UNIVERSITY OF NIŠ

STUDY PROGRAM

OF MASTER ACADEMIC STUDIES

APPLIED STATISTICS

Study program of master academic studies „Applied Statistics“

	Code	Course title	S	Status	Hours of active teaching				Other hours	ECTS	Teacher
					L	E	SRW	OTT			
First year											
1.	PS11	Introduction to probability theory	1	O	2	2				6	Miljana Jovanović
2.	PS12	Introduction to mathematical statistics	1	O	3	3				8	Biljana Popović
3.	PS13	Statistical software	1	O	1	2				5	Miroslav Ristić
4.	PS14	Methodologies for data collection	1	O	2	2				6	Biljana Popović
5.		Elective course from block 1	1	I	3	1				6	
6.	PS21	Sampling theory	2	O	2	2				6	Aleksandar Nastić
7.	PS22	Planning and analysis of experiments	2	O	2	2				6	Aleksandar Nastić
8.	PS23	Multivariate analysis	2	O	2	2				6	Biljana Popović
9.	PS24	Regression analysis	2	O	2	2				6	Aleksandar Nastić
10.	PSSP1	Professional practice 1 - Academic skills	2	O	2	1				5	Jelena Ignjatović
Second year											
Module: Ekonomics											
11.	PSME31	Econometrics	3	O	2	2				6	Vesna Janković-Milić
12.	PSME32	Mathematical models in finance	3	O	2	2				6	Miljana Jovanović
13.	PSME33	Time series analysis	3	O	2	2				6	Miroslav Ristić
Module: Engineering											
18.	PSMI31	Theory of modeling and Monte Carlo method	3	O	2	2				6	Branimir Todorović
19.	PSMI32	Time series analysis	3	O	2	2				6	Miroslav Ristić
20.	PSMI33	Statistical quality control	3	O	2	2				6	Miomir Stanković
Module: Medicine											
21.	PSMB31	Survival analysis	3	O	2	2				6	Zoran Milošević
22.	PSMB32	Biostatistics	3	O	2	2				6	Zoran Milošević
23.	PSMB33	Epidemiology	3	O	2	2				6	Dragan Bogdanović
Module: Social Sciences											
24.	PSMD31	Analysis of categorical data	3	O	2	2				6	Vladimir Hedrih
25.	PSMD32	Structural equations	3	O	2	2				6	Vladimir Hedrih
26.	PSMD33	Advanced linear modeling	3	O	2	2				6	Vladimir Hedrih
Svi moduli:											

27.		Elective course from block 2	3		2	2				6	
28.	PSSP2	Professional practice 2	3				4			6	
29.		Elective course from block 2	4		2	2				6	
30.	PSZR	Master thesis	4				16			24	
									Ukupno ESPB	120	
Elective courses											
Elective course from block 1											
1.1.	PSI11	Linear algebra and calculus	1	I	3	1				6	Dragan Đorđević
1.2.	PSI12	Basics of economics	1	I	3	1				6	Branislav Mitrović
1.3.	PSI13	Social medicine	1	I	3	1				6	Aleksandar Višnjić
1.4.	PSI14	General psychology	1	I	3	1				6	Jelisaveta Todorović
Elective course from block 2											
2.1.	PSI201	Spatial statistics	3-4	I	2	2				6	
2.2.	PSI202	Missing data analysis	3-4	I	2	2				6	Miroslav Ristić
2.3.	PSI203	Data mining	3-4	I	2	2				6	Branimir Todorović
2.4.	PSI204	Data visualization	3-4	I	2	2				6	Svetozar Rančić
2.5.	PSI205	Statistical software R	3-4	I	2	2				6	Miroslav Ristić
2.6.	PSI206	Decision theory	3-4	I	2	2				6	Miroslav Ćirić
2.7.	PSI207	Nonparametric statistics	3-4	I	2	2				6	
2.8.	PSI208	Reliability theory	3-4	I	2	2				6	Ljiljana Savić
2.9.	PSI209	Principal components analysis	3-4	I	2	2				6	Branimir Todorović
2.10.	PSI210	Operations research	3-4	I	2	2				6	Predrag Stanimirović
2.11.	PSI211	Cluster analysis	3-4	I	2	2				6	Jelena Ignjatović
2.12.	PSI212	Econometrics 2	3-4	I	2	2				6	Vinko Lepojević

