POZNAN UNIVERSITY OF TECHNOLOGY

EUROPEAN CREDIT TRANSFER AND ACCUMULATION SYSTEM (ECTS)

COURSE DESCRIPTION CARD - SYLLABUS

Course name
Introduction to control and measurement systems [S1MiKC1E>WdSKP]

Course

Field of study	Year/Semester
Microelectronics and Digital Communication	2/4
Area of study (specialization)	**Profile of study**
–	general academic
Level of study	**Course offered in**
first-cycle	English
Form of study	**Requirements**
full-time	elective

Number of hours

Lecture	Laboratory classes	Other
24	30	0
Tutorials	**Projects/seminars**	
0	0	

Number of credit points

3,00

Coordinators

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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 measurements, and electronic components and systems. A student 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 control and measurement systems. Learning the structure of basic elements of control and measurement systems. To introduce students with the methods of programming measurement devices in the NI LabVIEW environment. Learning about the structure and working principles of industrial PLC controllers. Learning the basics of PLC programming

Course-related learning outcomes

Knowledge:
A student has knowledge of the elements and structures of control and measurement systems [K1_W02] [K1_W03] [K1_W11].
A student has knowledge of the interfaces and communication standards in control and measurement systems [K1_W11] [K1_W13].
A student has knowledge of the construction, principles of operation and programming of the PLC controllers. [K1_W03] [K1_W05] [K1_W11].
A student knows the basics of the configuration of automatic control systems [K1_W01] [K1_W02].
A student has knowledge of the rules and basic structures of graphical programming in the NI LabVIEW environment [K1_W05].

Skills:
A student is able to build a control and measurement system dedicated to the required measurement or control task [K1_U10] [K1_U11] [K1_U13].
A student is able to use analog and intelligent measurement sensors for the required measurement or control task [K1_U05] [K1_U10] [K1_U11].
A student is able to use advanced programming mechanisms in the NI LabVIEW and available library programs [K1_U03] [K1_U06] [K1_U07].
A student is able to develop control programs for PLC in ladder language, function blocks language and structured text language [K1_U03] [K1_U06].
A student can retrieve data from literature, standards, and catalog cards in Polish or English, interpret the obtained information, and draw conclusions [K1_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 [K1_K02].
The student is able to cooperate effectively in project teams, using available work management tools, which allows for smooth integration, organization of tasks and enables the delivery of valuable solutions [K1_K03].
The student is able to formulate opinions on the basic challenges facing modern electronics and telecommunications [K1_K05].

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 published on the course website.
The 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).

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

Programming in the NI LabVIEW environment.
Control and measurement systems structure.

Interfaces in control and measurement systems.
PLC Programmable Logic Controllers.
Measurement sensors.

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. Fundamentals of control theory. Control system. Control objects. Controllers, selection and tuning of controllers. Stability of automatic control systems.
3. Construction, equipment and operation principle of programmable PLC controllers. Basics of PLC programming.
4. Elements of control and measurement systems.
The structure and organization of the control and measurement systems. Classification and construction of signal acquisition systems. NI PXI, NI CompactDAQ, NI CompactRIO and NI MyRIO hardware platforms.
5. Interfaces in measurement and control systems. The interface system definition, serial interfaces, synchronous and asynchronous transmission, serial interfaces: RS232 , I2C , SPI, UART, RS485.
6. Parameters and characteristics of sensors. Examples of sensors of electrical and non-electrical quantities. Smart sensors.
Laboratory:
Creating applications in the NI LabVIEW environment:
- using variables of different types,
- using 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,
- using design patterns in LabVIEW: state machine, data-driven, event loop, Master/Slave, Producer/Consumer.

High-level programming (NI LabVIEW) of FPGA and real-time RT devices (myRIO-1900 controller).
Application of intelligent measurement sensors: communication, reading and processing of measurement data.
Continuous PID and two-position control systems. Temperature control.
Use of encoders and servomechanisms.
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. Adam Słota, Sterowanie procesami ciągłymi: wykorzystanie LabVIEW, Wydawnictwo Naukowe PWN, 2022.

2. Dariusz Świsulski, Komputerowa technika pomiarowa. Oprogramowanie wirtualnych przyrządów pomiarowych w LabVIEW, Agenda Wydawnicza PAK, 2005.
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.
6. Waldemar Nawrocki, Komputerowe systemy pomiarowe, Wydawnictwa Komunikacji i Łączności, 2006.

Additional:
1. Robert H. Bishop, LabVIEW Student Edition, Wydawca Pearson, 2015.
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	84	3,00
Classes requiring direct contact with the teacher	54	2,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	30	1,00