COURSE DESCRIPTION CARD - SYLLABUS

Course name

Programmable controllers and industrial networks

Course

Field of study

Automation and robotics

Year/Semester

4/7

Area of study (specialization)

Profile of study

general academic

Level of study

First-cycle studies

Course offered in

polish

Form of study

full-time

Requirements

elective

Number of hours

Lecture

15

Laboratory classes

30

Other (e.g. online)

0

Tutorials

0

Projects/seminars

0

Number of credit points

3

Lecturers

Responsible for the course/lecturer:

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Engineering

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Responsible for the course/lecturer:

Prerequisites

Knowledge: A student starting this course should have basic knowledge of: programming, construction and operation of Programmable Controllers (PLCs), basics of automation and control systems, basics of electronics, use of programming tools in Windows operating system.

Skills: He/she should have the ability to solve basic problems with the use of programming tools to perform control and communication tasks and the ability to obtain information from indicated sources.

Social competences: In addition, in the field of social competences the student must present such attitudes as honesty, responsibility, perseverance, cognitive curiosity, creativity, personal culture, respect for other people.

Course objective

1. Providing students with basic and advanced knowledge on programming and application of programmable controllers in control systems and distributed control processes, in terms of algorithmisation and writing a machine or process control program using industrial network communication in a program executed by a programmable controller, use of programming tools to execute control and communication tasks.

2. Acquiring knowledge and skills of applying algorithms and control schemes in programmable equipment for the implementation of industrial process control, selected industrial communication systems of programmable equipment for the implementation of industrial process control, acquiring the ability to use selected programming languages (SCL, STL) designed for the programming of a control system, acquiring the ability to use tools used for the programming of industrial systems.

3. Developing in students the ability to solve problems in the field of industrial control system programming and the use of network communication.

Course-related learning outcomes

Knowledge

1. has an elementary knowledge of the operation and use of IT tools designed for rapid prototyping and design, simulation and visualization of automation and robotics systems and systems, as well as for recording mechanical structure design;

2. has knowledge of the structure and principle of operation of programmable controllers used to automate stations and processes;

3. knows the basics of industrial network communication;

4. is familiar with the basic methods, techniques, tools and materials used to solve simple engineering tasks in the field of automation and robotics;

5. is familiar with communication integration tools for distributed control systems;

Skills

1. is able to designate and use models of simple electromechanical systems and selected industrial processes, as well as use them for analysis and design of automation and robotics systems;

2. is able to use selected tools for rapid prototyping of automation and robotics systems;

3. is able to select parameters and settings of a basic industrial controller and to configure and program an industrial programmable controller;

4. is able to assess the usefulness of routine methods and tools for designing automation and robotics systems, and to select and apply an appropriate method and tools;

5. is able to design and implement a local ICT network (including industrial network) through the selection and configuration of communication elements and devices;

6. is able to use a selected programming language of the controller in order to write a programme;

7. is able to build the controller's program structure with the use of programming tools;

8. is able to build a structure of a selected industrial communication network with the use of the programmer's tools and to program it;

Social competences

1. is aware of the responsibility for his/her own work and willingness to comply with the rules of teamwork and take responsibility for jointly implemented tasks; is able to lead a small team, set goals and define priorities leading to task implementation;

2. is able to appropriately define priorities for the implementation of a task defined by him/her or other tasks;

3. is aware of the necessity of a professional approach to technical issues, scrupulous familiarisation with the documentation and environmental conditions in which the equipment and its elements may operate, observance of the rules of professional ethics and respect for diversity of views and cultures;

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

The knowledge acquired during the lecture is verified in one 45-minute colloquium during the 7th lecture. The colloquium consists of 8-10 questions (test and open questions), differently scored. The credit threshold: 50% of points. Credit issues on the basis of which the questions are prepared are made available to students using the university's e-mail system or remote access WEB.

The skills acquired in the laboratory classes are verified on the basis of the reports and the final credit colloquium, consisting of 5-7 questions/tasks with different scores depending on their level of difficulty. The credit threshold: 50% of points.

