COURSE DESCRIPTION CARD - SYLLABUS

Course name
Programmable industrial automation systems

Course

Field of study	Year/Semester
Automatic Control and Robotics	1/2
Area of study (specialization)	Profile of study
Vision systems	general academic
Level of study	Course offered in
Second-cycle studies	Polish
Form of study	Requirements
full-time	elective

Number of hours

Lecture	Laboratory classes	Other (e.g. online)
30	15	0
Tutorials	Projects/seminars	
0	15	

Number of credit points

4

Lecturers

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Prerequisites

Knowledge: The student starting this course should have basic knowledge of ladder and block programming and know the concepts of programming in high-level languages

Skills: Should have the ability to solve basic problems related to the implementation of algorithms and the selection of parameters, and the ability to obtain information from the indicated sources. It should also be ready to work as a team.

Social Competences: In addition, in terms of social competences, the student must show such qualities as honesty, responsibility, perseverance, cognitive curiosity, creativity, personal culture, respect for other people.

Course objective

1. Provide students with basic knowledge of programmable automation systems, their design and implementation.

2. Developing students' skills in solving problems related to the selection of appropriate parameters, programming methods and equipment for the implementation of programmable automation systems.

3. Shaping students' teamwork skills in the implementation of projects.

Course-related learning outcomes

Knowledge

A student:

1. possess specialist knowledge in the field of remote and distributed systems, real-time systems and network techniques - [K2_W3].

2. understands the methodology of designing specialized analog and digital electronic systems - [K2_W4].

3. has advanced and deepened knowledge of methods of analysis and design of control systems, - [K2_W7]

4. knows and understands the principles of designing programmable automation systems and has the knowledge necessary for their practical implementation - [-].

Skills

A student:

1. can integrate and program specialized robotic systems - [K2_U12].

2. can make a critical analysis of the functioning of control systems and robotics systems; also has the ability to select automation systems with the use of microprocessor controllers - [K2_U19].

3. can identify elements and control systems and formulate a design specification of a complex control system, taking into account non-technical aspects - [K2_U21].

4. is able to build an algorithm for solving a complex and unusual measurement and computing-control task and implement, test and run it in a selected programming environment on a microprocessor platform, - [K2_U26]

5. can design control systems for complex and atypical multidimensional systems; is able to consciously use standard functional blocks of automation systems and shape the dynamic properties of measurement paths, - [K2_U27]

Social competences

1. A student is aware of responsibility for their own work and is ready to submit to the principles of teamwork and responsibility for jointly performed tasks; can lead a team, set goals and define priorities leading to the implementation of the task - [K2_K3].

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Formative assessment:

a) in the scope of lectures:

based on answers to questions about the material discussed in previous lectures

b) in the scope of laboratories and projects, assesment of the assumed learning outcomes is based on:

i. assessment of student's preparation for individual sessions of laboratory classes ("entrance" test)and assessment of skills related to the implementation of laboratory exercises,

ii. continuous assessment, during each class (oral answers) -rewarding the increase in the ability to use known principles and methods,

iii. assessment of the laboratory reports prepared partly during the classes and partly at home; this assessment also includes teamwork skills.

Obtaining additional points for activity during classes, in particular for:

i. discuss of additional aspects of the issue,

ii. effectiveness of applying the acquired knowledge while solving a given problem,

iii. ability to work as part of a team that practically performs a specific task in the laboratory,

iv. comments related to the improvement of teaching materials,

v. indicating students' perceptive difficulties enabling ongoing improvement of the didactic process.

Summative assessment:

a) in the scope of lectures the verification of the assumed learning outcomes is carried out by:

i. assessment of the knowledge and skills shown in the exam - written work containing problem questions and written calculation tasks; getting 50% of the number of total points give a positive rating, the questions are a detailed version of the issues made available to students in order to prepare for the exam,

ii. discussion about exam results,

b) in the scope of laboratories and projects, it is a resultant assessment resulting from the formative assessments.

Programme content

The lecture covers the following topics:

1. Introduction to the issues of using PLC controllers: RS and SR trigger, motor current braking, automatic door opening, temperature control, technological process control algorithms in automatic and manual operation mode, device failure detection algorithms, control algorithms for PLC controllers.

2. PLC modules: CPU CPU, discrete input module, discrete output module, analog input module, analog output module, high-speed counter, communication ports.

3. Programmable Automation Controllers (PAC).

4. Communication protocols and networks: RS232, RS485, Modbus, Ethernet, Profibus, CANOpen, GSM / GPRS.

5. Programming languages according to IEC61131-1 standard, ladder programming language LAD: data types, relay functions, counters, arithmetic functions, relation functions, functions on bit sequences, conversion functions, control functions, PID function block.

6. IL instruction list language: data types, logical functions, input and transfer operations, timers, counters, arithmetic functions, relation functions, functions on bit sequences, data blocks, conversion functions, control functions.

