

**DOCTORAL (PHD) STUDIES  
COURSE DESCRIPTION**

Course title	Field of science	Faculty	Institute
<b>Stochastic Differential Equations</b>	Mathematics (N 001)	Faculty of Mathematics and Informatics	Institute of Data Science and Digital Technologies
Study method	Number of credits	Study method	Number of credits
Lectures	0	Consultations	1
Individual work	4	Seminars	0

Course summary
<ol style="list-style-type: none"> <li><i>Continuous local martingales and stochastic integrals.</i> Properties of quadratic variation, stochastic integrals and Ito formula for continuous semimartingales.</li> <li><i>Continuous martingales and Brownian motion.</i> Martingale characterization of Brownian motion, random time-change, Cameron–Martin and Girsanov’s theorems.</li> <li><i>Stochastic differential equations.</i> Linear stochastic differential equations, Ornstein–Uhlenbeck processes, existence and uniqueness of strong solution.</li> <li><i>Markovian property of the solution of stochastic differential equation and infinitesimal generator.</i></li> <li><i>Weak solutions of stochastic differential equation.</i> Weak solutions and martingale problem, Yamada-Watanabe theorem.</li> <li><i>Kalman-Bucy filter.</i></li> <li><i>Parabolic equations.</i> Heat equation. Feynman–Kac formula, the stochastic solution to a Cauchy problem for a parabolic equation.</li> <li><i>Elliptic equations.</i> Stochastic solutions of the Dirichlet problem for elliptic equations.</li> </ol>
Main literature
1.V. Mackevičius, Introduction to stochastic analysis: integrals and differential equations, Wiley-ISTE, 2011.
2. J.-F. Le Gall, Brownian motion, martingales, and stochastic calculus, Springer, 2016.
3. Kallenberg, Foundations of Modern Probability, Springer, 1997.
4. B.Oksendal. Stochastic Differential Equations, An Introduction with Applications, Springer, Berlin et all., 5 ed., 1998.
5. Karatzas, S.E. Shreve, <i>Brownian Motion and Stochastic Calculus</i> , Springer-Verlag, 1991
6. A. Friedman. Stochastic Differential Equations and Applications. I, II, Academic Press, 1975.

Consulting teacher	Scientific degree	Pedagogical name	Main publications in the field of science of the last 5 year period
Kęstutis Kubilius	Habil. dr.	Prof.	<ol style="list-style-type: none"> <li>K. Kubilius, Yu. Mishura, K. Ralchenko. Parameter estimation in fractional diffusion models. Cham: Springer International Publishing, 2017. XIX, 390 p. (Bocconi &amp; Springer Series).</li> <li>K. Kubilius, A. Medžiūnas, Positive solutions of the fractional SDEs with non-Lipschitz diffusion coefficient, <i>Mathematics</i>, 2021, 9(1), 1–14.</li> <li>K. Kubilius, Estimation of the Hurst index of the solutions of fractional SDE with locally Lipschitz drift. <i>Nonlinear Anal. Model. Control</i> 2020, 25, 1059–1078</li> <li>K. Kubilius, CLT for quadratic variation of Gaussian processes and its application to the estimation of the Orey index, <i>Statistics &amp; Probability Letters</i>, 165:108845, 2020.</li> <li>K. Kubilius, V. Skorniakov. <i>A short note on a class of statistics for estimation of the Hurst index of fractional Brownian motion.</i> <i>Statistics &amp; probability letters.</i> 2017, Vol. 121, p. 78-82.</li> </ol>

			6. K. Kubilius, V. Skorniakov, K. Ralchenko, <i>The rate of convergence of the Hurst index estimate for a stochastic differential equation</i> . Nonlinear analysis: modelling and control. 2017, Vol. 22, No. 2, p. 273-284
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Approved by the Board of Faculty of Mathematics and Informatics 10/12/2021. Resolution No. (1.5 E) 110000-TPN-42

Board Chairman – assoc. prof. dr. Kristina Lapin