 3	Outline of the finite element method (FEM).The FEM applied to 2D electromagnetic field problems.	2
Lec 4	The two dimensional FE model of induction machine. Field-circuit equations of an induction machine.	2
Lec 5	Accounting for movement and skew effect in modeling of induction machines. Methods of electromagnetic torque calculation.	2
Lec 6	Flux linkages and inductance of windings.	2
Lec 7	Calculation of losses and efficiency.	1
Lec 8	Written test.	2
Total hours:		15

Form of classes - project		Number of hours:
Proj 1	Course schedule and requirements. Instruction on a structure and usage of the Flux2D software.	2
Proj 2	Construction of geometrical model of the single-phase induction machine.	4
Proj 3	Modelling of the magnetic circuit of the stator and rotor.	4
Proj 4	Modelling of the stator and rotor windings.	4
Proj 5	FE discretization of the geometrical model of the induction machine.	4
Proj 6	Simulation of dynamic operation of the single-phase induction machine (motoring or/and generating mode).	4
Proj 7	Simulation of steady-state performance of the single-phase induction machine (motoring or/and generating mode).	4
Proj 8	Calculation of losses and efficiency.	2
Proj 9	Evaluation of the project.	2
Total hours:		30

TEACHING TOOLS USED
N1. Multimedia and traditional presentation.
N2. Modelling and computer simulation.

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT		
Evaluation <i>F - forming (during semester)</i> <i>P - concluding (at semester end)</i>	Educational effect number	Way of evaluating educational effect achievement
F1(W)	PEU_W01 PEU_W02	Written test
P(W)	P=F1	
F1(P)	PEU_U01 PEU_U02 PEU_K01	Preconditioning test.
F2(P)	PEU_U01 PEU_U02 PEU_K01	Evaluation of a project.
P(P)	P=0.25F1+0.75F2	

PRIMARY AND SECONDARY LITERATURE
PRIMARY LITERATURE:
<ol style="list-style-type: none"> 1. Hameyer K., Belmans R.: Numerical modeling and design of electrical machines and devices, WITT Press, Southampton, 1999 2. Di Barbra P., Savini A., Wiak S. : Field models in electricity and magnetism, Springer, 2008 3. Sadiku Matthew N.O. : Numerical techniques in electromagnetics, CRC Press, 2001 4. Jianming Jin: The finite element method in electromagnetics, John Wily & Sons, Inc., 2002 5. Bianchi Nicola: Electrical machine analysis using finite elements, CRC Taylor & Francis Group, 2005. 6. Meunier Gerard : The finite element method for electromagnetic modeling, John Wily & Sons, Inc., 2008 7. Sadiku Matthew N.O.: Numerical techniques in electromagnetics with Matlab, CRC Press, 2009 8. Flux 2D v. 11.1, User guide, CEDRAT, 2012
SECONDARY LITERATURE:
<ol style="list-style-type: none"> 1. Chapman S.J.: Electric machinery fundamentals, McGraw-Hill, N.Y., 2005 2. Zienkiewicz O.C., Taylor R.L., Zhu J.Z.: The finite element methods: its basis and fundamentals, Elsevier B-H, Amsterdam, 2005

SUBJECT SUPERVISOR
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