COURSE DESCRIPTION CARD - SYLLABUS

Course name

Programming transmission concerns in PLC controllers

Course

Field of study

Computing

Year/Semester

2/4

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

16

Laboratory classes

16

Other (e.g. online)

Tutorials

Projects/seminars

Number of credit points

3

Lecturers

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Prerequisites

A student starting this subject should have:

1. basic knowledge of electrical engineering, electronics, automation, digital technology, mathematical logic, measurement systems and executive systems.

2. The ability to solve the basic issues of system and software development of certain logical-functional structures, plotting ways of presenting their operation and creating algorithms for operating systems with conditional operation.

3. the ability to obtain information from the indicated sources.

In addition, in terms of social competence, the student must be characterized by honesty, responsibility, perseverance in solving the issues of the subject, cognitive curiosity, creativity and personal culture.

Course objective

1. to provide students with basic knowledge of the construction, operation, programming and application of programmable logic controllers and their selection for monitoring and controlling a technological process.

2. to acquire the principles of correct creation of a control system using a PLC including: declaration of system variables, algorithm of its operation, creation of a program and its verification.

3. to acquaint students with the structure, configuration and programming of serial ports of selected PLCs, RS standards of transmission and communication with open systems and security of transmitted data.

Course-related learning outcomes

Knowledge

1. The student has a structured, theoretically underpinned general knowledge of the properties and applicability of PLCs for selected technological processes, ways of their programming and application program testing.

2. The student has theoretically supported detailed knowledge related to selected issues of PLC programming.

3. the student has the knowledge necessary to:

- design an automation system using a PLC,

- develop an algorithm for signal processing and generation in a PLC,

- provide communication between PLCs,

- implement the processing algorithm in the PLC.

Skills

As a result of the course, the student is able to:

- obtain information from the literature on the subject and other sources, integrate them and interpret them,

- use analytical, simulation and experimental methods used during laboratory exercises to formulate and solve engineering tasks and simple research problems,

- design and implement a simple automation system based on a PLC.

- define and describe a system solution for a specific data transmission task,

- design the adopted solution on a selected PLC platform,

- run and verify the correct operation of the adopted system solution.

Social competences

As a result of the course, the student will acquire the competencies listed below. Passing the course means that the student:

- understands that there is constant modernization in the field of PLCs and their programming, requiring constant improvement of the skills of their application,

- knows examples and understands the causes that can lead to malfunctioning systems with PLC,

- is able to appropriately determine priorities to achieve a specific task in the field of PLC programming.

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Formative assessment:

a) for lectures:

● on the basis of answers to questions on the material discussed in previous lectures,

b) in terms of laboratories:

● on the basis of the evaluation of the current progress of the tasks.

Summative assessment:

a) in the field of lectures, verification of the established learning outcomes is realized by:

● assessment of knowledge demonstrated on a written problem-based assessment test: 10÷15 open-ended questions from the subject matter of the lectures without the right to use lecture notes; scoring (given) depending on the difficulty of the question on a scale of 1÷3 points; sufficient grade from 51% of the maximum number of points.

● discussion of test results,

b) in the field of laboratories, verification of the established learning outcomes is realized by:

● assessment of skills related to the implementation of laboratory exercises, this assessment also includes the ability to work in a team.

● continuous evaluation, at each class (oral answers) - bonus of incremental skills in the use of learned principles and methods,

● evaluation of the report prepared in the event of failure to complete a given exercise in the laboratory classes; (this also results in the need to complete the exercise outside of class) and evaluation of the report on the problem task assigned to your own solution.

Obtaining extra points for activity during laboratory classes, especially for:

- discussion of additional aspects of the issue,
- effectiveness of application of acquired knowledge during solving the assigned problem,
- comments related to the improvement of teaching materials,
- pointing out students' perceptual difficulties enabling ongoing improvements in the didactic process.

Programme content

The lecture program includes the following topics:

1. Discussion: subject matter, literature and credit conditions. Introduction: definition of PLC; freely programmable controller. Overview of PLC products from various companies. Compact and modular controllers: characteristics, configuration, kit completion. Expansion modules of the controller. Operator terminal. PLC programming languages.

Programmable relays - characteristics and possibilities on the example of controllers: LOGO (Siemens), Alpha XL (Mitsubishi Electric), Need (Relpol) and Easy (Moeller). I/O circuitry.

AlphaXL controller: place of the controller in the PLC hierarchy, construction and expansion possibilities, input and output signals, operator terminal functions. Input of analog signals. Communication with the environment. AL-VLS tool software and its functions: function blocks. Alpha XL controller programming: creation of logic functions, binary signal processing, memory, counter, arithmetic, time, communication and special blocks and circuits.

