GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Stochastic differential equations, PG_00023809		
Field of study	Mathematics		
Date of commencement of studies	October 2023	Academic year of realisation of subject	2024/2025
Education level	second-cycle studies	Subject group	Optional 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	Institute of Applied Mathematics -> Faculty of Applied Physics and Mathematics		
Name and surname of lecturer (lecturers)	Subject supervisor	dr Klaudiusz Czudek	
	Teachers	dr Klaudiusz Czudek prof. dr hab. inż. Tomasz Szarek	

Lesson types and methods of instruction	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	60.0	125

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_W09] Knows the rules of stochastic modeling in financial and actuarial mathematics or in natural sciences, in particular physics, chemistry or biology.	The student knows examples of applications in financial mathematics of stochastic differential equations. He can construct simple stochastic differential equations related to applications in financial mathematics.	[SW2] Assessment of knowledge contained in presentation [SW3] Assessment of knowledge contained in written work and projects
[K7_U11] Can construct mathematical models used in specific advanced applications of mathematics, can use stochastic processes as a tool for modeling phenomena and analyzing their evolution.	Student constructs probabilistic models related to stochastic differential equations. Student recognizes types of stochastic differential equations.	[SU1] Assessment of task fulfilment [SU4] Assessment of ability to use methods and tools [SU5] Assessment of ability to present the results of task
[K7_W10] Knows the numerical methods used to find approximate solutions to mathematical problems (e.g. differential equations) posed by applied fields (e.g. industrial technologies, management, etc.).	Student is able to use various numerical methods to simulate solutions of stochastic differential equations	[SW2] Assessment of knowledge contained in presentation [SW3] Assessment of knowledge contained in written work and projects
[K7_W05] Has enhanced knowledge of a selected branch of mathematics: knows most classical definitions and theorems and their proofs, Understands problems being examined, Knows relations between problems from particular field with other branches of mathematics, theoretical and applied	The student knows the basic theorems on the existence and uniqueness of solutions to stochastic differential equations.	[SW2] Assessment of knowledge contained in presentation [SW3] Assessment of knowledge contained in written work and projects

Subject contents

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.

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
Activity	51.0%	25.0%
Exam	51.0%	50.0%
Research project	51.0%	25.0%

Recommended reading

Basic literature

[1.]H. Kuo, *Introduction to stochastic integrati*on, Springer 2006.

[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.

[5.]N. Ikeda, S. Watanabe, *Stochastic differential equations and Diffusion precesses*, North-Holland 1981.

	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.
	eResources addresses	Adresy na platformie eNauczanie: Stochastyczne równania różniczkowe - Moodle ID: 41624 https://enauczanie.pg.edu.pl/moodle/course/view.php?id=41624
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.	
Work placement	Not applicable	

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