FACULTY OF ELECTRICAL ENGINEERING

SUBJECT CARD

Name in Polish:	**Dynamika i sterowanie napędami prądu stałego i przemiennego**
Name in English:	**Dynamics and Control of AC and DC Drives**
Main field of study (if applicable):	**Electrical Engineering**
Specialization (if applicable):	**Control in Electrical Power Engineering**
Level and form of studies:	**2nd level, full-time**
Kind of subject:	**obligatory**
Subject code:	**ELR053225**
Group of courses:	**NO**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU):	30		15	15	
Number of hours of total student workload (CNPS):	120		30	30	
Form of crediting:	examination		crediting with grade	crediting with grade	
For group of courses mark (X) final course:					
Number of ECTS points:	4		1	1	
including number of ECTS points for practical (P) classes :			1	1	
including number of ECTS points for direct teacher-student contact (BK) classes:	2.80		0.70	0.70	

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Has knowledge in the control theory (basics), informatics and fundamentals of electrical drives.

SUBJECT OBJECTIVES

C1. Consolidate knowledge and/or filling the knowledge gap in the field of torque and speed control of the DC and AC (induction motors and PMSM) motor drives.

C2. Familiarizing students with the extended knowledge on the application of advanced control theory methods in controlled converter-fed motor drives, including adaptive and sensorless control.

C3. The acquisition of practical knowledge and skills for design, testing and analysis of advanced control structures for DC and AC motor drives, including sensorless drives.

C4. Perfecting skills for the understanding, analysis and interpretation of steady-state and transient processes in chosen controlled DC and AC drive systems.

C5. Acquisition and fixing the social competences related to work in teams, solving engineering problems together; responsibility, honesty and fairness, observance of manners which are obligatory for academia and society.

SUBJECT LEARNING OUTCOMES

relating to knowledge:

PEU_W01 Has matured knowledge on the torque and speed control methods of the converter-fed DC motor drives], including adaptive systems.

PEU_W02 Has matured and in-depth knowledge on modern control methods of converter-fed induction motor drives (including scalar and vector methods, sensorless control).

PEU_W03 Has matured and in-depth knowledge on modern control methods of converter-fed brushless DC and AC motors drives (including vector methods and sensorless control).

relating to skills:

PEU_U01 Can realize the simulation tests of chosen controlled electrical drive in Matlab/Simulink environment using delivered software and can make analysis of the obtained results.

PEU_U02 Can realize the experimental tests of chosen controlled electrical drive in laboratory set-up and can make analysis of the obtained results.

PEU_U03 Can design and test in simulation a chosen structure of speed or position control of electrical drive.

relating to social competences:

PEU_K01 Student can act independently and cooperate within a group working on a complex engineering project.

PROGRAMME CONTENT		
Form of classes - lecture		**Number of hours:**
Lec 1	Introduction. Basics of control system synthesis problems for electrical drives; control quality indexes for electrical drives.	2
Lec 2	Static and dynamical optimization for electric motor drives. Torque control structures of electrical drives: classification, characteristic features, performance.	2
Lec 3	Adjustment criteria for linear controllers, integral criteria, modulus and symmetry criteria, pole-placement method.	2
Lec 4	Static optimization conditions for DC motor; constant and variable flux control, dynamical properties for constant and variable excitation flux.	2
Lec 5	Speed control methods of converter-fed DC motor drives: series and parallel speed control structure; dynamical performance comparison.	2
Lec 6	Influence of static rectifier to the DC motor drive dynamical performance; adaptive control structures.	2
Lec 7	Induction motor – mathematical model using vector representation, state equations.	2
Lec 8	Frequency controlled induction motor drives – conditions of static optimization. Torque control methods of the induction motor.	2
Lec 9	Influence of the control method to the static mechanical characteristic of the induction motor drive. Influence of the control orientation to dynamical performance of the induction motor drive.	2
Lec 10	Scalar control methods for induction motor drives; constant flux and constant slip frequency methods.	2
Lec 11	Field-oriented control methods and structures for the induction motor drive - part 1.	2
Lec 12	Field-oriented control methods and structures for the induction motor drive - part 2.	2
Lec 13	Direct torque control methods and structures for the induction motor drive.	2
Lec 14	Control methods of brushless DC and AC permanent magnet motors. Field-oriented and direct torque control methods.	2
Lec 15	Sensorless drives, state variables estimation methods and structures for AC motor drives.	2
	Total hours:	**30**

