



## COURSE DESCRIPTION CARD - SYLLABUS

Course name

Measurement data acquisition systems [S1MiKC1>SADP]

### Course

Field of study	Year/Semester
Microelectronics and digital communications	2/4
Area of study (specialization)	Profile of study
–	general academic
Level of study	Course offered in
first-cycle	Polish
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 measurement data acquisition systems. Presentation of the structure of measurement data acquisition systems and the construction of the main elements of these systems. To introduce students with the methods of programming measurement devices in the NI LabVIEW environment. Presentation of measurement data acquisition and processing methods.

### Course-related learning outcomes

#### Knowledge:

A student has knowledge of the elements and structures of measurement data acquisition systems

[K1\_W02] [K1\_W03] [K1\_W11].

A student has knowledge of the interfaces and communication standards in measurement data acquisition systems [K1\_W11] [K1\_W13].

A student he knows the rules of analog to digital conversion [K1\_W02] [K1\_W11].

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 measurement data acquisition system dedicated to the required measurement task [K1\_U10] [K1\_U11] [K1\_U13].

A student is able to use analog and intelligent measurement sensors for the required measurement 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 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 exam 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.

Measurement data acquisition system structure.

Interfaces in measurement data acquisition systems.

Data acquisition cards.

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. Elements of measurement data acquisition systems.

The structure and organization of the measurement data acquisition systems. Classification and construction of signal acquisition systems. NI PXI, NI CompactDAQ, NI CompactRIO and NI MyRIO hardware platforms. Virtual measuring instrument.

3. Data acquisition cards - construction, programming.

4. Interfaces in measurement data acquisition 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. LAN - network communication using TCP and UDP.

5. 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.
- multi-threaded application programming: pipelining, parallelization of operations,
- acquisition and processing of analog signals.

Measurement data acquisition systems with DAQ.

Measurement data acquisition systems with RS232, USB, LAN interfaces. SCPI standard.

Measurement data acquisition systems with analog sensors.

Application of intelligent measurement sensors: communication, reading and processing of measurement data (I2C, 1-wire).

Acquisition of measurement data from the distributed LoRaWAN radio system.

## 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. Waldemar Nawrocki, Komputerowe systemy pomiarowe, Wydawnictwa Komunikacji i Łączności, 2006.
2. Waldemar Nawrocki, Rozproszone systemy pomiarowe, Wydawnictwa Komunikacji i Łączności, 2006.
3. Dariusz Świsulski, Komputerowa technika pomiarowa. Oprogramowanie wirtualnych przyrządów pomiarowych w LabVIEW, Agenda Wydawnicza PAK, 2005.
4. Marcin Chruściel, LabVIEW w praktyce, Wydawnictwo BTC, 2008.
5. Wiesław Taczała, Środowisko LabView w eksperymencie wspomaganym komputerowo, Wydawnictwo WNT: PWN, 2017.

### Additional:

1. Robert H. Bishop, LabVIEW Student Edition, Wydawca Pearson, 2015.

2. Waldemar Nawrocki, Sensory i systemy pomiarowe, Wydawnictwo Politechniki Poznańskiej, 2006.

### 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