GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Metrology, PG_00047552		
Field of study	Electronics and Telecommunications		
Date of commencement of studies	October 2026	Academic year of realisation of subject	2026/2027
Education level	first-cycle studies	Subject group	Obligatory subject group in the field of study Subject group related to scientific research in the field of study
Mode of study	Full-time studies	Mode of delivery	at the university
Year of study	1	Language of instruction	Polish
Semester of study	2	ECTS credits	1.0
Learning profile	general academic profile	Assessment form	assessment
Conducting unit	Metrology and Electronic Systems Department -> Faculty of Electronics Telecommunications and Informatics -> Faculties of Gdańsk University of Technology		
Name and surname of lecturer (lecturers)	Subject supervisor	dr inż. Sylwia Babicz-Kiewlicz	
	Teachers	dr inż. Sylwia Babicz-Kiewlicz dr inż. Stanisław Galla	

Lesson types

Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
Number of study hours	15.0	0.0	0.0	0.0	0.0	15

E-learning hours included: 0.0

Learning activity and number of study hours

Learning activity	Participation in didactic classes included in study plan	Participation in consultation hours	Self-study	SUM
Number of study hours	15	1.0	9.0	25

Subject objectives

The aim is introduction to : the essence of measurement, units and standards, methods of measurement, analysis of measurement uncertainty, basic instruments for measurement of electrical quantities.

Learning outcomes

Course outcome	Subject outcome	Method of verification
[K6_W03] knows and understands, to an advanced extent, the construction and operating principles of components and systems related to the field of study, including theories, methods and complex relationships between them and selected specific issues - appropriate for the curriculum	Student knows the structure and metrological properties of instruments for measuring basic electrical quantities. He knows the principles of operation of analog / digital converters. Student knows the methods of constructing measurement systems.	[SW1] Assessment of factual knowledge
[K6_W02] knows and understands, to an advanced extent, selected laws of physics and physical phenomena as well as methods and theories explaining the complex relationships between them, constituting the basic general knowledge in the field of technical sciences related to the field of study	He knows the basic metrological terms. He knows the measurement methods. It strictly defines the measurand (menzurand). It presents the results of measurements according to the recommendations of the International System of Units (SI), using the correct markings and prefixes to create multiple and submultiple units of measurement. Student analyzes systematic errors in direct and indirect measurements. Student knows the causes of measurement uncertainty and methods of its minimization during measurements. Assesses the measurement uncertainty with the A-method and B-methods.	[SW1] Assessment of factual knowledge

Subject contents	Course content – lecture 1. Introduction, basic metrological terms, classification of measurement methods 2. Measurement errors, types of errors: systematic, random, gross 3. Permanent-magnet moving-coil instrument and its application 4. Digital methods of low and high frequency measurements 5. Digital methods of time-interval and phase measurements 6. Dual-slope integration ADC 7. Immunity of integration ADCs from disturbances 8. Flash and subranging ADC 9. Digital multimeters: architecture, resistance to voltage converter, current to voltage converter, multiterminal inputs 10. AC voltage measurements, waveform parameters, average value, peak value and RMS measurements 11. Oscilloscope: architecture, principles of operation 12. Measurements of voltage, frequency, phase, parameters of pulse, display of device characteristics 13. Measurement uncertainty 14. Measurement methods of impedance parameters R, L, C, |Z| 15. Measuring systems and virtual instruments.

Prerequisites and co-requisites	Presentations from the lectures are only auxiliary materials. Providing students with a presentation does not exempt them from the need to take their own lecture notes and does not replace the independent study of the applicable textbooks. The lecture is only a supplement to the student's independent work. The colloquium and the homeworks are valid for the scope of the material actually laid out during the lecture and contained in the corresponding fragments of the textbooks given in the list of literature for the lecture. Completion of the lecture in the subject takes place in a gamified form as homework or as a colloquium in the form of a multiple-choice test at least two weeks after the last lecture. Colloquium place: rooms EA222 / EA442 Groups of max. 16 people will be admitted to the room and they will solve the test on the e-learning platform on laboratory computers. After the time has elapsed, an open sample will be saved automatically. Multiple answers will be possible and the questions are tested with zero-one. So if the answers A and C are correct, then in order to get one point for the question, you need to mark exactly the answers A and C. Any other combination will result in not assigning a point for this question. Baseline results will be known as soon as the test is completed. The results of gamification tasks are provided immediately after completing the tasks. The colloquium is a form of re-sit for gamification tasks. Grades must be issued by the end of the class. Therefore, the retake date will take place before the end of the class, but not sooner than 5 days after the basic test is written. The maximum grade that can be obtained from the resit date is 3. Percentage thresholds for individual ratings: <0;60)% 2 <60; 68)% 3 <68; 76)% 3,5 <76; 84)% 4 <84; 92)% 4,5 <92; 100>% 5 It is not possible to increase the grade / performance of an additional task for a higher grade etc.
Assessment methods and criteria	

