COURSE DESCRIPTION CARD - SYLLABUS

Course name
Sensors and measuring systems [S1EiT1>SiUP]

Course

Field of study
Electronics and Telecommunications

Year/Semester
4/7

Area of study (specialization)
–

Profile of study
general academic

Level of study
first-cycle

Course offered in
polish

Form of study
full-time

Requirements
elective

Number of hours

Lecture
15

Laboratory classes
15

Other (e.g. online)
0

Tutorials
0

Projects/seminars
0

Number of credit points

3,00

Coordinators

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Lecturers

Prerequisites

A student has a basic knowledge in mathematics, physics, fundamentals of circuit theory and electronics. 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 physical foundations of operation non-electrical quantity sensors. Overview of the basic measurement circuits used for conditioning signals from the sensors. Presentation of practical applications of sensors in measuring devices, industrial, medical and common use.

Course-related learning outcomes

Knowledge:
1. A student has knowledge of the operation and construction of selected non-electrical quantity sensors.
2. Knows the basic measurement circuits used for conditioning signals from sensors.
3. Has knowledge of sensors used in measuring devices, industrial, medical and common use.

Skills:
1. Student can obtain information from literature and other sources, can integrate obtained information, interpret it, draw conclusions and justify opinions.
2. Can prepare a well-documented study on sensors and measurement systems.
3. Can use catalogs to select appropriate sensors taking into account the given criteria.
4. Can design and implement a simple measurement system with a sensor using appropriate engineering methods and tools.

Social competences:
1. A student is aware of the need for a professional approach to solved technical problems and taking responsibility for the proposed technical solutions.
2. Can formulate opinions on the basic challenges faced by modern measurement technology.
3. Can work in a group in the laboratory and perform team tasks.
4. Recognizes the legal, environmental and utilitarian aspects of measurements. Has a sense of responsibility for the presented measurement results.

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

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Lectures passing based on one written and/or oral examt from content of the lectures. The written exam contains 8 open questions. The oral exam contains 4-6 questions. 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 passing based on grades for reports, preparation for classes, behaviour and commitment during classes and tests. Grading scale: Sw>4,75 - 5,0 (bdb); 4,25=4,75 - 4,5 (db+); 3,75=4,25 - 4,0 (db); 3,25 =3,75 - 3,5 (dst+); 2,75=3,25 - 3,0 (dst); Sw<=2,75 - 2,0 (ndst) where Sw – the weighted arithmetic mean of all partial grades.

Programme content

Lecture
Basic terms: sensor, generation sensor, parametric sensor, integrated sensor, intelligent sensor, transient characteristics, static and dynamic parameters of the sensors, sensitivity, hysteresis, sensor"s dead zone, absolute error, non-linearity, accuracy, offset error, slope error, transmittance. Temperature sensors: RTD sensors, sensor class A and class B, two-wire circuit, four-wire circuit, integrated signal conditioner: Pt100 / 4-20 mA, NTC and PTC thermistors, thermometric characteristics, self-heating effect, thermocouple sensors, Seebeck effect , Peltier thermoelectric force, Thomson thermoelectric force, thermometric characteristics of selected thermocouples, compensation cables, DIN 43722 standard, integrated thermocouple signal conditioner: thermocouple / 4-20 mA, integrated temperature sensors, measuring system with Arduino Pro Mini 328 and temperature sensor TMP36GT9Z , contactless thermometry, pyrometers, thermal imaging cameras. Piezoelectric sensors: longitudinal piezoelectric effect, transverse piezoelectric effect, shear piezoelectric effect, Meissner model, tensor notation, constitutive equations, piezoelectric constants, voltage follower circuit, charge amplifier circuit, piezostos, reverse piezoelectric effect, bimorphic plates, piezoelectric actuator, piezoelectric scanner. Strain gauges, resistance strain gauges, strain gauge constant, semiconductor strain gauges, balanced bridge method, unbalanced bridge method, quarter-bridge system, half-bridge system, full bridge system, temperature compensation, pressure sensor, Wheatstone bridge circuit, instrumentation amplifier circuit, integrated instrumentation amplifiers, measurement of stress and vibration with the gauges. Passive and active light sensors. Displacement sensors, acceleration and distance sensors, capacitive displacement sensor, differential displacement sensor, electric choke sensor, solenoid sensor, transformer sensor, linear variable differential transformer, integrated signal conditioner for LVDT, micromechanical acceleration sensor, micromechanical-surface acceleration sensor, hall effect, hall effect sensor (hallotron), 3-axis integrated accelerometer, ultrasonic distance sensor, measuring system with Arduino Pro Mini 328 and ultrasonic distance sensor HC-SR04.
Laboratory
Basic terms: sensor, generation sensor, parametric sensor, integrated sensor, intelligent sensor, transient characteristics, static and dynamic parameters of the sensors, sensitivity, hysteresis, sensor"s

dead zone, absolute error, non-linearity, accuracy, offset error, slope error, transmittance. Non-contact thermometry, pyrometers, thermal imaging cameras. Signal conditioner components: voltage amplifier circuit, voltage follower circuit, charge amplifier circuit, current sources, reference voltage sources, generators, balanced bridge method, unbalanced bridge method. Passive and active light sensors. Transformer displacement sensors, linear variable differential transformer. Resistive, semiconductor and thermocouple temperature sensors, static and dynamic characteristics of temperature sensors. Design, soldering and assembly of systems for measuring non-electrical quantities.

Teaching methods

Lecture: traditional multimedia presentation (examples also on the blackboard) and conversational lecture.
Lab: traditional multimedia presentation (examples also on the blackboard) and performance of tasks given by the teacher - practical exercises.

Bibliography

Basic
1. Rząsa M. R., Kiczma B., Elektryczne i elektroniczne czujniki temperatury, WKiŁ, Warszawa 2005.
2. Nawrocki W., Sensory i systemy pomiarowe, Wydawnictwo Politechniki Poznańskiej, Poznań 2001.
3. Gajek A., Juda Z., Czujniki, WKiŁ, Warszawa 2009.
4. Zakrzewski J., Kampik M., Sensory i przetworniki pomiarowe, Wydawnictwo Politechniki Śląskiej, Gliwice 2013.
Additional
1. Zakrzewski J., Czujniki i przetworniki pomiarowe: podręcznik problemowy, Wydawnictwo Politechniki Śląskiej, Gliwice 2004.
2. Lesiak P. T., Inteligentna technika pomiarowa, Wydawnictwo Politechniki Radomskiej, Radom 2001.
3. Jacob F., Handbook of Modern Sensors, Springer, New York 2004.
4. Bosch, Czujniki w pojazdach samochodowych, WKiŁ, Warszawa 2009.

Breakdown of average student's workload

	Hours	ECTS
Total workload	75	3,00
Classes requiring direct contact with the teacher	31	2,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	44	1,00