COURSE DESCRIPTION CARD - SYLLABUS

Course name
Programming and digital transmission in Programmable Logic Controller [N2Inf1-AMiWdIP>PLC]

Course

Field of study
Computing

Year/Semester
1/1

Area of study (specialization)
Mobile and Embedded Applications for the Internet of Things

Profile of study
general academic

Level of study
second-cycle

Course offered in
Polish

Form of study
part-time

Requirements
compulsory

Number of hours

Lecture
12

Laboratory classes
16

Other
0

Tutorials
0

Projects/seminars
0

Number of credit points

4,00

Coordinators

mgr inż. Tomasz Lemański
tomasz.lemanski@put.poznan.pl

Lecturers

Prerequisites

A student starting this course should have: 1. Basic knowledge of electrical engineering, electronics, automation, digital technology, mathematical logic, measurement systems and executive systems. 2. Ability to solve basic issues in system and program development specific logical-functional structures, graphical ways of presenting their operation and creating algorithms for handling systems with conditional operation. 3. Ability to obtain information from indicated sources. Moreover, in terms of social competences, the student must be honest, responsible and strength, perseverance in solving subject issues, cognitive curiosity, creativity and culture personal.

Course objective

1. Providing students with basic knowledge about construction, operation, programming and application programmable controllers and their selection for monitoring and controlling the technological process logical. 2. Learning the principles of correct creation of a control system using a PLC controller including: declaration of system variables, algorithm of its operation, creation of the program and its verification. 3. To familiarize students with the structure, configuration and programming of selected serial ports PLC controllers, RS standards for transmission and communication with open systems and security combining transmitted data.

Course-related learning outcomes

Knowledge:
1. The student has structured, theoretically based general knowledge in the field of properties and possibilities
applications of PLC controllers for selected technological processes, methods of their programming and testing the application program.
2. The student has theoretically based, detailed knowledge related to selected issues in the end of PLC programming.
3. The student has the knowledge necessary to:
- designing an automation system using a PLC controller,
- development of an algorithm for processing and generating signals in a PLC controller,
- ensuring communication between PLC controllers,
- implementing the processing algorithm in the PLC controller.

Skills:
As a result of the classes, the student is able to:
- obtain information from the literature and other sources, integrate it and analyze it interpretation,
- use to formulate and solve engineering tasks and simple research problems analytical, simulation and experimental methods used during laboratory exercises,
- propose improvements (improvements) of existing technical solutions,
- design and implement a simple automation system based on a PLC controller.
- define and describe a system solution for a specific task,
- design the adopted solution on the selected PLC platform,
- run and verify the correct operation of the adopted system solution.

Social competence:
As a result of the classes, the student will acquire the competences listed below. Pass subject means that the student:
- understands that there is constant modernization in the field of PLC controllers and their programming, which is required
ensuring continuous improvement of the skills in their use,
- knows examples and understands the causes that may lead to malfunctioning systems PLC controller,
- is able to appropriately determine priorities for implementing a specific task in the field of programming operation of PLC controllers.

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

The learning outcomes presented above are verified in the following way:
Formative assessment:
a) in terms of lectures:
● based on answers to questions about the material covered in previous lectures,
b) in the scope of laboratories:
●based on the assessment of the current progress of task implementation.
Summary rating:
a) in the scope of lectures, verification of the assumed learning outcomes is carried out by: ●assessment knowledge demonstrated on a written, problem-based final test: 10÷15 questions
open lectures without the right to use lecture notes; score (given)

depending on the level of difficulty of the question on a scale of 1÷3 points; satisfactory grade from 51% of the maximum
number of points.
●discussion of the test results,
b) in the field of laboratories, verification of the assumed learning outcomes is carried out by:
●assessment of skills related to the implementation of laboratory exercises, this assessment also includes skills
teamwork.
●continuous assessment in each class (oral answers) - rewarding the growth of skills
using the learned principles and methods,
●assessment of the report prepared in case of failure to complete a given exercise in class
laboratory; (this also results in the need to complete the exercise outside of class) and a grade
reports on a problem task assigned for your own solution.
Obtaining additional points for activity during laboratory classes, especially for:
●discussing additional aspects of the issue,
●effectiveness of applying the acquired knowledge when solving a given problem,
●comments related to the improvement of teaching materials,
●indicating students' perceptual difficulties enabling ongoing process improvement
didactic.