Specification of the course for the Book of courses

Study program		Applied statistics	
Title of the course		**Introduction to probability theory**	
Teachers (for lectures)		Miljana Jovanović	
Teacher/fellow teacher (for exercises)		Jasmina Đorđević	
ESPB	8	**Status of the course (obligatory (O) /elective (E))**	O

Conditions	none
Aim of the course	The aim of this course is to give an introduction of the theory of probability and random variables necessary for understanding the statistical analysis. This course is a prerequisite for all other courses in the study program.
Course outcomes	After passing this exam, students will master the concept of probability and random variables. They will understand the characteristics of one-dimensional and multidimensional random variables. Students will understand and will be able to apply the central limit theorem, and will understand the basic principles of statistical analysis based on the theory of large numbers.
Content of the course	
Theoretical classes	Statistical experiment, probability space. Axioms of probability. The classical definition of probability. Geometric probability. Statistical definition of probability. Properties of probability. Independent events and conditional probability. The formula of total probability and Bayes formula. Random variables. Distribution functions. Discrete random variable. Continuous random variable. Random vectors. Independence of random variables. Functions of random variables and random vectors. Numerical characteristics of random variables. Mathematical expectation. Moments. Covariance and correlation coefficient. Covariance matrix. Information and entropy. Characteristic functions. Limit theorem. Types of convergence in probability theory. Čebyšev type inequalities. Laws of large numbers. Central limit theorem and its applications. Empirical distribution function and the central theorem of statistics. Conditional distribution. The definition of conditional distributions with respect to random variable. Conditional mathematical expectation and variance.
Practical classes	Content of practical classes follows theoretical classes through solving the problems in investigating areas.
References	
1	Ivković Z., "Teorija verovatnoća sa matematičkom statistikom", Naučna knjiga, 1989.
2	Spanos, Aris: Probability Theory and Statistical Inference, Cambridge: University Press, 1999
3	Danijela Rajter-Ćirić: Probability, Novi Sad: Faculty of Science, Department of Mathematics and Informatics, 2009.
4	Spiegel, Murray R.: Theory and Problems of Probability and Statistics, New York: McGraw-Hill, 2000

The number of contact hours per week during the semester / trimester / year

Lectures	**Exercises**	**DON**	**Research work**	**Other classes**
2	2	----	------	------

Teaching methods	Lectures, exercises, individual work

Evaluation of knowledge (maximum score 100)

Pre exam duties	**points**	**Final exam**	**points**
Activity during lectures	10	**oral exam**	40
colloquia	50		

Specification of the course for the Book of courses

Study program		Applied statistics	
Title of the course		**Statistical software**	
Teachers (for lectures)		Miroslav Ristić	
Teacher/fellow teacher (for exercises)		Miodrag Đorđević	
ESPB	4	**Status of the course (obligatory (O) /elective (E))**	O

Conditions	none
Aim of the course	The aim of this course is to introduce students to work in the statistical software.
Course outcomes	Students will be trained to use statistical software for complex statistical analysis. Students will understand the data matrix to the extent necessary for statistical analysis. Students will meet environment of statistical software (SPSS, Statistica, R. ..).
Content of the course	
Theoretical classes	Data matrix. Control data input (mask input, dual input), error correction, archiving, confidentiality, ethics information, handling. Basics statistical analysis programs for tabulation (Microsoft Excel, Calc Libre Office). Statistical package SPSS (using a programming language syntax and Matrix), Statistica, R. Introduction to Programming in SAS. Introduction to programming in R.
Practical classes	Content of practical classes follows theoretical classes. The realization of all theoretical content with practical training on computers.
References	
1	Dalgaard, P. (2002) Introductory Statistics with R, Springer. ISBN 0-387-95475-9
2	Venables, W.N., Ripley, B.D.: Modern Applied Statistics with S, Springer, 4th ed., 2002
3	Deep, R.: Probability and Statistics: With Integrated Software Routines, Academic Press, 2005
4	Field, A.(2005) Discovering Statistics Using SPSS (Introducing Statistical Methods S.) Sage Publications Ltd; 2nd edition.
5	Pallant, J. (2007) SPSS Survival Manual: A Step by Step Guide to Data Analysis Using SPSS for Windows, Open University Press; 3 edition.
6	Kasum D., Legović T. (2004) Uvod u korištenje R-a http://cran.r-project.org/doc/contrib/Kasum+Legovic-UvodUr.pdf (Serbian).

