STUDY MODULE DESCRIPTION FORM

Name of the module/subject		Code
Foundations of electrical drives		**1010331141010330053**

Field of study	Profile of study (general academic, practical)	Year /Semester
Control Engineering and Robotics	**(brak)**	**2 / 4**
Elective path/specialty	Subject offered in:	Course (compulsory, elective)
-	**polish**	**obligatory**

Cycle of study:	Form of study (full-time,part-time)
First-cycle studies	**full-time**

No. of hours				No. of credits
Lecture: **2**	Classes: **-**	Laboratory: **-**	Project/seminars: **-**	**2**

Status of the course in the study program (Basic, major, other)	(university-wide, from another field)
(brak)	**(brak)**

Education areas and fields of science and art	ECTS distribution (number and %)
technical sciences	**2 100%**

Responsible for subject / lecturer:

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Prerequisites in terms of knowledge, skills and social competencies:

1	**Knowledge**	Student should have knowledge in chosen branches of physics including the electricity and the magnetism and the knowledge of the theory of electric circuits.
2	**Skills**	Student is able to obtain information from literature, databases and other sources; has abilities of the self-education for improving qualifications and the update of professional competence.
3	**Social competencies**	Student is aware of a need to expand his competence and readiness to undertake the cooperation in the team; has an awareness of the importance and understands other aspects of engineering activity, including its influence on the environment.

Assumptions and objectives of the course:

Getting knowledge of building, operation and characteristics of the basic drives with converters.

Study outcomes and reference to the educational results for a field of study

Knowledge:

1. The student has a knowledge tidied up in the structure, the application and control of the automation and robotics systems - [K_W19++] - [-]

2. Student knows and understands typical engineering technologies, knows and understands principles of the selection of servo- and measuring-testing devices. - [K_W20++] - [-]

Skills:

1. Student is able to use models of simple electromechanical systems, as well as to use them for analysis and design automations and robotics systems. - [K_U05+++] - [-]

2. Student is able to select the kind and parameters of servo- and measuring system, control unit for the chosen application and to effect their integration in the form of the ultimate measuring-control system. - [K_U17++] - [-]

Social competencies:

1. Student has an awareness of the need for the professional approach towards technical issues, of meticulous acquainting oneself with documentation and environmental conditions, in which devices and their elements can function - [K_K04++] - [-]

Assessment methods of study outcomes

- Constant progress monitoring during all classes (awarding a bonus to the actively participating students),
- Evaluation of student's knowledge and skills on a written examination in a form of test.
- Getting additional points for the activity during classes, particularly for:

proposing answers to the questions and tasks presented during the lectures,

suggestions on how to improve the teaching materials.

Course description

Drive dynamics equations, notion of the mechanical characteristic, operation of the machine in the separate quadrants of the coordinate system, reduction of the torque and inertia moment to the motor shaft with consideration of the losses in the drive transmission elements.

Equation of the thermal balance of the electrical machine, thermal time constant of the machine, steady-state increase of the temperature, time course of the temperature increase after changing the load.

Standarized types of electrical machine duty, S1 continuous duty, selection of the continuous duty motor for drive task with constant load and with cyclic changing load, mean loss method, methods of the equivalent current, torque ane power, S2 short-time duty and selection of the motor for short-time duty, S3 intermittent duty and selection of the motor for intermittent duty, recalculation data between the S1, S2 and S3 types of duty and between different times of short-time duty and between different relative times of intermittent duty, recalculation of the power for ambient temperature diferrent from normalized ambient temperature.

Drives with induction motors: building of the slip ring motor and squirrel-cage motor, one-phase equivalent diagram of the slip ring motor and its mechanical characteristic, Kloss formula, interpretation of the data from the rating plate and determination of the Kloss formula parameters on the base of rating plate data, operation modes of the induction machine, mechanical characteristics of the normal, deep-bar and double squirrel cage motor, starting of the induction motors: direct-on starting, rotor resistor starting, soft-start (stator voltage decrease), star-delta starting, control of the induction motor speed: by means of rotor resistor, stator voltage, frequency control (two zones and limitations), by means of pole pair changing (two speed motor) and introduction of the additional voltage in thr rotor circuit (cascade arrangement).

Direct current drives: equations and characteristics of the DC machine, limitations in the continuous operation, thyristor DC drive: unidirectional and reversible with symmetrical control and with one bridge blocking, transistor DC drive with pulse converter: one-quadrant, two-quadrant and four-quadrant drive.

Drives with synchronous machine: torque-angle characteristic and two components of the torque, supplying the machine from direct frequency converter (cycloconverter), properties of the synchronous motor fed from the current source inverter, permanent magnet synchronous motor and its properties at vector control.

Stepper motor drive: torque-angle characteristic, dependence of the torque on pulse frequency, full-step and fraction-step operation, recalculation between speed and pulse frequency, rules of stepper motor selection.

Basic bibliography:

1. Drozdowski P.: Wprowadzenie do napędów elektrycznych. Skrypt Politechniki Krakowskiej, Kraków 1998. .
2. Sidorowicz J. Napęd elektryczny i jego sterowanie. Oficyna Wydawnicza Politechniki Warszawskiej 1994
3. Kaczmarek T.: Napęd elektryczny robotów, wyd.2, Wydawnictwo Politechniki Poznańskiej, Poznań 1998.

Additional bibliography:

1. . Muszyński R., Kaczmarek T.: Sterowanie układami elektromechanicznymi. Przykłady obliczeniowe. Wydawnictwo Politechniki Poznańskiej, Poznań 2007.
2. Tunia H., Kaźmierkowski M.P.: Automatic Control of Converter-fed Drives, Elsevier Amsterdam ? London ? New York ? Tokyo, PWN Warszawa 1994.
3. Dewan S. B., Slemon G. R., Straughen A.: Power Semiconductor Drives. John Wiley & Sons, New York, Chichester, Brisbane, Toronto, Singapore 1984.

Result of average student's workload

Activity	Time (working hours)
1. Participation in the lecture	30
2. Consultation	2
3. Preparation for examination	25
4. Participation in examination	3

Student's workload

Source of workload	hours	ECTS
Total workload	60	2
Contact hours	45	2
Practical activities	0	0