7. Sequence Graph? SFC language: start block, active block, transition, alternate branch, concurrent sequence.

8. FBD function block diagram language, ST structural language.

9. NI LabVIEW graphical programming environment: vi implementation, data acquisition, modular applications, event programming, typical program diagrams, user interface, support for communication interfaces, built-in functions.

10. Numerical calculations in PLCs: specificity of operations on integers, designing integer algorithms.

11. System supervising the course of the technological or production process: SCADA, distributed PLC control, telemetry, HMI interface, data logging; discussion of selected SCADA systems.

12. Overview of PLC controllers from various manufacturers: ABB, Allen-Bradley, Fatek, GeFanuc, Honeywell, Kinco, Mitsubishi, Moeller Electric, Omron, Panasonic, Schneider Electric (Modicon), Siemens (Simatic), Unitronics, Vipa, LG.

13. Construction of the system with visual coupling: intelligent camera, programmable image processing module, programmable control module; discussion of existing solutions and development trends.

14. Construction and types of vision sensors: CCD, CMOS image sensor; digital image representation, data processing processor, program, communication interface, input / output lines, lens, illuminator; application of intelligent cameras (automatic control, detection of defects and deficiencies, non-contact

measurements, sorting, robot vision systems, code reading, biometrics, sensor networks, surveillance systems).

15. System with video coupling on the example of NI Vision Assistant product: system features, installation, programming of the image processing and control process, use of NI LabVIEW VI or C language.

Laboratory classes are conducted in the form of seven 2-hour exercises in the laboratory, preceded by a 1-hour instructional session at the beginning of the semester. Individual exercises are performed by teams of 2/3 people.

Laboratory exercises topics:

1. Introduction to the TIA Portal environment: getting to know the structure of the program window, configuration of the Simatic s7-1200 controller and creating a new project; an introduction to LAD programming.

2. Types of variables and data blocks: getting to know the types of variables supported by the Simatic s7-1200 controller, local and global variables, controller inputs and outputs, variable addressing; creating, configuring and using DB data blocks.

3. Functions and function blocks: getting to know the types of program blocks supported by the Simatic s7-1200 controller; OB organization blocks (organization block), FB function blocks (function block), FC functions (function).

4. Adding the operator panel to the project: configuration of communication between the controller and the HMI KTP600 Basic Color panel, programming of the panel screens.

5. Configuration of the Ethernet connection between two controllers: PROFINET protocol; IP addressing and subnet configuration.

6. Automatic visual inspection part I: hardware configuration of the Keyence IV-500C vision sensor; getting acquainted with the vision inspection tools supported by the sensor, getting acquainted with the properties of the Position, Area, Color tools; implementation of test vision inspections.

7. Automatic visual inspection, part II: self-implementation of complex video inspection; integration of the operator panel, controller and vision sensor; consolidation and integration of acquired skills.

Design classes (projects) are conducted in the form of seven 2-hour meetings, preceded by 1-hour organizational classes. Projects are carried out by 2/3-person teams. During the design classes, students use the knowledge and skills acquired during the laboratories as well as the learned issues for the practical implementation of a laboratory automation system.

Teaching methods

1. Lecture: multimedia presentation, presentation illustrated with examples given on the board, solving problems

2. Laboratory classes: problem solving, practical exercises, conducting experiments, case studies, teamwork

3. Design classes (projects): implementation of a given project, team work

Bibliography

Basic

1. Wstęp do programowania sterowników PLC, Sałat R., Korpycz K., Obstawski P., WKŁ, Warszawa, 2010

2. terowniki PLC w praktyce inżynierskiej, Kwaśniewski J., Wydawnictwo BTC, Legionowo, 2008

Additional

1. Programowanie sterowników PLC zgodnie z normą IEC61131-3 w praktyce, Kacprzak S., Wydawnictwo BTC, Legionowo, 2011

2. Programowanie sterowników PLC w języku drabinkowym, Flaga S., Wydawnictwo BTC, Legionowo, 2010

3. Wprowadzenie do zagadnień sterowania ? wykorzystanie programowalnych sterowników logicznych PLC, Seta Z., MIKOM, 2000

4. Programowanie sterowników PLC, Legierski T., Kasprzyk J., Wyrwał J., Hajda J., Wydawnictwo Pracowni Komputerowej Jacka Skalmierskiego, Gliwice, 2008

5. Programowalne sterowniki przemysłowe w systemach sterowania, Kwaśniewski J., Fundacja Dobrej Książki, Kraków, 1999

Breakdown of average student's workload

	Hours	ECTS
Total workload	100	4,0
Classes requiring direct contact with the teacher	60	2,5
Student's own work (literature studies, preparation for laboratory classes/tutorials, preparation for tests/exam, project preparation) [1]	40	1,5

[1] delete or add other activities as appropriate