The number of contact hours per week during the semester / trimester / year

Lectures	Exercises	DON	Research work	Other classes
1	2	----	------	------

Teaching methods	Lectures, exercises, individual work on computer (1 student per 1 computer).

Evaluation of knowledge (maximum score 100)

Pre exam duties	points	Final exam	points
Activity during lectures	5		40
Practical classes	5		
colloquia	50		

Specification of the course for the Book of courses

Study program		Applied statistics	
Title of the course		**Methodologies for data collection**	
Teachers (for lectures)		Biljana Popović	
Teacher/fellow teacher (for exercises)		Predrag Popović	
ESPB	6	**Status of the course (obligatory (O) /elective (E))**	O

Conditions	
Aim of the course	The aim of this course is to introduce students to different methods of data collection. Beginning of the course is intended for the basics of data collection: problems and hypotheses, variables and events. Then, students will get known with the control of research, samples and additional information about the data, data types and levels of measurement, longitudinal data and data in one section of time. Special attention will be also paid to specific types of data, from those that are generated by computer simulation (modeling), epidemiological data and clinical data. Ethical and practical aspects of data collection will be demonstrated.
Course outcomes	Upon completion of the course, students will be able to independently plan and manage projects to collect data. In doing so, they will have detailed knowledge of the ethical protocols.
Content of the course	
Theoretical classes	The basics of data collection: problems and hypotheses, indicators, variables and their relationships. Preparation for data collection I: Sample and sampling, control of external influences. Preparation for data collection II: Additional information about the data, data types and levels of measurement. Experimental research. Quasi-experiment. Observation, interviewing and testing. Longitudinal data and data in one section of time. Computer modeling. Collecting data in epidemiology. Clinical studies and N = 1 experiments. Meta data and meta-analysis. Ethical and practical approach to data collection.
Practical classes	The central part of practical training will be dedicated to making a number of different plans of research. Doing so the educational background of each student will be taken into account, as well as her / his personal research interests.
References	
1	Locke, L. F., Silverman, S. J., & Spirduso (Eds.). (2010). *Reading and Understanding Research*. Thousand Oaks, CA: Sage.
2	Marczyk, G. R., DeMatteo, D., & Festinger, D. (2005). *Essentials of Research Design and Methodology*. Hoboken, NJ: John Wiley & Sons.
3	Laake, P., Benestad, H. B., & Olsen, B. R. (2007). *Research Methodology in the Medical and Biological Sciences*. Amsterdam: Elsevier.
4	Bergh, D. D., & Ketchen, D. J. J. (Eds.). (2009). *Research Methodology in Strategy and Management*. Bingley, UK: Emerald Group Publishing.
5	Gast, D. L. (2010). *Single Subject Research Methodology in Behavioral Sciences*. Oxon, UK: Routledge.

The number of contact hours per week during the semester / trimester / year

Lectures	**Exercises**	**DON**	**Research work**	**Other classes**
2	2	----	------	------

Teaching methods	Lectures, writing the draft (plan) of research, consultative teaching

Evaluation of knowledge (maximum score 100)

Pre exam duties	**points**	**Final exam**	**points**
Activity during lectures	10	**written exam**	60
		Oral exam	30

Specification of the course for the Book of courses

Study program		Applied statistics	
Title of the course		**Sampling theory**	
Teachers (for lectures)		Aleksandar Nastić	
Teacher/fellow teacher (for exercises)		Predrag Popović	
ESPB	6	**Status of the course (obligatory (O) /elective (E))**	O

