COURSE DESCRIPTION CARD - SYLLABUS

Course name
Control of Electric Drives [S1AiR2P>PO5-AUN]

Course

Field of study
Automatic Control and Robotics

Year/Semester
3/6

Area of study (specialization)
–

Profile of study
practical

Level of study
first-cycle

Course offered in
Polish

Form of study
full-time

Requirements
elective

Number of hours

Lecture
15

Laboratory classes
30

Other
0

Tutorials
0

Projects/seminars
0

Number of credit points

4,00

Coordinators

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Lecturers

Prerequisites

Knowledge: K1_W6 has a structured, theoretically supported general knowledge in the theory of electrical circuits and in the electrical engineering of direct and alternating current (including three-phase); K1_W16 has well-ordered knowledge in the scope of structures and principles of operation of analogue and discrete control systems (in an open system and in a system with feedback) as well as linear and simple K1_W17 knows and understands to an advanced degree the basic synthesis criteria and methods of controller tuning, tools and techniques for automatic selection of controller settings and object identification Skills: K1_U2 can read with understanding design technical documentation and simple technological schematics of automation and robotics systems; K1_U8 is able to use information and communication techniques; Social competences: K1_K2 is aware of the importance of and understands the non-technical aspects and effects of engineering activities, including their impact on the environment and the related responsibility for decision-making;is willing to take care of the achievements and traditions of the profession;

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 designing simple automation and robotics systems; knows and understands the principles of selecting execution systems, computing units
K1_W22 knows and understands the basic processes occurring in the life cycle of devices and selected protection systems used in automation and robotics;

Skills:
K1_U1 is able to acquire information from literature, databases and other sources also in a foreign language;
K1_U11 is able to determine and use models of simple electromechanical systems and selected industrial processes, as well as use them for the purpose of analysis and design of automatics systems;
K1_U12 is able to select the type of measuring system, control unit and peripheral modules.
K1_U22 is able to select the type and parameters of a measuring system, a control unit and peripheral and communication modules for a selected application, and to integrate them in the form of a resultant

Social competences:
K1_K3 is aware of the responsibility for his/her own work and is ready to follow the rules of teamwork and take responsibility for tasks performed jointly; he/she is able to manage
K1_K5 is aware of the necessity to have a professional approach to technical issues, to be scrupulously familiar with documentation and environmental conditions in which the equipment and its elements

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

To learn about the construction, principle of operation and methods and structures of advanced control systems for electrical drive systems used in heavy industry, industrial robots, electric vehicles, aircraft, domestic appliances.

Course topics

Lecture:
General structure of an automated drive system. Drive control systems used in heavy industry (drives with DC and AC motors (ACIM - squirrel-cage motors)). Control systems for electric drives in industrial robots (drives with PMSM motors), drones (drives with BLDC motors), household appliances (drives with universal motors, 1-phase induction, DC). Control of drive systems with complex and variable dynamic structure (friction, variable moment of inertia, backlash, elasticity in two-mass and multi-mass systems); Control problems of positioning servo drives. Control of electric drives used in cars, buses, trains, autonomous vehicles (electromobility, specific control of electric drives in vehicles, control in Zone II with weakened magnetic flux); (drives with ACIM motors, synRM (synchronous reluctance motors), SRM (switched reluctance motors). Electric drives used in aircraft - inertial drive, high speed drives.
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. Kaczmarek T. , Napęd elektryczny robotów, Wydawnictwo Politechniki Poznańskiej, Poznań, 1998
3. Kaźmierkowski M.P, Tunia H., Automatic Control of Converter-Fed Drives, ELSEVIER, Amstertdam, London, New York, Tokyo, Warszawa , 1994
4. Zawirski K., Deskur J., Kaczmarek T., Automatyka napędu elektrycznego, Wydawnictwo Politechniki Poznańskiej, Poznań, 2012.
5. Lech Grzesiak L., Kaszewski A., Ufnalski B.: Sterowanie napędów elektrycznych. Analiza, modelowanie, projektowanie. Wydawnictwo Naukowe PWN, Warszawa 2016.
6. Sieklucki G., Bisztyga B., Zdrojewski A., Orzechowski T., Sykulski R.: Modele i zasady sterowania napedami elektrycznymi, Wydawnictwo AGH, Kraków 2014.

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
5. Deskur J., Pajchrowski T., Zawirski K.: ?Speed Controller for a Drive With Complex Mechanical Structure And Variable Parameters?, Proceedings of 16th International Power Electronics and Motion Control Conference and Exposition, PEMC?2014, 21-24 September 2014, Antalya/Turkey, CD.
6. Brock S., Łuczak D., Nowopolski K., Pajchrowski T., Zawirski K.: Two Approaches to Speed Control for Multi-Mass System With Variable Mechanical Parameters, IEEE Transactions on Industrial Electronics, VOL. 64, NO. 4, APRIL 20
7. Zawirski K., Janiszewski D., Muszyński R.: Unscented and Extended Kalman filters study for Sensorless Control of PM Synchronous Motors with Load Torque Estimation, Bulletin of Polish Academy of Sciences ? Technical Sciences, vol. 61, No. 4, 2013
8. Fabiański B., Zawirski K.: Simplified model of Switched Reluctance Motor for real-time calculations, Przegląd Elektrotechniczny, ISSN 0033-2097, R. 92 NR 7/2016
9. Nowopolski K., Wicher B., Zawirski K.: Experimental Analysis of Selected Control Algorithms of Electromechanical Object with Backlash and Elastic Joint, IEEE 17th International Conference on Power Electronics and Motion Control, Varna, Bulgaria, 25 ? 30 of September 2016
10. Szczesniak P., Urbanski K., Fedyczak Z., Zawirski K.: Comparative study of drive systems using vector-controlled PMSM fed by a matrix converter and a conventional frequency converter, TURKISH JOURNAL OF ELECTRICAL ENGINEERING & COMPUTER SCIENCES, vol. 24, pp. 1516?1531, 2016

Breakdown of average student's workload

	Hours	ECTS
Total workload	100	4,00
Classes requiring direct contact with the teacher	47	2,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	53	2,00