Cracow University of Technology

Course syllabus

binding for the doctoral students of the CUT Doctoral School commencing their studies in the academic year 2022/2023

Information on the course

Name of the course in Polish	Teoria Niezawodności i Ryzyka w Zastosowaniach Inżynierskich
Name of the course in English	Reliability and Risk Analysis in Engineering Applications
Number of the ECTS points	2
Language of instruction	Polish
Category of the course	Choosable
Field of education	Engineering and Technology
Discipline of education	Civil Engineering and Transport
Person responsible for the course Contact	Prof. Mariusz Maślak PhD Eng. mmaslak@pk.edu.pl

Type of course, number of hours in the study programme curriculum

Semester	Credit type (G / NG)*	Lecture	Practical classes	Laboratory	Computer Lab	Project Class	Seminar
2, 3, 4, 5	G	15	0	0	0	15	0

*G – graded credit, NG – non-graded credit

Course objectives

Code	Objective description
Objective 1	Expanding knowledge about the random nature of phenomena that determine the behaviour of various types of engineering objects. Identification of the various sources of this randomness. Distinguishing between the randomness of individual interactions assigned to this object and the randomness of its responses to these interactions.
Objective 2	Expanding knowledge on the methods of qualitative and quantitative risk assessment that can be applied in practice. Acquisition of inference skills based on this type of analysis.
Objective 3	Acquiring the ability to take into account randomness and quantify risk in computational models used in engineering practice.

Learning Outcomes

Code	Description of the learning outcome adjusted to the specific characteristics of the discipline	Learning outcome symbol in the CUT SD	Methods of verification
OUTCOMES RELATED TO KNOWLEDGE			

EUW1	A PhD student recognizes and understands the specificity of the random nature of processes and phenomena, determining both the design-relevant effect of the impact on an object and the response of this object associated with the effect defined in this way.	E_W01, E_W02	Involvement in class activities, an oral test
EUW2	A PhD student identifies and associates the qualitative and quantitative effects of randomness. Understands the concepts of job probability and failure intensity.	E_W01, E_W02	Involvement in class activities, an oral test
OUTCOMES RELATED TO SKILLS			
EUU1	A PhD student is able to build and analyse simple probabilistic models that allow taking into account the random nature of both the processes and phenomena themselves, as well as the parameters that describe them.	E_U01, E_U02, E_U04	A credit for projects
EUU2	A PhD student is able to calibrate and verify the basic parameters of the probabilistic model he uses based on the available results of experimental research.	E_U01, E_U02	A credit for projects
EUU3	A PhD student is able to carry out a simple risk analysis based on decision trees and combining the probability of subsequent events with the consequence of their implementation.	E_U01, E_U02, E_U04	A credit for projects
OUTCOMES RELATED TO SOCIAL COMPETENCES			
EUK1	A PhD student is prepared to critically assess and verify probabilistic models that he may encounter in the future in engineering practice.	E_K01	A discussion
EUK2	A PhD student understands the need to apply knowledge-based inference in solving various types of cognitive and practical problems.	E_K03	A discussion

Course outline

No.	Contents	Learning outcomes for the course	No. of hours
LECTURE			
W1	probabilistic load models - part 1, including: - load as a random variable, - parameters for the description of the probability distribution of the implementation of a random load value, quantiles, representative and computational values, - decisive effect of the combination of permanent and variable loads.	EUW1, EUW2, EUU1, EUU2	2

W2	probabilistic load models - part 2, including: - constant load model, - variable load model, stationarity and ergodicity of the stochastic process, recovery period, - probability distributions of extreme values (Gumbel, Fréchet, Weibull)	EUW1, EUW2, EUU1, EUU2	3
W3	assessment of the probability of failure of a structural element or system, including: - random bearing capacity and random load of the considered object, - limit state function, - Hasofer-Lind reliability index, - verification of the guaranteed level of security.	EUW1, EUW2, EUU1, EUU2, EUK1, EUK2	2
W4	reliability of non-renewable facilities, including: - reliability function and unreliability function, - conditional intensity of the competition, - expected remaining service life, - probability of reliable operation of the object for a given time.	EUW1, EUW2, EUU1, EUU2, EUK1, EUK2	4
W5	making engineering decisions taking into account the risk of the profession, including: - classic interpretation of risk, - acceptable risk levels depending on the probability of the profession occurrence and its consequences, - consequence classes and reliability classes in terms of standards, - choosing the optimal decision based on the analysis of decision trees.	EUW1, EUW2, EUU3, EUK1, EUK2	4
PROJECT			
P1	Determination of the characteristic values of selected random variables on the basis of the results from a representative statistical sample, including: - specification of the characteristic value of random material strength, interpreted as a quantile of the p-order log-normal distribution, - specification of the characteristic value of random wind speed, interpreted as the most probable maximum of this speed modelled by the Gumbel probability distribution, calculated with the assumption of a 50-year reference period.	EUW1, EUW2, EUU1, EUU2, EUK1, EUK2	4

P2	verification of the level of safety guaranteed to the user of the corroded steel shell of a cylindrical overground tank with a floating roof, used for storing liquid fuels, made on the basis of the results of random thickness measurements of this shell, obtained after assessing the technical condition of the facility.	EUW1, EUW2, EUU1, EUU2, EUK1, EUK2	4
P3	determination of the reliability function and the function describing the conditional intensity of occupations for the given empirical data characterizing the process of using a non-renewable object.	EUW1, EUW2, EUU1, EUU2, EUK1, EUK2	3
P4	selection of the optimal strategy for the management of the structure used, minimizing the average cost of actions taken, on the basis of a comparative risk analysis based on a joint consideration of the reliability tree, the case tree and the decision tree.	EUW1, EUW2, EUU3, EUK1, EUK2	4

The ECTS points statement

WORKING HOURS SETTLEMENT	
Type of activity	Average number of hours (45 min.) dedicated to the completion of an activity type
SCHEDULED CONTACT HOURS WITH AN ACADEMIC TEACHER	
Hours allotted in the syllabus	30
Consultations	2
Examination / course credit assignment	4
HOURS WITHOUT THE PARTICIPATION OF AN ACADEMIC TEACHER	
Independent study of the course contents	8
Preparation of a paper, a report, a project, a presentation, a discussion	16
ECTS POINTS STATEMENT	
Total number of hours	60
The ECTS points number	2

Preliminary requirements

No.	Requirements
1	Knowledge of the basics of the theory of probability.

Course credit assignment conditions / method of the final grade calculation

No.	Description
COURSE CREDIT ASSIGNMENT CONDITIONS	
1	Credit for projects
2	Oral conversation
METHOD OF THE FINAL GRADE CALCULATION	
Weighted average of the grade obtained from the projects and the grade from the oral interview	

Additional information

Not specified

The course reading list

1	Żurański J. – *Modele obciążeń w normalizacji*, w: Mendera Z. et al. (Red.) – *Zastosowania probabilistyki w nowoczesnych normach konstrukcji i obciążeń*, PWN, Warszawa – Łódź, 1987.
2	Bobrowski D. – *Modele i metody matematyczne teorii niezawodności w przykładach i zadaniach*, Wydawnictwa Naukowo – Techniczne, Warszawa, 1985.
3	Migdalski J. (Red.) – *Poradnik niezawodności. Podstawy matematyczne*, Wydawnictwa Przemysłu Maszynowego „Wema", Warszawa, 1982.
4	Moore P. G. – *Ryzyko w podejmowaniu decyzji*, Państwowe Wydawnictwo Ekonomiczne, Warszawa, 1975.