GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Stochastic differential equations, PG_00069471					
Field of study	Mathematics					
Date of commencement of studies	October 2025		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	2		Language of instruction		Polish	
Semester of study	3		ECTS credits		4.0	
Learning profile	general academic profile		Assessment form		assessment	
Conducting unit	Divison of Dynamical Systems -> 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 Klaudiusz Czudek			
	Teachers		dr Klaudiusz Czudek			
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						
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	35.0	100	
Subject objectives	Introduction to advanced methods of stochastic analysis , in particular to the theory of stochastic differential equations.					

Learning outcomes			
	Course outcome	Subject outcome	Method of verification
	[K7_W02] has enhanced knowledge of a selected branch of mathematics,theoretical or applied, knows classical definitions and theorems and their proofs and connections with other fields,understands problems being examined	Student solves linear stochastic equations and is able to state the existence and uniqueness of solution of SDE theorem.	[SW1] Assessment of factual knowledge
	[K7_U09] constructs mathematical models used in specific advanced applications of mathematics, can use stochastic processes as a tool for modeling phenomena and analyzing their evolution,constructs mathematical models used in specific advanced applications of mathematics, uses stochastic processes as a tool for modeling phenomena and analyzing their evolution, recognizes mathematical structures in physical theories	Student defines a diffusion process and describes the applications of the Langevin equation.	[SU3] Assessment of ability to use knowledge gained from the subject [SU4] Assessment of ability to use methods and tools
	[K7_W04] demonstrates knowledge the rules of stochastic modeling in financial and actuarial mathematics or in natural sciences	Student is able to describe the Black-Scholes model and apply the Black-Scholes formula.	[SW1] Assessment of factual knowledge
	[K7_U06] uses probability distributions and their properties in practical issues, is familiar with the basics of statistics and the basics of statistical data processing	Student is able to find the volatility for geometric Brownian motion (via historical method)	[SU1] Assessment of task fulfilment [SU2] Assessment of ability to analyse information [SU3] Assessment of ability to use knowledge gained from the subject [SU5] Assessment of ability to present the results of task

Subject contents

Course content – lecture

1. . Multidimensional Brownian motion.
2. Integral and formula Ito.
3. Some examples SDE.
4. Bellman-Gronwall inequality and its applications.
5. Existence and uniqueness for Ito equation.
6. Markov property.
7. Some estimations for the solutions.
8. Semigroups and the Kolmogorov equations.
9. Linear SDE.
10. Martingale problem.
11. Some applications of SDE.

Course content – seminar

Examples of martingales, basic properties of conditional expectation, examples of local martingales and their properties, quadratic variation, stochastic integrals and their properties, SDE's, linear SDE's, Dynkin formula, Black Scholes model.

Prerequisites and co-requisites

Courses completed: Stochastic Processes (MAT2007) and Stochastic Integral.

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
Test	51.0%	50.0%
Exam	51.0%	50.0%

Recommended reading

Basic literature

[1.] O. Kallenberg "Foundations of modern probability", Springer 2002

[2.] F.C. Klebaner, *Introduction to Stochastic Calculus with Applications* , Imperial College Press, 2005.

[3.] P. Protter, *Stochastic Integration and Differential Equations*, Springer, New York 2005.

[4.] B. Oksendal, *Stochastic Differential Equations, An Introduction with Applications*, Springer-Verlag Heidelberg, New York 2000.

	Supplementary literature	[1.] L. Brieman, *Probability*, Society for Industrial and Applied Mathematics, 1992. [2.] P. Billingsley, *Prawdopodobieństwo i miara*, PWN, 1987. [3.] S. Łojasiewicz, *Wstęp do teorii funkcji rzeczywistych*, PWN, Warszawa 1976. [4.] H. Kuo, *Introduction to stochastic integratio*n, Springer 2006. [5.] N. Ikeda, S. Watanabe, *Stochastic differential equations and Diffusion precesses*, North-Holland 1981.
	eResources addresses	
Example issues/ example questions/ tasks being completed	• Prove that Brownian motion is a martingale and possesses the Markov property. • Introduce the Ito integral. • Prove the isometry property of stochastic integrals. • Show that stochastic integrals are linear. • Apply the Ito formula. • Find stochastic differentials. • Find stochastic exponential and logarithm. • Solve general linear SDEs. • Discuss the Martingale Problem.	
Practical activites within the subject	Not applicable	

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