COURSE DESCRIPTION CARD - SYLLABUS

Course name
Programming of Measurement and Control Systems [S2Teleinf2-ISS>PS]

Course

Field of study
Teleinformatics

Year/Semester
1/2

Area of study (specialization)
Intelligent control systems

Profile of study
general academic

Level of study
second-cycle

Course offered in
Polish

Form of study
full-time

Requirements
compulsory

Number of hours

Lecture
14

Laboratory classes
24

Other
0

Tutorials
0

Projects/seminars
0

Number of credit points

3,00

Coordinators

dr inż. Michał Maćkowski
michal.mackowski@put.poznan.pl

Lecturers

Prerequisites

A student has a basic knowledge of data structures and algorithms used in programming languages. A student has a practical knowledge of methodology and techniques of programming in high-level languages. A student has knowledge of computer systems, the operation of peripherals and the management of computer resources by operating systems. A student has knowledge of the theory of electrical circuits, electrical metrology, and electronic components and systems. Is able to extract information from literature, databases and other sources. Is able to participate in collaborative projects

Course objective

To introduce students to the modern measurement and control systems. To introduce students with the methods of programming measurement and control devices in the NI LabVIEW environment. Learning to prototyping FPGAs in the NI LabVIEW environment. Overview of the construction and operation of industrial PLC controllers. Learning the basics of PLC programming.

Course-related learning outcomes

Knowledge:
Has knowledge of the elements and structures of modern measurement and control systems as well as

the basics of automatic control systems.K2_W02
Has knowledge of the construction, principles of operation and programming of the PLC controllers.K2_W02
Has knowledge of the rules and basic structures of graphical programming in the NI LabVIEW environment. K2_W04
Has knowledge of the interfaces and communication standards in measurement and control systems.K2_W02

Skills:
Is able to use advanced programming mechanisms in the NI LabVIEW and available library programs.
Is able to choose the right PLC controller for the given control tasks. K2_U09
Is able to develop control programs for PLC in ladder language, function blocks language and structured text language.
Can retrieve data from literature, standards, and catalog cards in Polish or English, interpret the obtained information, and draw conclusions. K2_U01

Social competences:
A student is aware of the need for a professional approach to solved technical problems and taking responsibility for the proposed technical solutions.K2_K06
Can work in a group in the laboratory and perform team tasks.
Recognizes the legal, environmental, and utilitarian aspects of measurements and control. Has a sense of responsibility for the presented measurement results and control algorithms.

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Lecture:
Lectures passing based on one written and/or oral examt from content of the lectures. The exam contains from 3 to 8 questions. The issues for the test (20) are sent to students by e-mail.
Passing threshold 50% of the sum of points for the test.
Grading scale: <50% - 2.0 (ndst); 50% to 59% - 3.0 (dst); 60% to 69% - 3.5 (dst +); 70% to 79% - 4.0 (db); 80% to 89% - 4.5 (db +); 90% to 100% - 5.0 (bdb).
The passing threshold may change depending on the results of the tests.
Laboratory:
Skills achieved in the laboratory are assessed based on reports (summaries) from conducted laboratory exercises (RG) and final exam in the form of a self-implemented exercise or project (PG).
Social competences (SC) are assessed based on behavior and activity during classes as well as collaboration within a group.
The final grade (FG) is the weighted mean: FG = 0.5 RG + 0.3 PG + 0.2 SC
Grading scale:
5.0 for FG > 4.75;
4.5 for 4.75 > FG > 4.25;
4.0 for 4.25 > FG > 3.75;
3.5 for 3.75 > FG > 3.25;
3.0 for 3.25 > FG > 2.75;
2.0 for FG < 2.75.

Programme content

The program covers topics related to programming and designing measurement systems. Transferring knowledge about modern measurement and control systems. Constructing measurement and control systems. Methods of programming measurement and control devices in the NI LabVIEW environment. Construction and operating principle of industrial PLC controllers. Basics of PLC programming.

