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:	**ELR043110**
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 EDUCATIONAL EFFECTS

relating to knowledge:

PEK_W01 Student is able to formulate two-dimensional magnetic field problem in regions containing current sources by Maxwell’s equations

PEK_W02 Student is able to formulate two-dimensional field-circuit model of an induction machine

relating to skills:

PEK_U01 Student is able to create two-dimensional model of an induction machine using Flux 2D software

PEK_U02 Student is able to determine performance characteristics of the induction machine in motoring and generating mode of operation using Flux2D sofware

relating to social competences:

PEK_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 EDUCATIONAL EFFECTS ACHIEVEMENT		
Evaluation *F – forming (during semester) P – concluding (at semester end)*	**Educational effect number**	**Way of evaluating educational effect achievement**
F1(W)	PEK_W01 PEK_W02	Written test
P(W)	P=F1	
F1(P)	PEK_U01 PEK_U02 PEK_K01	Preconditioning test.
F2(P)	PEK_U01 PEK_U02 PEK_K01	Evaluation of a project.
P(P)	P=0.25F1+0.75F2	

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

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:

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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MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT
ELR043110 - Modelling of Electrical Machines
AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY **Electrical Engineering**
AND SPECIALIZATION **Renewable Energy Systems**

Subject educational effect	Correlation between subject educational effect and educational effects defined for main field of study and specialization (if applicable)	Subject objectives	Programme content	Teaching tool number
PEK_W01	S2RES_W10	C.1	Lec1 Lec2 Lec3 Lec4	N.1
PEK_W02	S2RES_W10	C.2	Lec5 Lec6 Lec7 Lec8	N.1
PEK_U01	S2RES_U10	C.2	Proj1 Proj2 Proj4 Proj5	N.2
PEK_U02	S2RES_U10	C.2	Proj6 Proj7 Proj8 Proj9	N.2
PEK_K01	K2ETK_K06	C.1 C.2	Proj1 Proj2 Proj3 Proj4 Proj5 Proj6 Proj7 Proj8 Proj9	N.1 N.2