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 2020	Academic year of realisation of subject	2022/2023
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

NIEZAWODNOŚĆ I DIAGNOSTYKA [2022/23] - Moodle ID: 26509
https://enauczanie.pg.edu.pl/moodle/course/view.php?id=26509

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_U06	Student posses knowledge concerning the reliability indicators of various categories of industrial objects and systems. He/she knows basic methods of probabilistic modelling of systems, particularly safety-related systems.	[SU4] Assessment of ability to use methods and tools [SU3] Assessment of ability to use knowledge gained from the subject [SU2] Assessment of ability to analyse information
K6_W11	Student has a basic knowledge concerning the diagnostics methods of processes and industrial installations regarding the systems of automation and robotics. He/she knows the architecture of industrial control systems and protection systems, and their importance in assuring the reliability and business continuity as well as the safety of people and environment.	[SW3] Assessment of knowledge contained in written work and projects [SW1] Assessment of factual knowledge

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. Markov processes and graphs in probabilistic modeling. 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
Midterm tests	60.0%	30.0%
Oral exam	60.0%	30.0%
Laboratory	60.0%	20.0%
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. (Ed.): Podstawy bezpieczeństwa funkcjonalnego. Wydawnictwo Politechniki Gdańskiej, Gdańsk 2016-2020 (III ed.).
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	

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 structure described using the reliability block diagram (RBD). Calculate the failure probability of a top event escribed using the fault tree (FT) based on minimal cut sets and probabilistic measures of basic events.
Work placement	Not applicable