

FACULTY OF ELECTRICAL  
ENGINEERING**SUBJECT CARD**

Name in Polish: **Napęd elektryczny 1**  
 Name in English: **Electrical Drive 1**  
 Main field of study (if applicable): **Control Engineering and Robotics**  
 Specialization (if applicable):  
 Level and form of studies: **1st level, full-time**  
 Kind of subject: **obligatory**  
 Subject code: **ARR043205**  
 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):	90	60			
Form of crediting:	examination	crediting with grade			
For group of courses mark (X) final course:					
Number of ECTS points:	3	2			
including number of ECTS points for practical (P) classes :		2			
including number of ECTS points for direct teacher-student contact (BK) classes:	2.10	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 knowledge on the methods of mathematical description, basic characteristics and analysis of linear control systems.
- 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.
- Understands the necessity of taking part in student laboratories and exercises to obtain new knowledge and skills.

**SUBJECT OBJECTIVES**

- C1. Familiarizing students with the basic problems of steady-state and dynamics of electrical drives.  
 C2. Familiarizing students with the basic DC and AC motor drives and speed shaping methods in various operation conditions.  
 C3. Gaining skills for understanding, interpretation and analysis of steady state and dynamical performance of basic electrical drives.  
 C4. The acquisition of practical knowledge and skills for calculation of basic parameters and values characterizing different operation states of electrical motor drives.

**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 calculate the basic parameters of DC and AC motors based on nominal data in different operation modes and choose those motors to various drive systems.  
 PEK\_U02 Can calculate basic values of chosen DC and AC motor drives characterizing their operation in different conditions.

*relating to social competences:*

- PEK\_K01 Student will obtain creativity in an interpersonal cooperation for solving technical problems in a team.

## 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 conditions.	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.	2
Lec 15	Future trends in electrical drive systems.	2
Total hours:		<b>30</b>

Form of classes - class		Number of hours:
Cl 1	Calculation of basic parameters of DC motor based on nominal data – solving of different tasks.	2
Cl 2	Analysis and task solving connected with basic steady-states of chosen DC motor drives - part 1.	2
Cl 3	Analysis and task solving connected with basic steady-states of chosen DC motor drives - part 2.	2
Cl 4	Colloquium - concerning the previous topics. Calculation of basic parameters of the induction motor based on nominal data – solving of different tasks.	2
Cl 5	Analysis and task solving connected with basic steady-states of chosen induction motor drives.	2
Cl 6	Choice of the electrical motor power for the drive system – solving different tasks. Choice of the suitable low voltage electric apparatus for given electrical drive – solving different tasks. Part 1.	2
Cl 7	Choice of the electrical motor power for the drive system – solving different tasks. Choice of the suitable low voltage electric apparatus for given electrical drive – solving different tasks. Part 2.	2
Cl 8	Colloquium concerning second part of the analysed problems.	1
Total hours:		<b>15</b>

## TEACHING TOOLS USED

- N1. Lecture with multimedia tools combined with classical lecture (problem oriented).  
 N2. Calculus exercises – discussion of the solutions.  
 N3. Consultations.

## EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

Evaluation <small>F - forming (during semester) P - concluding (at semester end)</small>	Educational effect number	Way of evaluating educational effect achievement
F1(w)	PEK_W01 PEK_W02	Participation in lectures.
F2(w)	PEK_W01 PEK_W02	Final exam
P(w)	$P=0,1 \cdot F1 + 0,9 \cdot F2$	
F1(c)	PEK_U01 PEK_U02 PEK_K01	Activity during exercises and self-solving of given tasks and problems.
F2(c)	PEK_U01 PEK_U02 PEK_K01	Partial and final colloquium.
P(c)	$P=0,2 \cdot F1 + 0,8 \cdot F2$	

## 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 **ARR043205 - Electrical Drive 1** AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY **Control Engineering and Robotics**

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	K1AiR_W27	C.1 C.2 C.3	Lec1 Lec2 Lec3 Lec4 Lec5 Lec6 Lec7 Lec8 Lec9 Lec10 Lec11 Lec12 Lec13 Lec14 Lec15	N.1 N.3
PEK_W02	K1AiR_W27	C.1 C.2 C.3	Lec1 Lec2 Lec3 Lec4 Lec5 Lec6 Lec7 Lec8 Lec9 Lec10 Lec11 Lec12 Lec13 Lec14 Lec15	N.1 N.3
PEK_U01	K1AiR_U23	C.4	CI1 CI2 CI3 CI4 CI5 CI6 CI7 CI8	N.2
PEK_U02	K1AiR_U23	C.4	CI1 CI2 CI3 CI4 CI5 CI6 CI7 CI8	N.2
PEK_K01	K1AiR_K03	C.1 C.2 C.3 C.4	CI1 CI2 CI3 CI4 CI5 CI6 CI7 CI8	N.2 N.3