COURSE DESCRIPTION CARD - SYLLABUS

Course name
Control of machines and devices [S1Mech2>SMiU]

Course

Field of study
Mechatronics

Year/Semester
3/5

Area of study (specialization)
–

Profile of study
general academic

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

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Lecturers

Prerequisites

Knowledge: 1. Structure, operation, and parameters of PC, IC, and PLC computer controllers, and their real-time operating systems. 2. Signal transmission methods and communication interfaces used in computer controllers. 3. Programming computer controllers and implementing control algorithms. 4. Basic components of electric drive systems (motors, gearboxes, couplings, sensors). Skills: 1. Selection of appropriate computer controllers and their components. 2. Designing control systems for mechatronic devices. 3. Implementing control systems based on PLCs and microcontrollers. 4. Programming computer controllers in high-level languages. Social Competences: 1. Understanding the need for lifelong learning and the ability to organize the learning process of others. 2. Awareness of the role of automation in the economy and its impact on societal development. 3. Ability to set priorities to achieve specific tasks.

Course objective

Familiarizing students with the construction, operation, and control methods of mechatronic machines and devices. The course covers both theoretical and practical issues related to the design and implementation of control systems.

Course-related learning outcomes

Knowledge:
1. Structure, operation, and parameters of PC, IC, and PLC computer controllers, and their real-time operating systems.
2. Signal transmission methods and communication interfaces used in computer controllers.
3. Programming computer controllers and implementing control algorithms.
4. Basic components of electric drive systems (motors, gearboxes, couplings, sensors).

Skills:
1. Selection of appropriate computer controllers and their components.
2. Designing control systems for mechatronic devices.
3. Implementing control systems based on PLCs and microcontrollers.
4. Programming computer controllers in high-level languages.

Social competences:
1. Understanding the need for lifelong learning and the ability to organize the learning process of others.
2. Awareness of the role of automation in the economy and its impact on societal development.
3. Ability to set priorities to achieve specific tasks.

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Lecture: Written exam covering theoretical issues from the lectures.
Laboratory: Pass based on the correct completion of exercises and the preparation of reports for each laboratory exercise according to the instructor's guidelines. Short entry tests are conducted before selected exercises. To pass the laboratory, all exercises must be completed successfully.

Programme content

The course covers issues related to the construction and operation of control systems for machines and devices, including PLC controllers and microcontrollers. It discusses signal transmission methods, ways to connect computer systems with control devices, and the implementation of control algorithms. Participants also learn methods for controlling drives such as DC motors, BLDC motors, stepper motors, PMSMs, and electro-hydraulic servo drives. Additionally, the course covers inertial sensors, signal filtering, and advanced functions in PLC controllers.

Course topics

Lecture Topics:
1. Structure of machine and device control systems.
2. Methods of connecting computer systems with PLC or microprocessor controllers.
3. Signals, their encoding, and data transmission in control systems.
4. Construction and operation of PC, IC, and PLC computer controllers.
5. Programming computer controllers - languages and tools.
6. Examples of control algorithms in mechatronic systems.
7. Pulse control: introduction to ideal pulse generators and zero-order extrapolators.
8. Basic components of electric drive systems: electric motors, gearboxes, couplings, measurement systems (encoders, resolvers), limit switches, and sensors for drive referencing, mathematical description.
9. Construction of DC motors, mathematical models, basic characteristics, position, speed, and torque control, control systems, discrete PID regulators.
10. Construction of stepper motors, mathematical models, basic characteristics, control methods, connection with microcontrollers/PLCs.
11. Construction of asynchronous and brushless DC motors (BLDC), control methods, applications.
12. Construction of PMSM motors, mathematical models, control methods, applications.
13. Implementation of electric drives on PLC controllers, advanced functions: drive libraries, CAM-automation, virtual cams.
Laboratory Topics:
1. Basics of object-oriented programming in PLC controllers.
2. Implementation of object models on controllers.

3. Serial communication between controllers and computer systems.
4. Inertial sensors and signal filtering.
5. Characteristics of DC motors.
6. PID (positional) control of DC motors.
7. Control of stepper motors.
8. Control of BLDC motors (sensor-based and sensorless).
9. Control of asynchronous motors.
10. Control of PMSM drives using PLCs.
Some exercises are performed in a rotational system.

Teaching methods

1. Lecture: multimedia presentation, presentation illustrated with examples given on a board, discussion and problem analysis.
2. Laboratory exercises: practical exercises, problem solving, discussion, teamwork
3. Design: making your own electronic system

Bibliography

Basic:
1. Skalski, L., "Linux. Basics and Applications for Embedded Systems," BTC Publishing, 2012.
2. Kuźniar K., Lal L., Rak T., "Programming in Linux. Exercises," Helion Publishing, 2012.
3. Kwiecień R., "Computer Systems of Industrial Automation," BTC Publishing, 2012.

Additional:
1. Monk S., "Raspberry Pi. A Guide for Python Programmers," Helion Publishing, 2014.
2. Przepiórkowski J., "Electric Motors in Electronics Practice," 2nd Edition.
3. Grzesiak L., Kaszewski A., Ufnalski B., "Control of Electric Drives."

Breakdown of average student's workload

	Hours	ECTS
Total workload	100	4,00
Classes requiring direct contact with the teacher	62	2,50
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	38	1,50