GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Reliability and Diagnostics, PG_00036207		
Field of study	Automation, Robotics and Control Systems		
Date of commencement of studies	October 2021	Academic year of realisation of subject	2023/2024
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	3	Language of instruction	Polish
Semester of study	5	ECTS credits	5.0
Learning profile	general academic profile	Assessment form	exam
Conducting unit	Department of Control Engineering -> Faculty of Electrical and Control Engineering		
Name and surname of lecturer (lecturers)	Subject supervisor	dr hab. inż. Marcin Śliwiński	
	Teachers	dr inż. Emilian Piesik dr hab. Anna Witkowska dr hab. inż. Marcin Śliwiński	

Lesson types and methods of instruction

Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
Number of study hours	30.0	15.0	15.0	0.0	0.0	60

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	60	8.0	57.0	125

Subject objectives

The student has knowledge concerning the methods and tools of reliability analysis, and diagnosis of devices and systems in automatics and robotics.

Learning outcomes

Course outcome	Subject outcome	Method of verification
K6_W11	The student has advanced knowledge of diagnostic methods for processes and installations with considering automation and robotics systems automation and robotics. He/she knows architecture industrial control systemsICS control and protection systems architecture and their importance in ensuring reliability and business continuity, as well as human and environmental safety.	[SW1] Assessment of factual knowledge [SW3] Assessment of knowledge contained in written work and projects
K6_U06	The student has knowledge of the reliability of different categories of industrial facilities and systems. He/she is familiar with various methods of modelling probabilistic modelling of systems, especially systems related to security.	[SU2] Assessment of ability to analyse information [SU3] Assessment of ability to use knowledge gained from the subject [SU4] Assessment of ability to use methods and tools

Subject contents	**LECTURE** Basic concepts and definitions of reliability theory. The failure mechanisms of technical objects. The reliability measures. Probabilistic models of elements. Distributions of random variable used in the reliability analysis. The estimation of exponential distribution parameter. Calculation of mean time to failure (MTTF) and mean time between failures (MTBF). Reliability data bases. Failure mode effect and criticality analysis (FMECA). Typical reliability structures: series, parallel and mixed. Redundancy and KooN architecture. Reliability block diagram (RDB) method. Logical and probabilistic modeling of systems. Fault tree (failure and errors) method (FT). Minimal cuts and minimal paths. Functional safety of the control and protection systems. Safety integrity level (SIL) of safety-related function. Determining required SIL from a risk graph and verifying SIL based on a probabilistic model of the system. Quality and reliability management in technical systems in a life cycle. Technical diagnostics. Diagnosis of devices and systems. Reliability centered maintenance (RCM). **TUTORIALS** Random events and definitions of probability. Probability calculus. Venn diagrams. Independent and dependent events. Conditional probability, Bayes rule. Random variables and distributions: discrete and continuous. Examples of distributions: Bernoulli, Poisson, exponential; their parameters and characteristic values. Application of probability calculus in reliability analysis of systems of various structures. **LABORATORY** Analysis of the operation times to failure: functions and reliability indices. Selected distributions in random variables in reliability analysis. Parameter estimation of exponential distribution with assessment of confidence interval. Diagnostic modules available in programmable logic controllers (PLC). Calculation of measures and functions of unreliability and unavailability using the reliability block diagram method. Failure mode, effect and criticality analysis using FMECA method. Probabilistic modelling of systems using fault tree method (FT).
Prerequisites and co-requisites	Knowledge concerning basic rules of devices functioning in technical systems. Basics of the probability calculus and statistics. Using engineering software.

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
Laboratory	60.0%	20.0%
Midterm tests	60.0%	30.0%
Oral exam	60.0%	30.0%
Written exam	60.0%	20.0%

Recommended reading

Basic literature	1. Zio E.: An introduction to the basics of reliability and risk analysis. New Jersey, World Scientific, 2007. 2. Kosmowski K.T. (red.): Podstawy bezpieczeństwa funkcjonalnego. Wydawnictwo Politechniki Gdańskiej, Gdańsk 2016-2020 (III wyd.).
Supplementary literature	1. Hoyland A., Rausand M.: System Reliability Theory. Models and Statistical Methods. New York: John Wiley & Sons, Inc. 1994. 2. MIL-HDBK-217F. Reliability Prediction of Electronic Equipment. Washington, DC: U.S. Department of Defence, 1991. 3. MIL-STD-1629A. Procedures for performing a failure mode, effects and criticality analysis. Washington, DC: U.S. Department of Defence, 1980. 4. MIL-HDBK-338B, Military Handbook, Electronic Reliability Design Handbook, 1998. 5. Probabilistic Risk Assessment, Procedures Guide for NASA Managers and Practitioners, Prepared for Office of Safety and Mission Assurance NASA Headquarters, Washington, DC 20546, August, 2002. 6. Reliability Centered Maintenance, Guide for Facilities and Collateral Equipment , National Aeronautics and Space Administration (NASA), February 2000.
eResources addresses	Adresy na platformie eNauczanie: NIEZAWODNOŚĆ I DIAGNOSTYKA [23/24] - Moodle ID: 33405 https://enauczanie.pg.edu.pl/moodle/course/view.php?id=33405

Example issues/ example questions/ tasks being completed	Calculate the mean time to failure MTTF of given category elements knowing failure intensity. Calculate the failure probability of a stucture described using the reliability block diagram (RBD). Calculate the failure probability of a stucture described using the fault tree (FT) based on minimal cut sets.
Work placement	Not applicable