GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Advanced Measurement and Diagnosis Methods, PG_00048677						
Field of study	Electronics and Telecommunications						
Date of commencement of studies	February 2025		Academic year of realisation of subject		2025/2026		
Education level	second-cycle studies		Subject group		Optional subject group Specialty subject group 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		2.0		
Learning profile	general academic profile		Assessment form		exam		
Conducting unit	Department of Metrology and Optoelectronics -> Faculty of Electronics, Telecommunications and Informatics						
Name and surname of lecturer (lecturers)	Subject supervisor		dr hab. inż. Grzegorz Lentka				
	Teachers		dr inż. Michał Kowalewski dr hab. inż. Grzegorz Lentka dr inż. Barbara Stawarz-Graczyk dr inż. Andrzej Kwiatkowski dr hab. inż. Zbigniew Czaja				
Lesson types and methods of instruction	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	15.0	0.0	15.0	0.0	0.0	30
	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	30		4.0	16.0		50
Subject objectives	Familiarize students with new techniques of analog to digital conversion, methods of impedance measurements, methods of testing and diagnosis of analog and digital circuits, evaluate test quality metrics using a probabilistic approach to the analysis of measurement process in accordance with guidance provided by a Joint Committee for Guides in Metrology (JCGM) in "Evaluation of measurement data - The role of measurement uncertainty in conformity assessment" JCGM 106: 2012.						

Learning outcomes	Course outcome	Subject outcome	Method of verification
	[K7_U03] can design, according to required specifications, and make a complex device, facility, system or carry out a process, specific to the field of study, using suitable methods, techniques, tools and materials, following engineering standards and norms, applying technologies specific to the field of study and experience gained in the professional engineering environment	Student carries out a series of measurements of impedance parameters, collects and processes the results using a computerized measuring system. Identifies elements of replacement electronic circuit models using impedance spectroscopy. Tests digital systems by signature analysis. Performs detection and location of faults in fully differential systems. With the computer simulation method performs diagnostics of the electronic system with incomplete access to internal nodes using the verification method and matrix decomposition according to singular values. Determines test quality metrix: defects level and yield loss.	[SU1] Assessment of task fulfilment [SU2] Assessment of ability to analyse information [SU4] Assessment of ability to use methods and tools
	[K7_W10] knows and understands, to an increased extent, the basic processes occurring in the life cycle of equipment, objects and technical systems, as well as methods of supporting processes and functions, specific to the field of study	Knows the method of constructing a fault dictionary. Knows the verification method of fault location in systems with limited measuring access to the internal nodes. Knows the types of risk of incorrect decision when testing technical objects and systems, resulting from measurement uncertainty.	[SW1] Assessment of factual knowledge
	[K7_W04] knows and understands, to an increased extent, the principles, methods and techniques of programming and the principles of computer software development or programming devices or controllers using microprocessors or other elements or programmable devices specific to the field of study, and organization of work of systems using computers or such devices	Knows and understands the principles of work and properties of modern analog-to-digital converters: pipelined and cyclic. Knows how to program HP 5004A and HP 5006A signature analyzers to perform a digital system test. Programs the Solartron SI 1255 frequency response analyzer. Programs the Agilent E4980A impedance analyzer.	[SW1] Assessment of factual knowledge
	[K7_W03] knows and understands, to an increased 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	Knows the construction of impedance analyzer working with the use of "auto-balancing bridge method". Knows the measurement configurations used to measure the parameters of transformers, CMOS transistors, batteries, quartz resonators, RLC components.	[SW1] Assessment of factual knowledge

Subject contents	1. Introduction 2. New techniques of analog-digital conversion: the pipelined ADC. 3. The cyclic ADC 4. Testing of fully differential circuits 5. Microsystem for diagnosis of fully differential circuits 6. Built-in self-test for OTA-C filter 7. Testing of digital circuits with signature analysis method. Serial and parallel shift register. Signature analyzer. 8. Verification method for fault location 9. The role of measurement uncertainty in conformity assessment. 10. Estimation of test quality metrics with the aid of a probabilistic model for measurement processes 11. Measurement of RLCQDZ parameters of two-port in serial and parallel equivalent circuit. 12. Measurement methods applied for impedance measurements 13. Impedance measurement applications 14. Guide for the use of the International System of Units 15. Rules and style conventions for expressing values of quantities.
Prerequisites and co-requisites	No requirements

Assessment methods and criteria	Subject passing criteria	Passing threshold	Percentage of the final grade
	Activity	0.0%	10.0%
	Exam	50.0%	60.0%
	Laboratory	50.0%	30.0%

Recommended reading	Basic literature	1. Barsoukov E., Macdonald J.R.: Impedance Spectroscopy. Theory, Experiment, and Applications. Wiley-Interscience, 2005. 2. Bushnell M.L., Agrawal V.D.: Essentials of electronic testing for digital, memory and mixed-signal VLSI circuits. Kluwer Academic Publishers, 2000. 3. Hurst S.L. :VLSI testing, digital and mixed analogue/digital techniques. The Institution of Electrical Engineers, London 1998. 4. Sun Y.: Test and Diagnosis of Analogue, Mixed-Signal and RF Integrated Circuits, The Institution of Enginering and Technology, London 2008. 5. Maloberti F.: Przetworniki danych, WKŁ, Warszawa 2010.

	Supplementary literature	No requirements
	eResources addresses	Adresy na platformie eNauczanie:
Example issues/ example questions/ tasks being completed	1. Architecture of single stage of a pipelined A/D converter. 2. Calculate result of conversion of four stage pipelined A/D converter, if input voltage equals 0,6 V, reference voltage equals 1 V, and all comparator thresholds = 0,5 V. 3. When to use differential signal processing? 4. Methods of testing fully differential circuits using common-mode voltage. 5. Probabilities which characterize producer's and consumer's risks. 6. Probabilistic model of measurement process. 7. Testing digital circuits using signature analysis. 8. Draw the generator of pseudorandom sequence based on linear feedback shift register, explain the principle of working. 9. Substitution theorem and current source shift theorem. 10. Principle of auto-balancing bridge method of impedance measurements. 11. Technique of high-value capacitance measurement. 12. Measurements of transformer parameters with RLCZ meter. 13. Simulation of grounded and floating resistors using OTA. 14. Simulation of inductance using OTA.	
Work placement	Not applicable	