



COURSE UNIT (MODULE) DESCRIPTION

Course unit (module) title	Code
Multivariate Statistics	

Lecturer(s)	Department(s) where the course unit (module) is delivered
Coordinator: prof. Vydas Čekanavičius Other(s):	Department of Statistical Analysis, Institute of Applied Mathematics, Faculty of Mathematics and Informatics

Study cycle	Type of the course unit (module)
Second	Compulsory

Mode of delivery	Period when the course unit (module) is delivered	Language(s) of instruction
Face-to-face	First Semester	English/Lithuanian

Requirements for students	
Prerequisites: First course in Statistics	Additional requirements (if any):

Course (module) volume in credits	Total student's workload	Contact hours	Self-study hours
5	150	42	108

Purpose of the course unit (module): programme competences to be developed

... To teach students professionally analyze economic, social, biologic etc. data applying classical and modern methods of statistical analysis. Enhance critical and analytic thinking.

Learning outcomes of the course unit (module)	Teaching and learning methods	Assessment methods
<ul style="list-style-type: none"> • To know various multivariate statistical research methods , principles of their application, interpretation and application strategies; • To know relations among normal-based tests (ANOVA, MANOVA, ANCOVA); • To comprehend interdependence of regression models (linear regression, logistic regression, HLM); • To be able explain relations between latent factor and observed variables; • To be able interpret latent factors in structural equation models; • Correctly use in research context the main concepts of statistical modeling (SEM, HLM, GLM etc.), 	Lectures, case analysis	Control tests, individual problem solving, written examination
<ul style="list-style-type: none"> • To be able explain and interpret obtained results and draw relevant conclusions,; • To be able understand proofs of main propositions; • To understand the main principles of adequacy of economic and statistical model to observed data; 	Problem solving during seminars, group discussion	Control tests, written examination

<ul style="list-style-type: none"> To be able apply statistical packet for statistical data analysis correctly; To be able relate theoretical model to given data; To be able to choose correct estimation method in practice. 	Problem solving during seminars, group discussion; correct usage of statistical program	Control tests
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Content: breakdown of the topics	Self-study work: time and assignments						Self-study hours	Assignments
	Lectures	Seminars	Exercises	Laboratory work	Internship/work placement	Contact hours		
1. Review of classical tests of statistics.	3					3	2	
2. Matrix algebra, Spectral decomposition; generalized Cauchy inequality.	3		2			5	12	[1] prob. 2.13, 2.15, 2.38
3. Random samples. Properties of sample means and variances	3		2			5	12	[1] prob. 3.14, 3.15, 3.16
4. Multivariate normal distribution. Conditional density.	1		2			3	15	[1] prob. 4.3, 4.4
5. Statistic inference about mean vectors, MANOVA.	3		1			4	15	[1] prob. 6.5, 6.17, 6.18, 6.24
6. Linear models. ANCOVA	3		1			4	12	[2] prob 6
7. Generalized linear models, Poisson and negative binomial regressions.	6		2			8	14	[2] prob.. 1,
8. Hierarchical linear models	3		2			5	12	[2] prob. 7
9. Factor analysis and structural equation models	3		2			5	14	[2] prob. 10
Total	28		14			42	108	

Tests and exams	h
Consultation	2
Control tests	8
Exam	1

Assessment strategy	Weight, %	Deadline	Assessment criteria
Control tests (90%) and exam on theory (10%)			
Topics for the first control test	25%	During semester	Open book test. Theoretical problems related to multivariate normal distribution, problems related to spectral decomposition of matrices, simultaneous confidence intervals. Modeling of ANOVA, MANOVA and ANCOVA with statistical program..
Topics for the second control test	25%	During semester	Open book test Canonical link function for given density from exponential family. Practical data analysis modeling logit, Poisson, negative binomial and Probit regressions.
Topics for the third control test	15%	During semester	Open book test. Matrix form of given HLM. Modeling of HLM with chosen statistical program.
Topics for the fourth control test	25%	During semester	Open book test, EFA and SEM models for given data.
Final exam	10%	January	Closed book consisting of theoretical propositions given during semester.

Author	Year of publication	Title	Issue of a periodical or volume of a publication	Publishing place and house or web link
Compulsary reading				
1. R.A. Johnson, D.W. Wichern	2002	Applied Multivariate Statistical Analysis (5 ed.)		Prentice Hall
2. V.Čekanavičius	2019	Multivariate Statistical Analysis, lecture notes		www.esec.vu.lt
3. V.Čekanavičius	2019	Training excercises		www.esec.vu.lt
Optional reading				
A.C. Rencher	2002	Methods of Multivariate Analysis (sec.ed.)		Wiley-Interscience
R.B. Kline	2005	Principles and practice of Structural Equation Modeling (sec.ed.)		Guiford Press
S.W. Raudenbush, A.S. Bryk	2002	Hierarchical Linear Models (sec.ed.)		Sage