STUDY MODULE DESCRIPTION FORM

Name of the module/subject		Code
Sensors and Instrumentation		**1010831171010833990**
Field of study: **Electronics and Telecommunications**	Profile of study (general academic, practical): **general academic**	Year /Semester: **4 / 7**
Elective path/specialty: **Telecommunication Systems**	Subject offered in: **Polish**	Course (compulsory, elective): **elective**
Cycle of study: **First-cycle studies**	Form of study (full-time,part-time): **full-time**	
No. of hours: Lecture: **2** Classes: **1** Laboratory: **-** Project/seminars: **-**		No. of credits: **3**
Status of the course in the study program (Basic, major, other): **other**	(university-wide, from another field): **from field**	
Education areas and fields of science and art: **technical sciences** **Technical sciences**		ECTS distribution (number and %): **3 100%** **3 100%**

Responsible for subject / lecturer:

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Prerequisites in terms of knowledge, skills and social competencies:

1	**Knowledge**	Has a systematic knowledge of mathematical analysis and algebra. (K1_W01) 2. Has a basic, systematic knowledge of physics. (K1_W02) 3. Has a detailed, systematic knowledge of the fundamentals of circuit theory, together with necessary mathematical background. (K1_W05) 4. Has a systematic knowledge, together with necessary mathematical background, of the fundamentals of metrology, which is necessary to measure the signal properties and the parameters of electronic and telecommunication systems components. Has knowledge of measurement methods, measurement equipment. (K1_W18)
2	**Skills**	1. Is able to extract information from literature and other sources. Is able to synthesize gathered information, draw conclusions and justify opinions. (K1_U01) 2. Demonstrates the ability to solve basic problems in physics. (K1_08) 3. Demonstrates the ability to solve typical tasks and problems related to analysis of electrical circuits. (K1_09) 4. Is able to measure typical parameters of signals, systems and devices. Is able to choose appropriate methods to measure given electrical quantities and parameters of signals and devices. Is able to plan and perform measurements and analyze the results. (K1_U17)
3	**Social competencies**	1. Is aware of the limitations of his/her current knowledge and skills; is committed to further self-study. (K1_K01) 2. Is able to participate in collaborative projects. (K1_K02)

Assumptions and objectives of the course:

To understand the terminology, operation and performance of sensors. To demonstrate of recent developments in sensor technologies. To analyze the performance of a sensor system, including electronics and signal processing

Study outcomes and reference to the educational results for a field of study

Knowledge:

1. Has a wide, systematic knowledge of the properties and characteristics of electronic components, as well as of construction, analysis and design of electronic circuits. - [K1_W08]
2. Knows and understands basic concepts and methods of description of linear and non-linear electronic systems. - [K1_W10]
3. Has knowledge of devices and systems exploitation. - [K1_W20]

Skills:

1. Is able to extract information from literature, databases and other sources. Is able to synthesize gathered information, draw conclusions, and justify opinions. - [K1_U01]

2. 2. Is able to prepare a well-documented study on problems related to electronics and telecommunication. - [K1_U03]

3. Is capable of studying autonomously. - [K1_U05]

4. Is able to use catalogues, find required information from application notes of semiconductor elements and electronic circuits, select appropriate elements and electronic circuits. Is able to identify a problem and formulate a design specification of a simple analogue electronic circuit. Is able to design and implement a simple analogue electronic circuit. - [K1_U12]

5. Is able to analyze, design and build electronic circuits , using appropriate methods and engineering tools, and taking into consideration predefined criteria. Is able to use models, catalogue cards and application notes of semiconductor electronic elements. Is able to analyze and design circuits and systems using CAD. - [K1_U16]

6. Is able to select the construction of devices according to technical requirements and service conditions. - [K1_U21]

Social competencies:

1. Demonstrates responsibility and professionalism in solving technical problems. - [K1_K02]

2. Demonstrates responsibility for designed electronic and telecommunication systems. Is aware of the hazards they pose for individuals and communities if they are improperly designed or produced. - [K1_K03]

3. Is aware of the main challenges facing electronics and telecommunication in the 21st century. - [K1_K04]

Assessment methods of study outcomes

- Lectures passing based on a written test from content of the lectures.
- Classes passing based on written tests.
- Reports from laboratory experiments.

Course description

- Sensor characteristics: sensitivity, accuracy, resolution, transfer function, transmittance, full-scale input, full-scale output, , dynamic characteristics, excitation, hysteresis, nonlinearity, calibration error, dead band, saturation, excitation, repeatability.

- Physical principles: electric charges, fields, capacitance, dielectric constant, faraday?s law, solenoid, toroid, permanent magnets, piezoelectric effect, pyroelectric effect, hall effect, seebeck effect, peltier effect, thermal properties of materials, thermal expansion, heat capacity, heat transfer, thermal conduction, thermal convection, thermal radiation, emissivity.

- Interface electronic circuits, amplifiers, operational amplifiers, voltage follower, instrumentation amplifier, charge amplifiers, current generators, voltage references, oscillators, drivers, analog-to-digital converters, v/f converters, dual-slope converter, successive-approximation converter, resolution extension, direct digitization and processing, ratiometric circuits, disbalanced bridge, null-balanced bridge, temperature compensation of resistive bridge, bridge amplifiers, two-wire transmission, four-wire sensing, six-wire sensing.

- Occupancy sensors, motion detectors, position sensors, displacement sensors, level sensors, velocity sensors, acceleration sensors, force sensors, strain sensors, tactile sensors, pressure sensors, flow sensors, acoustic sensors, humidity sensors, moisture sensors, light detectors, radiation detectors, temperature sensors, chemical sensors, sensor materials and technologies.

- Noise in sensors and circuits, inherent noise, transmitted noise, electric shielding, bypass capacitors, magnetic shielding, mechanical noise, ground planes, ground loops and ground isolation, Seebeck noise.

Basic bibliography:

1. Andrzej Gajek, Zdzisław Juda, Czujniki, WKiŁ, Warszawa 2009.
2. Fraden Jacob, Handbook of Modern Sensors, Springer, New York 2004.
3. Waldemar Nawrocki, Sensory i systemy pomiarowe, Wydawnictwo Politechniki Poznańskiej, Poznań 2001.
4. Mariusz R. Rząsa, Bolesław Kiczma, Elektryczne i elektroniczne czujniki temperatury, WKiŁ, Warszawa 2008.

Additional bibliography:

1. Bosch, Czujniki w pojazdach samochodowych, WKiŁ, Warszawa 2009.
2. Maloberti F., Przetworniki danych, Wydawnictwo Komunikacji i Łączności, Warszawa, 2010.
3. Kulka Z., Nadachowski M., Analogowe układy scalone, WKŁ, Warszawa, 1985.
4. Praca zbiorowa, Podręcznik metrologii tom 1 i 2, Wydawnictwo Komunikacji i Łączności, Warszawa 1988 i 1990.

Result of average student's workload

Activity	Time (working hours)
1. Participation in lectures, practical classes and lab exercises.	47
2. Preparation for lab exercises.	11
3. Preparing the project.	5
4. Preparation to the test.	12

Student's workload

Source of workload	hours	ECTS
Total workload	90	3
Contact hours	50	2
Practical activities	20	1