COURSE DESCRIPTION CARD - SYLLABUS

Course name
Introduction to measurements in electronics [S1MiKC2>WdPwE]

Course

Field of study
Microelectronics and Digital Communication

Year/Semester
1/2

Area of study (specialization)
–

Profile of study
general academic

Level of study
first-cycle

Course offered in
Polish

Form of study
full-time

Requirements
compulsory

Number of hours

Lecture
15

Laboratory classes
24

Other
0

Tutorials
0

Projects/seminars
0

Number of credit points

3,00

Coordinators

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Lecturers

Prerequisites

A student starting this course should have basic knowledge of mathematics, physics, and fundamental circuit theory. They should also have the ability to acquire information from designated sources and be prepared to collaborate as part of a team. XD

Course objective

Familiarization with basic definitions and concepts used in measurement techniques and measurement methods applied in electronics. Presentation of the principles of operation and application of measuring instruments, as well as methods for analyzing, interpreting, and presenting measurement data. Conducting laboratory experiments, including the preparation, execution, and documentation of measurements of electronic circuit characteristics.

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. Has knowledge of the fundamental dilemmas of modern civilization in the field of ICT, including ethical aspects. (K1_W17)

Skills:
1. Understands the limitations of their own knowledge and skills and recognizes the need for continuous learning. (K1_K01)
2. Is aware of the necessity of a professional approach to solving technical problems and taking responsibility for the proposed technical solutions. (K1_K02)
3. Can 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. Is able to formulate opinions on the fundamental challenges facing modern electronics and telecommunications. (K1_K05)

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 and/or oral 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); XD
80% to 89% - 4.5 (db+); 90% to 100% - 5.0 (bdb). The test questions are prepared based on the slides published on the course website.
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

Measurements in electronics - basic concepts and definitions.
Measuring instruments - construction and applications.
Analog-to-digital converters.
Measurement of signal and electronic circuit parameters - instruments and measurement methods.

Course topics

Lecture
Introduction: measurable quantity, unit of measurement, concept of measurement, International System of Units, definitions of selected base units, method of introducing derived units, unit standard, primary and secondary standards, chain of traceability to the primary standard, verification and

calibration of measuring instruments, national authorities responsible for maintaining units standards, classification of measurement methods, obtained value, measurement result, actual value, conventionally true value, absolute error, relative error, measurement accuracy and precision, systematic, random errors, correction of systematic error, instrument error and class error, measurement uncertainty, determination of expanded uncertainty in laboratory practice, proper notation of measurement results.
Analog oscilloscope: cathode ray tube, oscilloscope bandwidth, block diagram of the oscilloscope, operating modes and trigger parameters, deflection coefficient, time base coefficient, time base generator, image formation on the oscilloscope screen, signal image stabilization, measurement of amplitude, frequency, and DC component of periodic signals, X-Y operation mode, phase shift measurements.
Digital oscilloscope: block diagram, triggering modes and parameters, digital oscilloscope operation cycle, measurement of waveforms preceding triggering, capturing transient disturbances, probe models, probe compensation.
Measurement of signal and electronic circuit parameters: measuring instruments, basic parameters of voltage and current signals, measurement of average, RMS, instantaneous values, peak factor, form factor, rise time, fall time, duty cycle, frequency, basic parameters of electronic circuits, measurement XD
of resistance, capacitance, inductance, impedance, measurement of basic characteristics of electronic circuits.
Analog-to-digital converters: analog, discrete analog, and digital signals, signal sampling, signal quantization, digital signal coding in A/D converters, operational amplifier, voltage follower, sample-and-hold circuit, voltage amplifiers, voltage follower, integrating circuit, A/D converter parameters, conversion errors, direct parallel comparison A/D conversion, simple time-based A/D conversion, dual-slope A/D conversion, R-2R ladder D/A converter, uniform compensation A/D conversion, weighted compensation A/D conversion.
Laboratory
Measurement of signal and electronic circuit parameters: measuring instruments, proper notation of measurement results, basic parameters of voltage and current signals, measurement of average, RMS, and instantaneous values, peak factor, form factor, rise time, fall time, duty cycle, resistance measurement, current-voltage characteristic measurement of semiconductor devices, inverting and non-inverting voltage amplifiers, frequency response measurement, analog voltage comparator, measurement of input and output signals, transient characteristic measurement.
Analog oscilloscope: oscilloscope operating modes, trigger parameters, image stabilization, deflection coefficient, time base coefficient, measurement of amplitude, frequency, and DC component of periodic signals, phase shift measurements.
Digital oscilloscope: triggering modes, trigger parameters, automatic measurement of time and voltage parameters of signals, pre-triggering waveform measurement, capturing transient disturbances, probe compensation.
Selected measurement methods: measurement circuit diagram, assembling the circuit based on the diagram, correction of measurement method systematic errors, proper notation of measurement results for indirect measurements, uncertainty rectangles, principles of plotting characteristics.

Teaching methods

Lecture: traditional multimedia presentation with examples 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. Dusza J., Gąsior P., Tarapata G., Podstawy pomiarów, Oficyna Wydawnicza Politechniki Warszawskiej, Warszawa 2019.
2. Tumański S., Technika pomiarowa, Wydawnictwo Naukowe PWN, Warszawa 2016.
3. Kamieniecki A., Współczesny oscyloskop. Budowa i pomiary, Wydawnictwo BTC, 2014.
4. Kester W., Przetworniki A/C i C/A. Teoria i praktyka, Wydawnictwo BTC, 2014.
XD

Additional:

1. Barzykowski J., Domańska A., Kujawińska M., Współczesna metrologia. Zagadnienia wybrane, Wydawnictwo Naukowo-Techniczne WNT, Warszawa 2016.
2. Rydzewski J., Pomiary oscyloskopowe, Wydawnictwo Naukowo-Techniczne, Warszawa 2007.
3. Maloberti F., Przetworniki danych, Wydawnictwa Komunikacji i Łączności WKŁ, 2010.

Breakdown of average student's workload

	Hours	ECTS
Total workload	84	3,00
Classes requiring direct contact with the teacher	39	1,50
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	45	1,50