GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Reliability and Diagnostic Testing, PG_00055354		
Field of study	Electronics and Telecommunications		
Date of commencement of studies	October 2022	Academic year of realisation of subject	2023/2024
Education level	second-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	2	Language of instruction	English
Semester of study	4	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. Paweł Wierzba	
	Teachers	dr hab. inż. Paweł Wierzba dr inż. Michał Kowalewski dr inż. Katarzyna Karpienko	

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	2.0	18.0	50

Subject objectives	The aim is introduction to: statistical theory of reliability, plan and design of reliability tests, testing methods of electronic circuits - electrical, optical, x-ray and fault diagnosis with fault dictionary methods using neural network classifiers.

Learning outcomes

Course outcome	Subject outcome	Method of verification
[K7_U09] can carry out a critical analysis of the functioning of existing technical solutions and assess these solutions, as well as apply experience related to the maintenance of advanced technical systems, devices and facilities typical for the field of studies, gained in the professional engineering environment	Uses statistical reliability theory. Uses reliability standards. Constructs a fault dictionary for fault location in the electronic system. Investigates and analyzes the operation of the neural classifier in application to fault location in the analog electronic system.	[SU4] Assessment of ability to use methods and tools
[K7_U06] can analyse the operation of components, circuits and systems related to the field of study; measure their parameters; examine technical specifications; interpret obtained results and draw conclusions	Assembles and tests the measuring system implementing the voltage follower method of isolating the tested element from the surrounding electrical network.	[SU1] Assessment of task fulfilment
[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.	Lists and describes testing methods for bare and assembled printed circuit boards. Knows the construction of in-circuit electronic packet testers. Knows the methods of guarding to isolate a component under test.	[SW1] Assessment of factual knowledge
[K7_W06] Knows and understands, to an increased extent, the basic processes taking place in the life cycle of devices, facilities and technical systems.	Explains the meaning of the terms: defect, fault, diagnostic levels: detection, location, identification, prediction of faults. Classifies faults of technical objects.	[SW1] Assessment of factual knowledge
[K7_W08] Knows and understands, to an increased extent, the fundamental dilemmas of modern civilisation, the main development trends of scientific disciplines relevant to the field of education.	Appreciates the importance of testing in maintaining product quality.	[SW1] Assessment of factual knowledge

Subject contents

1. Statistical reliability theory. Essential characteristics of reliability. Failure physics. Items (components, devices, functional units, equipment or systems). Failure modes. 2. Resources of reliability data. Methods of acquisition of reliability data. Quality and reliability of items in life time design, technology, operation, wear-out, damage. 3. Analysis and graphic-analysis methods for hazard function deduction. Failure frequency distributions: normal, exponential, Weibull, lognormal, gamma. 4. Plan of reliability tests. Determination, compliance tests. Methods of test time shorten. Accelerated tests. 5. Reliability block diagram. Methods of reliability improving. 6. Excess reliability objects. Objects with active, stand-by and lightly loaded redundancy. Management and control of quality and reliability. Quality and reliability in business. 7. Life cycle costing. Polish and international standards. 8. Test strategies for electronic circuits. Functional and structural testing. Production testing of monolithic integrated circuits. 9. Board test and diagnosis. In-circuit testing. Techniques of component isolation from the surrounding electronic environment. Signature analysis method. 10. Design for testability (DfT) techniques. IEEE standard 1149.1 test access port and boundary scan architecture for testing digital circuits genesis and architecture, structure and state diagram for a TAP controller. 11. IEEE standard 1149.4: for a mixed signal test bus, architecture, test bus interface circuit TBIC, analogue boundary module ABM. 12. Built-in self-testers. Digital BIST. Structures of the Build-in logic block observers (BILBO). 13. Fault location by fault dictionary methods. Fault models in electronic circuits at different abstraction levels. Fault signatures generation using Karhuen-Loeve transform. 14. Fault diagnostics with the aid of artificial neural network classifiers. Linear discriminant function. The perceptron algorithm. The two-layer perceptron. 15. Contact-less methods: automatic optical inspection, radiography, termovision.

Prerequisites and co-requisites

No requirements

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
Written exam	50.0%	60.0%
Laboratory	50.0%	40.0%

Recommended reading

Basic literature	1.Burns M., Roberts G.W.: An introduction to Mixed-Signal IC Test & Measurement. New York: Oxford University Press, 2001. 2.Bushnell M.L., Agrawal V.D.: Essentials of Electronic Testing for Digital, Memory, and Mixed Signal VLSI Circuits. Kluwer Academic Publishers, 2000. 3.Papoulis A., Pillai S.U.: Probability, Random Variables and Stochastic Processes. Mc Graw Hill 2002. 4.Segura J., Hawkins C.F.: CMOS Electronics how it works, how it fails. IEEE Press, A John Wiley and Sons, Inc. 2004. 5.Sun Y.: Test and Diagnosis of Analogue, Mixed-Signal And RF Integrated Circuits. The System On Chip Approach. IET 2008.
Supplementary literature	No requirements

	eResources addresses	Adresy na platformie eNauczanie: Niezawodność i Diagnostyka 2023/2024 - Moodle ID: 29294 https://enauczanie.pg.edu.pl/moodle/course/view.php?id=29294
Example issues/ example questions/ tasks being completed	1. Explain meaning of: defect, fault, characterization testing, production testing, burn-in testing, diagnostics. 2. Problems connected with application of solder paste in assembling cards. 3. Methods of bare printed circuit boards (PCB) testing. 4. Forms of defects occurring on assembled PCBs (20 forms). 5. Testing methods of assembled PCBs. 6. In-circuit test principles. 7. Available probe tip styles using in testers of assembled PCBs with "bed-of- nails" test fixture. 8. Advantages and disadvantages of a flying probe test systems. 9. Describe a "Bead probes" technology. 10. The operational amplifier technique used for the in-circuit resistance measurement. 11. A voltage follower guarding technique to isolate a component under test from the adjacent components. 12. Idea of fault dictionary diagnostic method. 13. Feature extraction techniques from the results of measurements. 14. The goals of using principal component analysis in feature extractions. 15. Metrics used in geometrical classifiers. 16. For linear classifier derive equation for the distance from a decision line to the origin of the feature space. 17. For linear classifier derive measure of the Euclidean distance of the point **x** from the decision hyperplane. 18. For linear classifier write linear discriminant function equation and calculate coordinates of cross-points of the decision line with x1 , x2 axes, for weight vector and . Calculate distance of decision line from the origin. 19. Draw the block diagram of integrated circuit with the IEEE 1149.1 test bus and explain the principle of operation. 20. Describe the signals of the IEEEE 1149.1 test bus. 21. Describe the basic states of the controller TAP of the IEEE 1149.1 test bus. 22. Describe mandatory instruction of the IEEE 1149.1 test bus. 23. Sketch the bathtub curve and describe three stages of product lifetime 24. What probability distributions are used to describe reliability data. 25. Consider a system consisting of three subsystems arranged in parallel. Subsystem 1 has a reliability of R1, subsystem 2 R2 and subsystem 3 R3 for the operational period of 5000 hours. What is the overall reliability of the system for a 5000 hour operational period?	
Work placement	Not applicable	