GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Risk Processes, PG_00044138					
Field of study	Mathematics					
Date of commencement of studies	October 2026		Academic year of realisation of subject		2026/2027	
Education level	second-cycle studies		Subject group		Specialty subject group 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	1		Language of instruction		Polish	
Semester of study	2		ECTS credits		5.0	
Learning profile	general academic profile		Assessment form		exam	
Conducting unit	Institute of Applied Mathematics -> Faculty of Applied Physics and Mathematics -> Faculties of Gdańsk University of Technology					
Name and surname of lecturer (lecturers)	Subject supervisor		dr hab. Sergey Kryzhevich			
	Teachers		dr hab. Sergey Kryzhevich			

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

E-learning hours included: 0.0

eNauczanie source address: https://enauczanie.pg.edu.pl/2025/course/view.php?id=5220

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	5.0	60.0	125

Subject objectives	Introduction to basic mathematical concepts related to risk modeling in terms of stochastic (Markov) processes and stochastic differential equations.

Learning outcomes

Course outcome	Subject outcome	Method of verification
[K7_W04] demonstrates knowledge the rules of stochastic modeling in financial and actuarial mathematics or in natural sciences	Deals with issues related to building mathematical models of risk processes, including ruin processes.	[SW1] Assessment of factual knowledge [SW2] Assessment of knowledge contained in presentation
[K7_U03] uses differential and integral calculus, elements of complex analysis, algebraic methods, applies them in typical practical	Analizes Markow risk processes w continuous time.	[SU1] Assessment of task fulfilment [SU2] Assessment of ability to analyse information
[K7_K04] forms opinions on mathematical issues	Applies stochastic process methods to financial engineering, in particular to modeling insurance risk or survival risk.	[SK1] Assessment of group work skills [SK5] Assessment of ability to solve problems that arise in practice

<table>
<tr><td>Subject contents</td><td colspan="2">Course content – lecture

1) Winner and Poisson processes.
2) Insurance company business model.
3) Assets, options, Bachelier model.
4) Stochastic equations, Ito integrals.
5) Black-Sholes model.
6) Branching processes.
7) Autoregression. Ornstein-Uhlenbeck model.
8) Heath-Jarrow-Morton model and similar models.

Course content – seminar

1) The Risk Process as a Random Walk. Probability of Ruin
2) Fit Coefficient.
3) Probability of Ruin.
4) Probability of Ruin: Continuous Time
5) Claim Process - Renewal Theory.
6) Probability of Ruin: Poisson Claim Process.
7) Probability of Ruin for Phased Distributions.
8) Probability of Ruin for Heavy-Tailed Distributions.
9) Copula Functions.
10) Definition and Properties of Copula Functions.
11) Archimedes' Copula Functions.
12) Randomized Model.
13) Examples of Models with Dependent Claim Sizes.
14) Claims about the Pareto Distribution with Clayton's Copula
15) Claims about the Weibull Distribution with Gumbel's Copula
16) Intervals between Claims about the Pareto Distribution with Clayton's Copula
17) Intervals between Claims about the Weibull Distribution with Gumbel's Copula
18) Further Extensions of the Mixture Method
19) Statistical Techniques for Continuous Distributions
20) Fitting a Distribution to Data
21) Empirical Distribution Function
22) Quantile Plot (Q-Q Plot)
23) Mean Surplus Function
24) Pareto Distribution
25) Pareto-Type Distributions
26) Heavy-tailed distributions
27) Subexponential classes</td></tr>
<tr><td>Prerequisites and co-requisites</td><td colspan="2">Knowledge of the matter of subjects: Probability Theory, Stochastic Processes.</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>51.0%</td><td>50.0%</td></tr><tr><td>Exam</td><td>51.0%</td><td>50.0%</td></tr></table></td></tr>
<tr><td rowspan="3">Recommended reading</td><td>Basic literature</td><td>Jacek Jakubowski, Rafał Scztencel, Wstęp do teorii prawdopodobieństwa. SCRIPT, Warszawa, 2010.</td></tr>
<tr><td>Supplementary literature</td><td>1) Olav Kallenerg, Foundations of modern probability, Springer, 2002.

2) Ioanis Kartazas and Steven E. Sherve, Brownian Motion and Stochastic Calculus, Springer, 1991.

3) Tomasz R.Bilelecki, Marek Rutkowski, Credit Risk, Modeling, Valuating and Hedging, Springer, 2004.</td></tr>
<tr><td>eResources addresses</td><td>Basic
https://enauczanie.pg.edu.pl/2025/course/view.php?id=5220 -</td></tr>
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Example issues/ example questions/ tasks being completed	During the first lecture, students receive a topic for independent development and presentation of a project by a designated deadline. Theoretical knowledge acquired in the lecture and seminar will be assessed during the exam. 1) State and prove the properties of a homogeneous Markov chain. 2) Solve a problem involving multivariate linear regression. 3) Determine stochastic differentials using Ito's formula.
Practical activites within the subject	Not applicable

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