2. Binary channel, basic definitions: transmission coding, modulation, modulation rate and transition. Structure of the UKTD data transmission terminal device. Interfaces: RS232, RS422, RS485 for communication with PLC: parameters, signals, control of data transmission. FX compact controller: hardware characteristics of FX family; input and output of binary, analog and transmission signals to/from controller. Possibilities and limitations of modular expansion of the controller; external devices working with the controller.

3. FX. Internal devices - operands of logical and advanced instructions; order of actions in a program loop and loop cycle time. Characteristics of the controller's instructions: ladder program elements; basic instructions of the controller: creating simple and block logic functions, differentiation of the state of a binary variable, memory of the state of a binary point of a logic network, counter and time relays. System binary variables of status and initialization, and numeric variables of status and diagnostic.

4. FX. Characteristics of advanced instructions and their notation for 16- and 32-bit operations; instructions for changing the order of program execution; comparison, transfer, decoding and enko-dation instructions; arithmetic of controller processing: ranges of numeric variables, arithmetic and logical instructions; quadratic notation for writing binary operands; index addressing; floating-point operations. SFC state sequence programming: cyclic and multistate processes: process state graph and state network: decomposition of states and definition of transition conditions; construction of state sequence network in tool software: state markers, start states, alternative and parallel process state

divergence/divergence, instructions to change the order of execution of state functions and exit from SFC section; order of PLC program creation with SFC section.

5. FX compact controller: programming of external communication serial sweeps: hardware configuration; instructions for operating the controller's built-in serial ports. External communication smart modules: RS and network.

6. Redundant serial data protection. Linear codes in matrix and polynomial notation; properties of linear codes. Control matrix and generating matrix; Hamming distance, distribution of weights, detection and correction capability of the code. Polynomial serial coding "on the fly".

Laboratory exercises are performed in pairs.

Each of the 8 exercise stations is equipped with a PC with controller programming software tools and Mitsubishi Electric's Alpha XL and FX PLCs. Each computer contains the contents of the exercise tasks as well as the manufacturer's literature on PLCs in Polish and English. The exercise tasks consist of writing a program, running it and testing it until it is working correctly. Within one exercise, depending on the topic of the exercise, the group performs from one to several tasks. Each student can obtain didactic tool software for a given type of controller, designed to write and test programs written by themselves.

Exercise topics:

1. AL: Introduction to programming the Alpha (AL) controller: communication with the controller; simulation and monitoring of the program; programming of memory circuit elements - flip-flops and their synthesis. Programming a 3-bit serial counter with state decoder. Visualization of the state of the counter and decoder on the operator panel and software counter.

2. AL: Asynchronous frame transmitter and receiver.

3. AL: Pump station simulator: programming of pump control systems and tank water level transmitter.

4. FX: Introduction to FX controller programming: GX-Developer utility: controller communication; program simulation and monitoring; basic instructions; flip-flops; logic function programming; pulse control with memory. Timer and counter relay programming: types of timers and counters;

5. FX. SFC programming : Direct reading of level transmitter from pumping station simulator.

6. FX or AL : Serial encoder based on polynomial generating g(x) for code (n,k) = (8,4).

Teaching methods

Lecture:

Multimedia presentation or demonstration of controller programming using a software tool.

Laboratory exercises:

Discussion on the topic of the exercise, programming the task and its verification, performing team experiments.

Bibliography

Basic

1. R. Mielcarek: Programowanie zagadnień transmisyjnych w sterownikach PLC. WPP, Poznań 2019.

2. R. Mielcarek: Programowanie sterowników PLC. WPP, Poznań 2012.

3. Legierski, J. Wyrwał, J. Kasprzyk, J. Hajda: Programowanie sterowników PLC. Wydawnictwo Pracowni Komputerowej Jacka Skalmierskiego, Gliwice 1998.

4. J. Kwaśniewski: Programowalne sterowniki przemysłowe w systemach sterowania. Wydawnictwo: Katedra Automatyzacji Procesów AGH, Kraków 1999.

5. W. Mielczarek: Szeregowe interfejsy cyfrowe. Helion, 1993.

6. S.Flaga: Programowanie sterowników PLC w języku drabinkowym. BTC 2010.

Additional

1. www.mitsubishi-automation.pl: Mitsubishi Electric PLC controllers: manuals: programming, communication and industrial networks of Alpha and FX controllers.

2. www.siemens.com: Siemens PLC controllers: manuals programming and communication controllers Logo and Simatic.

3. www.relpol.pl: Need controller - application and programming.

4. www.moeller.pl: Easy controller - properties, programming, application.

Breakdown of average student's workload

	Hours	ECTS
Total workload	75	3,0
Classes requiring direct contact with the teacher	32	1,5
Student's own work (literature studies, preparation for laboratory classes, preparation of reports, preparation for a final test) [1]	43	1,5

[1] delete or add other activities as appropriate