DOCTORAL (PHD) STUDIES
COURSE DESCRIPTION

Course title	Field of science	Faculty	Institute
Time Series Analysis	Mathematics (N 001)	Faculty of Mathematics and Informatics	Institute of Applied Mathematics
Study method	Number of credits	Study method	Number of credits
Lectures	0	Consultations	1
Individual work	4	Seminars	0

Course summary
1. **Stationary time series:** the notion of stationarity; ARMA processes; calculation of covariance function. 2. **Spectral representation of stationary processes:** Herglotz theorem; processes with orthogonal increments and spectral representation of stationary processes; inversion formula. 3. **Forecasting of stationary processes:** prediction equation; recursive methods (Durbin-Levinson, innovation algorithms); forecasting of ARMA processes; Wold decomposition and Kolmogorov formula. 4. **Partial autocorrelation:** calculation methods, properties**.** 5. **Estimation of ARMA parameters:** estimation of mean and covariance; estimation of ARMA parameters; maximum likelihood estimator. 6. **Estimation of spectra:** periodogram; asymptotic properties; smoothed periodogram; estimation of spectral distribution function. 7. **Multivariate time series:** stationary multivariate time series; multivariate ARMA processes; estimation of parameters of multivariate ARMA; unit root and cointegration. 8. **Long memory time series:** properties; examples. 9. **Conditionally heteroskedastic models:** ARCH models; GARCH models; their properties; stationarity. 10. **Estimation and testing ARCH/GARCH models:** maximum likelihood estimator and quasi maximum likelihood estimator; testing homoskedasticity. 11. **Integrated ARCH models:** theoretical properties; strong and weak stationarity. 12. **ARCH(∞) and ir FIGARCH models**. 13. **Stochastic volatility models; EGARCH models**: definitions, properties, examples. 14. **Nonlinear time series models:** threshold models; bilinear models; Markov and regime switching models. 15. **Multivariate ARCH models:** multivariate GARCH; CCC and DCC models; factor ARCH models.
Main literature
Brockwell P. J., Davis R.A. *Time Series: Theory and Methods*. Springer-Verlag, New York, 1996.
Hamilton J. D. *Time Series Analysis*. Princeton University Press, Princeton, NJ, 1994.
Fan J., Yao Q. *Nonlinear Time Series: Nonparametric and Parametric Methods*. Springer, New York, 2003.
Francq C., Zakoian J. M. *GARCH Models: Structure, Statistical Inference and Financial Applications*. Wiley, New York, 2019, 2nd ed.
Lütkepohl H. *New Introduction to Multiple Time Series Analysis*. Springer, New York, 2005.

Consulting teacher	Scientific degree	Pedagogical name	Main publications in the field of science of the last 5 year period
Remigijus Leipus	Habil. dr.	Prof.	1. Skorniakov V., Leipus R., Juzeliūnas G., Staliūnas K. Group testing: Revisiting the ideas. *Nonlinear Analysis: Modelling and Control*. 2021. **26**. 534-549. 2. Jokubaitis S., Celov D., Leipus R. Sparse structures with LASSO through Principal Components: forecasting GDP components in the short-run. *International Journal of Forecasting*. 2021. **37**. 759-756. 3. Leipus R., Philippe A., Pilipauskaitė V., Surgailis D. Estimating long memory in panel random-coefficient AR(1) data. *Journal of Time Series Analysis*. 2020. **41**. 520-535.

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