

FACULTY OF ELECTRICAL
ENGINEERING**SUBJECT CARD**

Name in Polish: **Napęd elektryczny**
 Name in English: **Electrical Drive**
 Main field of study (if applicable): **Electrical Engineering**
 Specialization (if applicable):
 Level and form of studies: **1st level, full-time**
 Kind of subject: **obligatory**
 Subject code: **ELR043203**
 Group of courses: **NO**

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

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

- Has a basic knowledge in the field of electrical machines, their construction, way of operation, knows equivalent schemes, mathematical models and basic characteristics of DC and AC motors.
- Has a basic knowledge on the basic low voltage apparatus, their parameters and applications indifferent electrical systems.
- Has a basic knowledge on description of linear control systems, their performance and analysis.
- Is able to use the knowledge of differential and integral calculus in the problems connected with the engineering studies.
- Can solve the problems related to the analysis of linear controlled systems; knows how to use the proper mathematical methods for time-domain analysis of controlled plants.
- Is able to use the known measurement methods to connect, put into the operation and test the designed measurement system, can analyze and evaluate the measurement results.
- Understands the necessity of taking part in student laboratories and exercises to obtain new knowledge and skills.

SUBJECT OBJECTIVES

- Familiarizing students with the basic problems of steady-state and dynamics of electrical drives.
- Familiarizing students with the basic DC and AC motor drives and speed shaping methods in various operation conditions.
- Gaining skills for understanding, interpretation and analysis of steady state and dynamical performance of basic electrical drives.
- The acquisition of practical knowledge and skills for connection, putting into operation and testing of the electrical motor drives and elaboration of their static and dynamical characteristics.
- Familiarizing students with application of previously known measurement techniques for testing of the DC and AC motor drives.
- 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 EDUCATIONAL EFFECTS

relating to knowledge:

- PEK_W01 Has matured knowledge on basics of the DC and AC motor drives and their operation modes.
- PEK_W02 Can define and describe basic elements of converter-fed electrical drives and can describe and characterize basic speed shaping methods of the DC and AC motors in open and closed-loop systems, in various operation modes.

relating to skills:

- PEK_U01 Can choose the suitable low voltage electric apparatus for given electrical drive of different power.
- PEK_U02 Can realize the measurements of static and dynamical characteristics of different DC and AC electrical drive.

relating to social competences:

- PEK_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, the main goal of the lecture, credit requirements. Electrical drive system - basic definition, components, steady state characteristics of different types of motors and loading machines.	2
Lec 2	Regions of operation of a drive system. Motion equation of electrical drive system, static and dynamic states, stable steady-state operation condition.	2
Lec 3	Influence of different types of mechanical connections to equation of motion.	2
Lec 4	Basic rules of electrical motor choice depending on different load types.	2
Lec 5	DC motor with separate excitation - equivalent circuit, dynamical equations, main and disturbance transfer functions, dynamical performance.	2
Lec 6	DC motor drive systems: speed control methods, starting and braking methods.	2
Lec 7	Forming of DC motor characteristics using different feedbacks.	2
Lec 8	Speed and torque control of the DC motor in the cascade control structure. One and two-directional converter fed DC drive systems.	2
Lec 9	Induction motor drives - methods of speed control, braking methods and their technical realization; principles, basic schematic diagrams, modes of operation, control and mechanical characteristics.	2
Lec 10	Frequency scalar speed and torque control method of the induction motor drive, basics of vector control methods.	2
Lec 11	Speed control methods of wound-rotor induction motors; constant torque and constant power cascade systems.	2
Lec 12	Starting systems for squirrel-cage induction motors; starting methods, basic schemes and mechanical characteristics.	2
Lec 13	Starting systems for wound-rotor induction motors; starting methods, basic schemes and mechanical characteristics.	2
Lec 14	Electrical drives with permanent magnet synchronous motors. Future trends in electrical drive systems.	2
Lec 15	Colloquium - assessment with grade.	2
Total hours:		30

Form of classes - laboratory		Number of hours:
Lab 1	Introduction, presentation of the laboratory stands and safety requirements. Repetition the basic rules of application of analog and digital measurement devices.	1
Lab 2	Kształtowanie charakterystyk silnika obcowzbudnego prądu stałego w różnych stanach pracy. Sterowanie prędkością przy zasilaniu z nawrotnego prostownika sterowanego.	2
Lab 3	Testing of the electrical drive with DC series motor. Testing of DC series motor drive controlled by DC chopper.	2
Lab 4	Testing of the electrical starting systems for the squirrel-cage and wounded-rotor induction motors.	2
Lab 5	Testing of the induction motor drive supplied form the voltage inverter - scalar control, vector control.	2
Lab 6	Testing of the induction motor cascade drive system of constant power.	2
Lab 7	Testing of the induction motor cascade drive system of constant torque.	2
Lab 8	Additional term. Assesment of the laboratory 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.

EVALUATION OF SUBJECT EDUCATIONAL EFFECTS 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)	PEK_W01 PEK_W02	Participation in lectures.
F2(W)	PEK_W01 PEK_W02	Test.
P(W)	$P=0,1 \cdot F1 + 0,9 \cdot F2$	
F1(L)	PEK_U01 PEK_U02 PEK_K01	Activity during laboratory exercises (including grades obtaining during short tests).
F2(L)	PEK_U01 PEK_U02 PEK_K01	Preparation of the report.
P(L)	$P=0,3 \cdot F1 + 0,7 \cdot F2$	

PRIMARY AND SECONDARY LITERATURE**PRIMARY LITERATURE:**

- [1] Napęd elektryczny, praca zbiorowa pod red. Z. Grunwalda, WNT, 1987
 [2] Napęd elektryczny – laboratorium, praca zbiorowa pod red. T. Orłowskiej-Kowalskiej, Oficyna Wyd. P.Wr., 2000

SECONDARY LITERATURE:

- [1] W. Leonhard, Control of Electrical Drives, Springer Verlag, 1990

SUBJECT SUPERVISOR

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MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT
ELR043203 - Electrical Drive
AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY **Electrical Engineering**

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	K1ETK_W31	C.1 C.2 C.3	Lec1 Lec2 Lec3 Lec4 Lec5 Lec6 Lec7 Lec8 Lec9 Lec10 Lec11 Lec12 Lec13 Lec14 Lec15	N.1 N.2
PEK_W02	K1ETK_W31	C.1 C.2 C.3	Lec1 Lec2 Lec3 Lec4 Lec5 Lec6 Lec7 Lec8 Lec9 Lec10 Lec11 Lec12 Lec13 Lec14 Lec15	N.1 N.2
PEK_U01	K1ETK_U28	C.4 C.5 C.6	Lab1 Lab2 Lab3 Lab4 Lab5 Lab6 Lab7 Lab8	N.3 N.4
PEK_U02	K1ETK_U28	C.4 C.5 C.6	Lab1 Lab2 Lab3 Lab4 Lab5 Lab6 Lab7 Lab8	N.3 N.4
PEK_K01	K1ETK_K05	C.1 C.2 C.3 C.6	Lec1 Lec2 Lec3 Lec4 Lec5 Lec6 Lec7 Lec8 Lec9 Lec10 Lec11 Lec12 Lec13 Lec14 Lec15 Lab1 Lab2 Lab3 Lab4 Lab5 Lab6 Lab7 Lab8	N.1 N.2 N.3 N.4