



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	prof. dr hab. inż. Kazimierz Kosmowski					
	Teachers						
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						
	K6_U06						

Subject contents	<p>LECTURE</p> <p>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).</p> <p>TUTORIALS</p> <p>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.</p> <p>LABORATORY</p> <p>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).</p>																	
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	<table border="1" data-bbox="448 1128 1495 1301"> <thead> <tr> <th data-bbox="448 1128 794 1160">Subject passing criteria</th> <th data-bbox="794 1128 1141 1160">Passing threshold</th> <th data-bbox="1141 1128 1495 1160">Percentage of the final grade</th> </tr> </thead> <tbody> <tr> <td data-bbox="448 1160 794 1191">Laboratory</td> <td data-bbox="794 1160 1141 1191">60.0%</td> <td data-bbox="1141 1160 1495 1191">20.0%</td> </tr> <tr> <td data-bbox="448 1191 794 1223">Written exam</td> <td data-bbox="794 1191 1141 1223">60.0%</td> <td data-bbox="1141 1191 1495 1223">20.0%</td> </tr> <tr> <td data-bbox="448 1223 794 1254">Oral exam</td> <td data-bbox="794 1223 1141 1254">60.0%</td> <td data-bbox="1141 1223 1495 1254">30.0%</td> </tr> <tr> <td data-bbox="448 1254 794 1301">Midterm tests</td> <td data-bbox="794 1254 1141 1301">60.0%</td> <td data-bbox="1141 1254 1495 1301">30.0%</td> </tr> </tbody> </table>			Subject passing criteria	Passing threshold	Percentage of the final grade	Laboratory	60.0%	20.0%	Written exam	60.0%	20.0%	Oral exam	60.0%	30.0%	Midterm tests	60.0%	30.0%
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Recommended reading	Basic literature	<ol style="list-style-type: none"> Zio E.: An introduction to the basics of reliability and risk analysis. New Jersey, World Scientific, 2007. Kosmowski K.T. (Ed.): Basics of functional safety. Wydawnictwo Politechniki Gdańskiej, Gdańsk 2016-2020 (III ed.). 																
	Supplementary literature	<ol style="list-style-type: none"> Hoyland A., Rausand M.: System Reliability Theory. Models and Statistical Methods. New York: John Wiley & Sons, Inc. 1994. MIL-HDBK-217F. Reliability Prediction of Electronic Equipment. Washington, DC: U.S. Department of Defence, 1991. MIL-STD-1629A. Procedures for performing a failure mode, effects and criticality analysis. Washington, DC: U.S. Department of Defence, 1980. MIL-HDBK-338B, Military Handbook, Electronic Reliability Design Handbook, 1998. 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. 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 structure described using the fault tree (FT) based on minimal cut sets.
Work placement	Not applicable