POZNAN UNIVERSITY OF TECHNOLOGY

EUROPEAN CREDIT TRANSFER AND ACCUMULATION SYSTEM (ECTS)

COURSE DESCRIPTION CARD - SYLLABUS

Course name
Sensors and intelligent sensors [S1MiKC1>SiCI]

Course

Field of study
Microelectronics and digital communications

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
30

Laboratory classes
15

Other
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

Familiarization with the physical principles of operation of selected non-electrical quantity sensors. Discussion of basic measurement circuits used for sensor signal conditioning. Presentation of modern smart sensors, their architecture, communication methods, and data processing algorithms implemented directly within the sensor. Introduction to the basics of microcontroller programming used in smart sensors.

Course-related learning outcomes

Knowledge:
1. Understands the principles of operation of modern measuring equipment and sensors used in ICT

systems. (K1_W11)
2. Has knowledge of the properties and characteristics of electronic components, as well as basic methods for designing and analyzing electronic systems, including analog and digital circuits used in ICT. (K1_W02)
3. Possesses detailed knowledge of microprocessors, microcontrollers, microcomputer systems, and reconfigurable circuits. Understands the architecture of these systems, their programming principles, and methods of implementation in ICT systems. (K1_W03)
4. Has knowledge of software engineering tools, team programming techniques, and methodologies for software development and testing. (K1_W05)

Skills:
1. Is able to analyze requirements and specify the design of electronic circuits. Can select appropriate electronic components based on catalogs and application notes, as well as design and implement electronic circuits, including digital ones. (K1_U05)
2. Is capable of measuring signal parameters as well as ICT devices and systems. Can conduct measurements of optoelectronic component parameters. (K1_U10)
3. Can program in high-level languages, including the use of multithreading and multiprocessor systems. Is able to write and execute programs that solve technical problems in ICT. Can consciously select programming languages for specific applications and use software engineering tools, including tools for collaborative programming. (K1_U06)
4. Is able to effectively organize individual and team work, as well as collaborate within a group, taking responsibility for the execution of shared tasks. (K1_U02)
5. Can acquire and analyze information from literature, databases, and other sources in both Polish and English. Is able to integrate and interpret the obtained information, draw conclusions, and justify opinions. (K1_U01)

Social competences:
1. Is aware of the limitations of their own knowledge and skills and understands the need for continuous learning. (K1_K01)
2. Recognizes the necessity of a professional approach to solving technical problems and taking responsibility for proposed technical solutions. (K1_K02)
3. Is able to collaborate effectively in project teams, utilizing available work management tools to ensure smooth integration, task organization, and the delivery of valuable solutions. (K1_K03)
4. Can formulate opinions on the fundamental challenges facing modern electronics and telecommunications. (K1_K05)

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

The knowledge acquired during the lecture is assessed through a written test. The written test consists of 8 questions with varying point values. The passing threshold is 50% of the total points. The test questions are prepared based on the slides published on the course website. Grading scale: <50% (total points) - 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 skills acquired during the laboratory are assessed through a written test, report preparation, and evaluation of preparation, behavior, and engagement during the sessions. The written test involves solving 8 tasks with varying point values. The final grade is determined based on a weighted average: Sw=0.45SO+0.55OzK where SO is the average grade obtained for report preparation, preparation to the laboratory, and engagement in the laboratory, and OzK is the grade from the test. Scale for the final grade: Sw > 4,75 - 5,0 (bdb); 4,25 < Sw <= 4,75 - 4,5 (db+); 3,75 < Sw <= 4,25 - 4,0 (db); 3,25 < Sw <= 3,75
- 3,5 (dst+); 2,75 < Sw <= 3,25 - 3,0 (dst); Sw <= 2,75 - 2,0 (ndst).

Programme content

Sensors, integrated sensors, smart sensors - basic concepts.
Structure and operating principles of selected sensors and integrated sensors.
Methods of signal conditioning for sensors.
Architecture, programming, and application of smart sensors.
Application of high-level programming languages for microcontroller programming in measurement

systems with smart sensors.

Course topics

Basic concepts: sensor, generative sensor, parametric sensor, integrated sensor, smart sensor, processing characteristics, static and dynamic parameters of sensors, sensitivity, processing constant, hysteresis, dead zone, absolute processing error, nonlinearity, accuracy, zero offset error, slope error, sensor calibration.
Measurement sensors: resistive temperature sensors, NTC and PTC thermistors, thermoelectric sensors, piezoelectric sensors, piezoelectric actuators, application of strain gauges for force and displacement measurement, strain gauges and strain gauge sensors, application of strain gauges for force, stress, and vibration measurements, capacitive displacement sensors, micromechanical acceleration sensors, integrated accelerometers, ultrasonic distance sensors.
Signal conditioners and converters: block diagram of a measurement system, instrumentation amplifier, charge amplifier, voltage follower, analog comparator, measurement bridges, integrated signal conditioners, analog-to-digital converters used in integrated and smart sensors.
Smart sensors: definition and architecture of smart sensors, wired and wireless interfaces in smart sensors, programming selected smart sensors, example intelligent procedures, applications of smart sensors in industry, medicine, and IoT.
Microcontroller programming in measurement systems with smart sensors: selected software engineering tools, hardware and software integration of measurement systems with sensors, application of high-level programming languages for microcontroller programming.

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. Zakrzewski J., Kampik M., Sensory i przetworniki pomiarowe, Wydawnictwo Politechniki Śląskiej, Gliwice 2013.
2. Gajek A., Juda Z., Czujniki, WKiŁ, Warszawa 2021.
3. Gawędzki W., Pomiary elektryczne wielkości nieelektrycznych, Wyd. AGH, Kraków, 2010.
754. Mikrokontrolery AVR ATmega w praktyce, Wydawnictwo BTC, 2005.

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 2015.
4. Francuz T., Język C dla mikrokontrolerów AVR. Od podstaw do zaawansowanych aplikacji, Wydawnictwo Helion, 2015.

Breakdown of average student's workload

	Hours	ECTS
Total workload	85	3,00
Classes requiring direct contact with the teacher	45	1,50
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	40	1,50