COURSE DESCRIPTION CARD - SYLLABUS

Course name
Electric Drives [S1AiR2P>NP]

Course

Field of study
Automatic Control and Robotics

Year/Semester
3/5

Area of study (specialization)
–

Profile of study
practical

Level of study
first-cycle

Course offered in
Polish

Form of study
full-time

Requirements
compulsory

Number of hours

Lecture
30

Laboratory classes
30

Other
0

Tutorials
0

Projects/seminars
0

Number of credit points

4,00

Coordinators

dr hab. inż. Tomasz Pajchrowski prof. PP
tomasz.pajchrowski@put.poznan.pl

Lecturers

Prerequisites

The student has basic knowledge of physics, covering electricity, magnetism, including knowledge necessary to understand physical phenomena occurring in electrical and electronic systems, he has knowledge of the theory of electrical circuits and AC and DC electrotechnology (including three-phase). He/she can acquire information from literature, databases and other sources; he/she has the ability of self-education in order to improve and update his/her professional competence.

Course objective

Poznanie budowy, zasady działania oraz metod i struktur zaawansowanych układów sterowania elektrycznych układów napędowych stosowanych w przemyśle ciężkim, robotach przemysłowych, pojazdach elektrycznych, statkach powietrznych, sprzęcie gospodarstwa domowego.

Course-related learning outcomes

Knowledge:
K1_W18 has advanced structured knowledge in the field of construction, application and control of automation and robotics executive systems;
K1_W20 knows and understands typical engineering technologies, principles and techniques of

constructing simple automation and robotics systems; knows and understands the principles of selecting execution systems, computational units and measuring and control elements and devices;

Skills:
K1_U11 is able to determine and use models of simple electromechanical systems and selected industrial processes, and use them for the purpose of analysis and design of automation and robotics systems;
K1_U15 is able to build, commission and test a simple electronic and electromechanical system;
K1_U21 is able to design and practically use simple diagnostic and decision-making systems dedicated to automation and robotics systems;

Social competences:
K1_K1 is ready to critically evaluate his/her knowledge;understands the need and knows the possibilities of continuous training - improving professional, personal and social competences, is able to inspire and organise the learning process of others;
K1_K5 is aware of the necessity of professional approach to technical issues, scrupulous familiarisation with documentation and environmental conditions in which devices and their elements may operate;is ready to observe principles of professional ethics and require this from others, respecting diversity of views and cultures;

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Lecture: pass/fail, consists of a test in the form of a written response to the question and a conversation (optional) on selected issue(s) with the explanation of written answers from the range of program content.
Laboratory classes: attendance at classes and performing laboratory exercises in groups and submitting written reports.

Programme content

Introduction to the construction, principle of operation and characteristics of selected drives converters in open-loop control systems used in machinery, equipment,
robots, land and water vehicles, aircraft. Acquiring the ability to analyse
electrical drive systems.

Course topics

Lecture:
1. Construction and principle of operation of selected electrical machines:
DC commutator motors: mechanical characteristics and speed control in I and II zones. AC commutator motors (universal motor). Brushless DC motors (BLDC). AC induction motors (1-phase, 3-phase machine). Permanent magnet synchronous motors (PMSM). Synchronous reluctance motors (synRM). Switched reluctance motors (SRM). Stepper motors. 2.
2. Construction and principle of operation of converter systems - thyristor and transistor systems used in simple household appliances and in industry. 3.
3. Electric drive systems:
Equation of drive dynamics, concept of mechanical characteristics, work in particular quadrants of the coordinate system, characteristics of driven devices, reduction of torque and moment of inertia to the motor shaft taking into account losses in transmission elements. Selection of machine to load.
Heating of electrical machines. Heat balance equation of electric machine.Standardized types of operation of electric machine.
DC motor drives (output base): equations and characteristics of DC machine, thyristor DC drive unidirectional and reversible, transistor DC drive with pulse converter: one-quadrant, two-quadrant and four-quadrant, II control zone.
Drives with induction motors: operating states of squirrel-cage induction motors, mechanical characteristics of squirrel-cage ordinary, deep-groove and double-cage motors, starting of induction motors: direct, by lowering the stator voltage (soft-start), by means of star-delta switch, speed control of induction motors: frequency control (two zones and control limits).
Drives with stepper motors: angular momentum characteristics, torque dependence on pulse frequency,

full-step and fractional-step operation, conversion of angular velocity into pulse frequency, principles of stepper motor selection.
Laboratory exercises. The program of laboratory exercises includes getting acquainted with the design, software, commissioning and testing of static and dynamic properties of selected physical drive systems discussed at lectures.

Teaching methods

Lecture
Lecture with multimedia presentation (including: drawings, photos, animations, sound, films) supplemented by examples given on the board. Initiating discussion during the lecture.
Laboratory.
Working in teams and team programming, carrying out tasks given by the teacher - practical exercises.

Bibliography

Basic:
1. Zawirski K., Deskur J., Kaczmarek T., Automatyka napędu elektrycznego, Wydawnictwo Politechniki Poznańskiej, Poznań, 2012.
2. Kaźmierkowski M.P, Tunia H., Automatic Control of Converter-Fed Drives, ELSEVIER, Amstertdam, London, New York, Tokyo, Warszawa , 1994
3. Zawirski K., Deskur J., Kaczmarek T., Automatyka napędu elektrycznego, Wydawnictwo Politechniki Poznańskiej, Poznań, 2012.
4. Lech Grzesiak L., Kaszewski A., Ufnalski B.: Sterowanie napędów elektrycznych. Analiza, modelowanie, projektowanie. Wydawnictwo Naukowe PWN, Warszawa 2016.
5. Sieklucki G., Bisztyga B., Zdrojewski A., Orzechowski T., Sykulski R.: Modele i zasady sterowania napedami elektrycznymi, Wydawnictwo AGH, Kraków 2014.
6. A. M. Plamitzer, Maszyny Elektryczne, wyd. VII, WNT Warszawa, 1982.
7. Stein Z. :Maszyny i nap□d elektryczny Wyd. 5. WsiP, Warszawa 1989

Additional:
1. Leonhard W., Control of Electrical Drives, Springer, Berlin, New York, 2001
2. Leonhard W., Control of Electrical Drives, Springer, Berlin, New York, 2001
3. Kaczmarek T. , Napęd elektryczny robotów, Wydawnictwo Politechniki Poznańskiej, Poznań, 1998
4. Kaźmierkowski M.P, Tunia H., Automatic Control of Converter-Fed Drives, ELSEVIER, Amstertdam, London, New York, Tokyo, Warszawa , 1994

Breakdown of average student's workload

	Hours	ECTS
Total workload	100	4,00
Classes requiring direct contact with the teacher	60	2,50
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	40	1,50