Programme content

The program of 6 2-hour lectures covers the following topics:
1. Discussion of: subject matter, literature and passing conditions. Introduction: driver definition
PLC; freely programmable controller. Overview of PLC products from various companies. Drivers
compact and modular: characteristics, configuration, set completion. Expansion modules
controller. Operator terminal. PLC programming languages.
Programmable relays - characteristics and possibilities based on the example of controllers: LOGO
(Simens), Alpha XL (Mitsubishi Electric), Need (Relpol) and Easy (Moeller). I/O circuits.
AlphaXL controller: the controller's place in the hierarchy of PLC controllers, structure and expansion possibilities,
input and output signals, operator terminal functions. Inputting signals
analog. Communication with the environment. AL-VLS utility software and its functions: blocks
functional. Programming the Alpha XL controller: creating logical functions, signal processing
binary, memory, counter, arithmetic, time and communication blocks and systems
and special.
2. Binary channel, basic definitions: transmission coding, modulation, modulation rate and transmission
mission. Structure of the UKTD data transmission terminal device. Interfaces: RS232, RS422, RS485
and USB for communication with the PLC: parameters, signals, data transfer control.
Alpha XL communication with the environment: additional RS232 communication port: configuration
communication: with the master controller using a modem or radio modem in the GSM network.
FX compact controller: hardware characteristics of the FX family; input and output
binary, analog and transmission signals to/from the controller. Possibilities and limitations
modular controller expansion; external devices cooperating with the controller.
3.FX. Internal devices – operands of logical and advanced instructions; sequence of actions
in the program loop and the loop cycle time. Characteristics of controller instructions: program elements
ladder; basic instructions of the controller: creating simple and block logical functions,
differentiation of the state of a binary variable, memory of the state of a binary point of a logical network, relays
counter and timers. System state and initialization binary variables and numeric variables
status and diagnostics. Support for external and time interrupts. Quick counters.
4.FX. Characteristics of advanced instructions and their notation for 16- and 32-bit operations; instructions
changing the order of program execution; compare, transfer, decode and enco-
docking; controller processing arithmetic: ranges of numerical variables, instructions
arithmetic and logic; quad notation for writing binary operands; index addressing;
floating point operations. SFC state sequence programming: cyclic and multi-processes
state: process state graph and state network: decomposition of states and determination of transition conditions;
building a network of state sequences in software: state markers, starting states,
alternative and parallel separation of process states, instructions to change the order of execution

state functions and output from the SFC section; the order of creating a PLC program with the SFC section.
5. FX compact controller: Programming serial external communication ports: configuration
hardware; instructions for using the controller's built-in serial ports. Intelligent modules
external communication: RS and network.
6. Redundant serial data protection. Linear codes in matrix and polynomial notation
new; properties of linear codes. Control and generation matrix; Hamming distance, distribution
weights, detection and correction ability of the code. Polynomial serial coding on the go.
Advanced Redundant Encoding Instructions in the FX Driver. Encoding and decoding
polynomials in the FX controller.
Laboratory exercises are performed in groups of 2 people during 8 2-hour classes.
Each of the 8 training stations is equipped with a PC computer with software
tool for programming controllers and a PLC controller from Mitsubishi Electric, type Alpha
XL and FX. Each computer contains the content of exercise tasks as well as the manufacturer's literature
regarding PLC controllers in Polish and English. The exercise tasks involve writing
program, running it and testing it until it works correctly. Within
one exercise, depending on the topic of the exercise, the group performs from one to several tasks.
Everyone
the student can receive teaching tool software for a given type of controller,
intended for writing and testing self-written programs.

Exercise topics:
1. Introduction to programming the Alpha (AL) controller: communication with the controller; simulation
and program monitoring; programming elements of memory systems - flip-flops and theirs
synthesis. Programming a 3-bit serial counter with a state decoder. Status visualization
counter and decoder on the operator panel and software counter.
2. AL: Asynchronous frame transmitter and receiver.
3. AL: Pumping station simulator: programming pump control systems and water level transmitter
in the tank.
4. Introduction to programming FX controllers: GX-Developer utility program: communication
with controller; program simulation and monitoring; basic instructions; flip-flops; program-
valence of logical functions; impulse control system with memory. Relay programming
timers and counters: types of timers and counters;
5.FX. SFC programming: Direct reading of the level transmitter from the pumping station simulator.
6. AL: Serial encoder by g(x) for code (n,k) = (7,4).
7. FX: Polynomial (16.8) encoder.
8. FX: Serial port support. Serial transfer via RS485 link between two controllers
nothing.

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Teaching methods

Lecture:
Multimedia presentation or presentation of controller programming using a utility program.

Laboratory exercises:
Discussion regarding the topic of the exercise, programming the task and its verification, performing experiments
team ments.

Bibliography

Basic:
1. R. Mielcarek: Programming transmission issues in PLC controllers. WPP, Poznań 2019.
2. R. Mielcarek: Programming PLC controllers. WPP, Poznań 2012.
3. Legierski, J. Wywał, J. Kasprzyk, J. Hajda: Programming PLC controllers. Pracownia Publishing House Komputerowa Jacek Skalmierski, Gliwice 1998.
4. J. Kwaśniewski: Programmable industrial controllers in control systems.
Publisher: Department of Process Automation, AGH, Kraków 1999.
5. W. Mielczarek: Serial digital interfaces. Helion, 1993.
6. S.Flaga: Programming PLC controllers in ladder language. BTC 2010.
Supplementary:
1. www.mitsubishi-automation.pl: Mitsubishi Electric PLC controllers: manuals: programming, communication
and industrial networks of Alpha and FX controllers
2. www.simens.com: Simens PLC controllers: Logo controller programming and communication manuals and Simatic.
3. www.relpol.pl: Need controller – application and programming.
4. www.moeller.pl: Easy controllers: properties, programming, application.

Breakdown of average student's workload

	Hours	ECTS
Total workload	100	4,00
Classes requiring direct contact with the teacher	28	1,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	72	3,00