# SYLLABUS

**Name:** ***Measurement systems (AESAu>SI4MS24)***
**Name in Polish:**
**Name in English:** ***Measurement systems***

## Information on course:

**Course offered by department:** Faculty of Automatic Control, Electronics and Computer Science
**Course for department:** Silesian University of Technology

**Default type of course examination report:**

EGZ

**Language:**

English

**Course homepage:**

https://platforma.polsl.pl/rau1/course/view.php?id=1122

**Short description:**

Course objectives:
The goal of the course is to make students acquainted with measurement systems and their role in Automatic Control and Robotics, Electronics and Telecommunication, Computer Science.
Pre-requisite qualifications:
Completed or partially completed courses on Physics, Introduction to electronics, Probability and statistics.

**Description:**

ECTS: 5
Total workload: 140 ( contact hours70/ 70 student's own work hours)
Lecture: 30h
Laboratory:30h
Other ( disscusion of laboratory reports): 10h

Student's own work:
• preparation for classes and tests
• preparation of laboratory reports
• exam preparation

Lecture - list of topics:
1. Basic term and definitions
Introduction to measurement systems in industry, research & development and science. Elements of measurement systems. Vocabulary of Basic and General Terms in Metrology: sensor, measuring instrument, measuring chain, measuring system, static characteristics - range, span, zero, sensitivity, resolution, response, linearity, hysteresis, calibration, accuracy… ; dynamic characteristics.
2. From sensor to acquisition device
Sensors properties: range, sensitivity, characteristic, intrinsic and additional errors. Error and uncertainty of measurement. Smart transducer, standardized signals and most popular industrial protocols – HART, Profibus, Foundation Fieldbus. The IEEE 1451- a smart transducer interface standard for sensors and actuators.
3. Devices and interfaces
Analog to digital converters for sensors and data acquisition. Devices and interfaces in measurement systems: bench top and modular instruments (multimeters, generators, oscilloscopes, PXI, universal DAQ boards).
5. Programming of measurement systems
Introduction to Virtual Instrumentation. LabVIEW programming.
6. Measurements of selected physical and electrical quantities
Temperature measurements (RTDs, thermocouples, CJC circuits, thermistors, p-n junction sensors, IR sensors). Strain gauges and force measurements. Pressure measurements (sensing elements, piezoresistive sensors, capacitive sensors). Flow measurement (pressure gradient technique, thermoanemometers, ultrasonic and electromagnetic sensors). Acceleration measurements.

Laboratory classes – list of ecercises:
1. Basics of programming in LabVIEW 1
2. Basics of programming in LabVIEW 2
3. Virtual voltage and temperature measurements in LabVIEW 1
4. Virtual voltage and temperature measurements in LabVIEW 2
5. Voltage waveform generation and acquisition using Data Acquisition Boards
6. Waveform measurements using a digital oscilloscope
7. NTC thermistor temperature characteristics experiments
8. Thermocouple calibration in freezing point of tin
9. Strain gauges and pressure sensors
10. True AC RMS measurement

**Bibliography:**

1. Bentley J.P.: Principles of Measurement Systems, Fourth Eddition, Pearson, Prentice Hall, 2005
2. Fraden J.: Handbook of Modern Sensors – Physics, Design, and Applications, Fifth Edition, Springer, 2016
3. Liptak B.G.: Instrument Engineers' Handbook, vol. 1, Process Measurement and Analysis, Fourth Eddition, CRC Press, 2003
4. Liptak B.G.: Instrument Engineers' Handbook, vol. 2, Process Control and Optimization, Fourth Eddition, CRC Press, 2006
5. Liptak B.G.: Instrument Engineers' Handbook, vol. 3, Process Software and Digital Networks, Fourth Eddition, CRC Press, 2012
6. Travis J., Kring J.: LabVIEW for Everyone: Graphical Programming Made Easy and Fun, Third Edition, Prentice Hall, 2006
7. Yang Y.: LabVIEW Graphical Programming Coockbook, Packt Publishing, 2014

**Learning outcomes:**

At the completion of the course, students:
know about metrology, selected sensors, measuring transducers and measurement systems, about measurement techniques for different physical and electrical quantities including dynamic properties of sensors and signal acquisition and reconstruction. Has basic knowledge

about software design for DAQ (Data AcQuisition) systems. (K1A_W6, K1A_W7, K1A_W7), (test),
can design a simple measurement system and create the application for this system. (K1A_U2), (laboratory report),
can acquire and analyze signals with the use of DAQ devices. (K1A_U10)(laboratory report).

**Assessment methods and assessment criteria:**

Lecture: not obligatory.
Laboratory classes: obligatory, additional term for absent.
Students need to pass two written assessment tests (T1, T2) and must complete all (8) laboratory exercises and obtain a pass mark on all reports. Final laboratory grade (L) is calculated as average of all report grades. Students need to pass written final exam (E). On the final exam, students must obtain a minimum of 60% to pass.
The final grade of the course is calculated as a weighted average:
Final grade of the course =0,1* T1 + 0,1* T2 + 0,3* L + 0,5* E

The grade is rounded according to the following rules:
50.00% - 67.00%=3.0
67.01% - 75.00%=3.5
75.01% - 85.00%=4.0
85.01 - 92.00%=4.5
92.01% - 100%=5.0

The syllabus is valid from academic year 2024/25 and its content cannot be changed during the semester.

## Course credits in various terms:

**<without a specific program>**

| Type of credits | Number | First term | Last term |
|---|---|---|---|
| European Credit Transfer System (ECTS) | 5 | 2024/2025-Z | |