Course topics

Lecture:
1. Graphical programming languages. Integrated NI LabVIEW environment. Basics of programming in G language. Data types, local and global variables, operations on arrays and strings, control structures, state machine, event handling, queue management, hierarchical programming, subroutines and their

synchronization, error handling, library functions, program diagrams. Design patterns used in LabVIEW: state machine, data-driven, event loop, Master/Slave, Producer/Consumer. Multi-threaded application programming: pipelining, parallelization of operations. Help system in NI LabVIEW.
2. Construction, equipment and principle of operation of industrial PLC controllers. Basics of programming PLC controllers.
3. Elements of measurement and control systems.
The structure and organization of the measurement-control system. Classification and construction of signal acquisition systems. NI PXI, NI CompactDAQ, NI CompactRIO and NI MyRIO hardware platforms. Virtual measuring instrument.
Interfaces in measurement and control systems. The interface system definition, serial and parallel interfaces, synchronous and asynchronous transmission, serial interfaces: RS232 , I2C , SPI, UART; parallel interface IEEE 488 , IEEE 488.2 (SCPI) standard.
Parameters and characteristics of sensors. Examples of sensors of electrical and non-electrical quantities. Smart sensors.
Applications of FPGA circuits in measurement and control systems.
Laboratory:
Creating applications in the NI LabVIEW environment:
- using variables of different types,
- utilizing local, global, and shared variables,
- operations on arrays and strings,
- applying structured programming elements, control structures, event handling,
- queue management,
- understanding hierarchical programming, subroutines, and their synchronization,
- error handling, library functions,
- utilizing design patterns in LabVIEW: state machine, data-driven, event loop, Master/Slave, Producer/Consumer.
- multi-threaded application programming: pipelining, parallelization of operations,
- acquisition and processing of analog signals.
High-level programming of FPGAs. Real-time operating systems, response time to an event, clocking of processors and I / O circuits.
Application of intelligent measurement sensors: communication, reading and processing of measurement data.
Programming PLC controllers in ladder diagram (LD), function block diagram (FBD), and structured text (ST) languages in the Mitsubishi Electric GX Works 3 environment:
- implementation of logical functions in the PLC controller,
- utilization of counters and timers,
- utilization of registers and special relays of the PLC controller,
- implementation of sample control tasks.

Teaching methods

Traditional lecture: multimedia presentation, illustrated by demonstrations of discussed measurement systems and circuits, and conversational lecture (with elements of discussion). Possible hybrid lecture using e-learning tools from Poznan University of Technology.
Laboratory exercises: multimedia presentation with examples given on the blackboard and practical laboratory exercises according to the instructions.

Bibliography

Basic:
1. Dariusz Świsulski, Komputerowa technika pomiarowa. Oprogramowanie wirtualnych przyrządów pomiarowych w LabVIEW, Agenda Wydawnicza PAK, 2005.
2. Marcin Chruściel, LabVIEW w praktyce, Wydawnictwo BTC, 2008.
3. Wiesław Taczała, Środowisko LabView w eksperymencie wspomaganym komputerowo, Wydawnictwo WNT: PWN, 2017.
4. Stanisław Flaga, Programowanie sterowników PLC w języku drabinkowym, Wydawnictwo BTC, 2010.
5. Sławomir Kacprzak, Programowanie sterowników PLC zgodnie z normą IEC61131-3 w praktyce, Wydawnictwo BTC, 2011.

Additional:

1. Robert H. Bishop, LabVIEW Student Edition, National Instruments Inc.
2. Roman Mielcarek, Programowanie zagadnień transmisyjnych w sterownikach PLC : przewodnik do ćwiczeń laboratoryjnych, Wydawnictwo Politechniki Poznańskiej, 2019.
3. Robert Sałat, Krzysztof Korpysz, Paweł Obstawski, Wstęp do programowania sterowników PLC, Wydawnictwa Komunikacji i Łączności, 2014.

Breakdown of average student's workload

	Hours	ECTS
Total workload	78	3,00
Classes requiring direct contact with the teacher	38	1,50
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	40	1,50