Subject passing criteria	Passing threshold	Percentage of the final grade
Test/homework	60.01%	100.0%

<table>
<tr><td rowspan="3">Recommended reading</td><td>Basic literature</td><td>• Piotrowski J., Podstawy Metrologii, PWN 1977
• Piotrowski J., Podstawy miernictwa, WNT 2000
• Parchański J., Miernictwo elektryczne i elektroniczne, WSP 1998
• Jaworski J., Morawski R., Olędzki J., Wstęp do metrologii i techniki eksperymentu, WNT 1992
• Piotrowski J., Podstawy metrologii, Politechnika Śląska 1971
• Taylor J. R., Wstęp do analizy błędu pomiarowego, PWN 1999
• Tumański S., Technika pomiarowa, WNT 2007
• Chwaleba A., Poniński M., Siedlecki A., Metrologia elektryczna, WNT 2009</td></tr>
<tr><td>Supplementary literature</td><td>• Domańska A., Barzykowski J., Kujawińska M., Współczesna metrologia wybrane zagadnienia, WNT 2016
• Jakubiec W., Malinowski J., Metrologia wielkości geometrycznych, PWN 2018
• Bewoor A. K., Kulkarni V. A., Metrology & Measurements, Tata McGraw-Hill Education 2009 (dostępna częściowo w books.gogle)
• Banerjee G. K., Electrical And Electronic Measurements, PHI Learning Pvt. Ltd (books.gogle)</td></tr>
<tr><td>eResources addresses</td><td></td></tr>
<tr><td>Example issues/ example questions/ tasks being completed</td><td colspan="2">1 Two voltmeters could be used to measure the voltage U = 12 V. The first was a class 0.5 laboratory voltmeter with a measuring range of 60 V, and the second was a class 1.5 blackboard voltmeter with a measuring range of 15 V. Which voltmeter allowed the voltage value to be determined with less error?

2. What is the measured frequency if 3587 pulses were counted in the 10 ms gate-opening time of the frequency meter.

3. A frequency meter, normally operating with an internal reference frequency source of 1 MHz, was used with an external reference generator of 4 MHz. How should the frequency measurement results be corrected: (a) multiply by 4, (b) multiply by 2, (c) divide by 4.

4. Represent in the figure the voltage waveform that occurs at the output of the integrator in an A/D converter with double integration processing. Mark with "a" the time interval in which the reference voltage is integrated, with "b" the time interval in which the measured voltage is integrated, with "c" the time interval proportional to the measured voltage, with "d" the moment when the state of the comparator output changes, with "e" the moment when the counter overflows, with "f" the time interval which is to be equal to 20 ms to ensure immunity of the converter to mains frequency interference.

5. The Y channel of the oscilloscope has a bandwidth of 40 MHz. What is the rise time of the step response of the oscilloscope. What is the rise time of the pulse you will read from the screen of this oscilloscope if you are testing a pulse whose rise time is 20 ns.

6. The uncertainty of the voltage measurement is expressed in the multimeter specification as ±(1%+2 digits) and the reading is 1.200 V. Calculate the uncertainty of the voltage measurement.

7 Explain the meaning of the abbreviations read from the face plate of the multimeter: AC, DC, 2W, 4W.

8. Express the voltage ratios in dB: U1/U2 = 10^3, 1, 10^{-2}.

9. Give the rms and peak-to-peak value of the voltage in a domestic power network.

10. Why is a four-wire connection between a resistor and a measuring instrument used when measuring small resistances?</td></tr>
<tr><td>Practical activites within the subject</td><td colspan="2">Not applicable</td></tr>
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