Programme content

The programme of the lecture includes:

W1. Discussion of the construction and operation of a programmable controller: modularity of the construction, configurability, hardware inputs and outputs, real-time system and its implementation, clock and event interruptions, tools for programming the controller, the programmer as a programming environment, communication between the programmer and the controller, discussion of the controller programmer and the rules of using it, representation of the project in the programmer and in the controller, the formula of modular project construction and evaluation of its modules, module properties, organizational blocks, project archiving.

W2. Programming: elementary and complex data types, numerical formats, EN/ENO mechanism, program processing and OB blocks, program structures, interruptions, error handling, variable types, programming languages, analogue card software handling.

W3. Structural programming of controllers: hierarchy of program modules, functions, function blocks, user data blocks (programmers) and functions, function blocks, system data blocks, function and local data stack, parameterized blocks, multiple model of local data block, modifications of parameterized block, function conversions.

W4. STL programming language (STatment List): status word register, logical operations, word logical operations, conversion operations, comparisons, arithmetic, extended mathematical operations, shift and rotation operations, battery operations, data block instructions, program control, charging and transfer operations, time and counter relay operations, basic addressing types, indicators, registers, indirect addressing, program examples.

W5. Practical implementations of controllers in programmable controllers: PID controller, two-position/triposition controller, implementation examples.

W6. Program testing tools: diagnostic properties of the controller and programmer and simulator, program structure indicators, program cycle and memory space indicators, diagnostic buffer, program references to the status word, data reference lists, local data stack, call stack, stack of interruptions, priorities of organisational blocks, cyclical and one-time program start-up, identification of communication errors.

W7. Industrial Ethernet networks: PROFInet and EtherCAT: base protocols, network operation models, communication channels, determinism - isochronous cycles, configuration schemes, format, types and processing of datagrams, application layer functions, examples for Profinet.

The laboratory exercises are carried out in 3-person teams, which use 6 workstations equipped with configured computer and communication equipment, programming tools and programmable controllers and measuring and executive devices. Laboratory tasks consist in hardware and software configuration of devices connected in field networks, writing a program for a controller or controllers, their commissioning and testing until the correctness of operation is achieved.

The programme of laboratory exercises:

C1. Programming procedures for generating time-varying signals on digital outputs integrated with the CPU and distributed.

C2. Processing and recording of analogue quantities to buffers of a fixed length depending on the observation horizon.

C3. Processing and recording of electric drive position and speed measurements.

C4. Controlling a variable speed pump and recording of measurements of selected parameters of the hydraulic system.

C5. Execution of speed control of a mechanism driven by an asynchronous motor with an inverter.

C6. Using the machine safety system in programming the PLC.

C7. Control of portal manipulator drives through the communication network.

Teaching methods

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

2. Laboratory exercises: introduction to the task, programming the task and its verification, testing the results of the written controller programme for a given exercise.

Bibliography

Basic

1. Statement List (STL) for S7-300 and S7-400 Programming, Reference Manual, 6ES7810-4CA10-8BW1, Siemens 05/2010.

2. J. Kwaśniewski, Programowalny sterownik SIMATIC S7-300 w praktyce inżynierskiej, Wydawnictwo BTC, Legionowo 2009.

3. Help on Statement List, LAD/STL/FBD: Program blocks, (c) STEP7/M7/C7, ver. 5.5, Siemens AG, 1995-2010.

Additional

1. STEP7 Professional, Reference Manual, Siemens A.G., 1998.

2. Ladder Logic (LAD) for S7-300 and S7-400 Programming, Reference Manual, 6ES7810-4CA10-8BW1, 05.2010, Siemens A.G.

3. S7-CPs for Industrial Ethernet. Manual Part B3A, Release 2/2006, SIEMENS 2006.

4. Technology EtherCAT Protocol, Hardware Data Sheet Section I, v. 2.2, Beckhoff 2014.

5. SIMATIC System Software for S7-300/400 System and Standard Functions,Reference Manual, Edition 03/2006, SIEMENS, 6ES7810-4CA08-8BW1.

Breakdown of average student's workload

	Hours	ECTS
Total workload	80	3,0
Classes requiring direct contact with the teacher	45	2,0
Student's own work (literature studies, preparation for laboratory classes/tutorials, preparation for tests/exam, project preparation) [1]	35	1,0

[1] delete or add other activities as appropriate