GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Uncertainty Quantification and Reliability Analysis, PG_00069980		
Field of study	Uncertainty Quantification and Reliability Analysis		
Date of commencement of studies	February 2025	Academic year of realisation of subject	2025/2026
Education level	second-cycle studies	Subject group	
Mode of study	Full-time studies	Mode of delivery	at the university
Year of study	1	Language of instruction	English
Semester of study	2	ECTS credits	3.0
Learning profile	general academic profile	Assessment form	assessment
Conducting unit	Division of Ecoengineering and Combustion Engines -> Institute of Energy -> Faculty of Mechanical Engineering and Ship Technology -> Faculties of Gdańsk University of Technology		
Name and surname of lecturer (lecturers)	Subject supervisor	dr hab. inż. Jacek Kropiwnicki	
	Teachers	dr hab. inż. Jacek Kropiwnicki	

Lesson types

Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
Number of study hours	30.0	0.0	0.0	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	0.0	0.0	30

Subject objectives

The objective of this course is to introduce the theoretical framework of probability theory and stochastic modeling while developing practical skills in the effective management and quantification of uncertainty. Students will learn to use both classical Monte Carlo techniques and advanced Polynomial Chaos Expansions to perform core UQ tasks, including uncertainty propagation, input sensitivity analysis, and system reliability assessment.

Learning outcomes

Course outcome	Subject outcome	Method of verification
[K7_K82] is equipped to participate actively in lectures, seminars and laboratory classes conducted in foreign language	is prepared to actively participate in lectures, seminars, and laboratories conducted in a foreign language in the field of uncertainty quantification and reliability analysis	[SK2] Ocena postępów pracy
[K7_W12] identifies and interprets the main developmental trends and significant new achievements in the field of engineering and technical sciences and disciplines relevant to the course of study	identifies and interprets the main development trends and the most important new achievements in the field of uncertainty quantification and reliability analysis	[SW1] Ocena wiedzy faktograficznej
[K7_U82] is able to proficiently obtain and process information related to field of study and academic environment in foreign language at B2+ level of the Common European Framework of Reference for Languages (CEFR)	has the ability to efficiently acquire and process information in a foreign language in the field of uncertainty quantification and reliability analysis	[SU1] Ocena realizacji zadania
[K7_U14] integrates information obtained from literature and other properly selected sources, including those in a foreign language, creatively interpreting and critically evaluating them, and drawing conclusions	integrates information obtained from literature and other carefully selected sources, also in a foreign language, interpreting and critically evaluating it creatively and drawing conclusions in the field of uncertainty quantification and reliability analysis	[SU1] Ocena realizacji zadania

Subject contents

Course content – lecture
Introduction to Uncertainty Quantification, Probability Theory, Probabilistic Modeling, Monte Carlo Simulation, Uncertainty Propagation using Monte Carlo, Reliability Analysis, Polynomial Chaos Expansions, Sensitivity Analysis.

<table>
<tr><td>Prerequisites and co-requisites</td><td colspan="2"></td></tr>
<tr><td>Assessment methods and criteria</td><td colspan="2"><table><tr><th>Subject passing criteria</th><th>Passing threshold</th><th>Percentage of the final grade</th></tr><tr><td>Project</td><td>50.0%</td><td>100.0%</td></tr></table></td></tr>
<tr><td rowspan="3">Recommended reading</td><td>Basic literature</td><td>Ang, A. H-S.; Tang, W. H. Probability Concepts in Engineering. 2nd ed. Wiley, 2006.

Ghanem, R.; Higdon, D.; Owhadi, H. Handbook of Uncertainty Quantification. Springer Cham, 2017.

Melchers, R. E.; Beck, A. T. Structural Reliability: Analysis and Prediction. 3rd ed. John Wiley and Sons, 2018.</td></tr>
<tr><td>Supplementary literature</td><td>Sorensen, J. D. Notes in Structural Reliability Theory and Risk Analysis. Aalborg University, 2004.

Sudret, B.; Der Kiureghian, A. Stochastic finite element methods and reliability: a state-of-the-art report. Department of Civil and Environmental Engineering, University of California, 2000.</td></tr>
<tr><td>eResources addresses</td><td></td></tr>
<tr><td>Example issues/ example questions/ tasks being completed</td><td colspan="2">1. Characterize the different types of uncertainty involved in a given engineering problem.

2. Determine suitable probability distributions for parameters from a limited set of observations.

3. Define limit states that properly address the safety of a selected engineering system.

4. Perform Importance Sampling Monte Carlo Simulation to asses probability of failure.

5. Interpret the coefficients of the Polynomial Chaos Expansion of a given limit state function.</td></tr>
<tr><td>Practical activites within the subject</td><td colspan="2">Not applicable</td></tr>
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