Form of classes - laboratory		**Number of hours:**
Lab 1	Introduction. Modeling of basic drive system elements using Matlab/Simulink - repetition.	1
Lab 2	Simulation tests of the cascade control structure for chosen dynamical object. Application of different design methods for the PI/PID controllers. Anti-windup systems.	2
Lab 3	Testing of the cascade control structure of DC motor drive; simulation and experimental tests.	2
Lab 4	Testing of the scalar control method for the induction motor.	2
Lab 5	Testing of the vector control methods for the induction motor - the FOC metod. Part 1 - simulation tests.	2
Lab 6	Testing of the vector control methods for the induction motor - the FOC metod. Part 2 - experimental tests.	2
Lab 7	Testing of the direct torque control method for the induction motor drive.	2
Lab 8	Testing of the chosen sensorless control structure of the induction motor drive. Crediting with grade.	2
	Total hours:	**15**

Form of classes - project		**Number of hours:**
Proj 1	Introduction, basic requirements for course assessment. Methodology for project realization. Description of the project topics and distribution the project between student groups.	1
Proj 2	Description of the modeling methodology of chosen elements of the drive systems in Matlab/Simulink. Implementation of basic mathematical and simulation models (DC motor, induction motor. AC/DC and DC/AC converter, modulator for DC/AC converter).	2
Proj 3	Realization of the projects in students groups. Presentation and continuous consultations on project results.	10
Proj 4	Project presentation. Crediting with grade.	2
	Total hours:	**15**

TEACHING TOOLS USED	
N1.	Lecture with multimedia tools combined with classical lecture (problem oriented).
N2.	Consultations.
N3.	Laboratory exercises in student groups; testing of student knowledge with short test before laboratory exercises.
N4.	Assessment of the laboratory exercises by reports.
N5.	Project presentation and its evaluation.

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT		
Evaluation *F – forming (during semester)* *P – concluding (at semester end)*	**Educational effect number**	**Way of evaluating educational effect achievement**
F1(W)	PEU_W01 PEU_W02 PEU_W03	Participation in lectrures.
F2(W)	PEU_W01 PEU_W02 PEU_W03	Exam.
P(W)	P=0,1F1+0,9F2	
F1(L)	PEU_U01 PEU_U02 PEU_K01	Activity during laboratory exercises (including short written test).
F2(L)	PEU_U01 PEU_U02 PEU_K01	Preparationn of the reports.
P(L)	P=0,3F1+0,7F2	
F1(P)	PEU_U03 PEU_K01	Evaluation of the activity during classes.
F2(P)	PEU_U03 PEU_K01	Evaluation of the project and the form of its presentation.
P(P)	P=0,3F1+0,7F2	

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] M.P. Kazmierkowski, F. Blaabjerg, R. Krishnan, Control in Power Electronics - Selected Problems, Academic Press, USA, 2002
[2] P. Vas, Sensorless Vector and Direct Torque Control, Oxford University Press, 1998
[3J M.D. Murphy, F.G.Turnbull, Power Electronic Control of AC Drives, Pergamon Press, Oxford, 1988
[4] W. Leonhard, Control of Electrical Drives, Springer Verlag, 1990
[5] K. Ogata, Modern Control Engineering

SECONDARY LITERATURE:

[1] Kaźmierkowski M.P., Tunia H., Automatyka napędu przekształtnikowego. PWN, 1987
[2] Orlowska-Kowalska T., Bezczujnikowe układy napędowe z silnikami indukcyjnymi. Oficyna Wydawnicza P.Wr., Wrocław, 2003
[3] Orlowska-Kowalska T., Automatyka napędu elektrycznego - podstawy. Oficyna Wydawnicza P.Wr., Wrocław, w druku
[4] Zawirski K., Deskur J., Kaczmarek T., Automatyka napędu elektrycznego, Wyd. Polit. Poznańskiej, 2012
[5] T. Kaczorek, A. Dzieliński, W Dobrowolski, R. Łopatka. Podstawy teorii sterowania, WNT, 2005

SUBJECT SUPERVISOR

Teresa Orłowska-Kowalska, teresa.orlowska-kowalska@pwr.edu.pl