Conditions	
Aim of the course	The aim of this course is to introduce students to the sampling theories and the importance of proper sampling for subsequent statistical analysis.
Course outcomes	Students will be able to make decisions about how to choose the sample depending on the statistical analysis to be used. Students will be able to apply different sampling theory in real situations and to evaluate the quality of the sample in the research.
Content of the course	
Theoretical classes	Sampling: Basic concepts related to sampling and evaluation. The main steps in the planning of sampling and selection of sample units. Simple random sampling. Assessment of population size, mean, proportion and relationships. Systematic random sampling, stratified random sampling and the second step. Sampling with unequal probabilities. Clusters and sampling plans in more steps. Surveys: Basic concepts related to sampling and evaluation. The main steps in the planning of sampling and selection of sampling units. Procedures for data collection in the sampling for the survey. Surveys by households, the telephone survey, the survey by mail and electronic mail, the survey online, snowball surveys and online polls. Procedure with unanswered questions and measurement errors. Unreliable sampling populations, sequential, spatial, adaptive sampling, and sampling kvota. The Bootstrap and Jackknife procedures.
Practical classes	Practical instructions follows the course content, ie. theoretical instructions. Using of statistical software. The analysis of case studies related to sampling.
References	
1	Carl-Eri Sarndal, Bengt Swensson, Jan Wretman: Model Assisted Survey Sampling, Springer series in statistics,2003
2	Shao, Tu: The Jackknife and Bootstrap, Springer series in statistics 1995.

The number of contact hours per week during the semester / trimester / year

Lectures	**Exercises**	**DON**	**Research work**	**Other classes**
2	2	----	------	------

Teaching methods	lectures, exercises, analysis of examples with applications, writing reports.

Evaluation of knowledge (maximum score 100)

Pre exam duties	**points**	**Final exam**	**points**
activity during lectures	5	**Oral exam**	40
excercises	5		
homeworks	20		
seminars	30		

Specification of the course for the Book of courses

Study program		Applied statistics	
Title of the course		**Planning and analysis of experiments**	
Teachers (for lectures)		Aleksandar Nastić	
Teacher/fellow teacher (for exercises)		Predrag Popović	
ESPB	6	**Status of the course (obligatory (O) /elective (E))**	O

Conditions	
Aim of the course	The course aims to enable students to plan an experiment using a scientific approach. Analysis and understanding of different approaches to the planning of the experiment.
Course outcomes	Students will be able to choose an appropriate plan of experiments based on the observed problems. The student will master the skills necessary for expert analysis of factorial experiments, including selection of influential factors and models.
Content of the course	
Theoretical classes	Introduction to experiments. The strategy of experimentation. Fundamentals of planning experiments. Simple comparative experiments. Experiments with a single factor. Analysis of variance. Nonparametric methods of analysis of variance. A randomized block layout. Latin squares. Factorial plans. 2k factorial plans. A partial factorial experiments with two levels. Experiments with random factors. Hierarchical plan and plot plan divided.
Practical classes	Practical instructions follows the course content, ie. theoretical instructions. Using of statistical software. The analysis of case studies related to sampling.
References	
1	Montgomery, D. C.: Design and Analysis of Experiments, 5th Edition, John Wiley and Sons, Inc., New York, 2001.
2	Cox, D., Read, N.: The theory of the design of experiments, Chapmann and Hall, 2000.
3	Weber, D., Skillings, J.: A first course in the design of experiments, CRC Press, 2000.

The number of contact hours per week during the semester / trimester / year

Lectures	**Exercises**	**DON**	**Research work**	**Other classes**
2	2	----	------	------

Teaching methods	lectures, exercises, analysis of examples with applications, writing reports.

Evaluation of knowledge (maximum score 100)

Pre exam duties	**points**	**Final exam**	**points**
activity during lectures	5	**Oral exam**	40
excercises	5		
homeworks	20		
seminars	30		

Specification of the course for the Book of courses

Study program		Applied statistics	
Title of the course		**Multivariate analysis**	
Teachers (for lectures)		Biljana Popović	
Teacher/fellow teacher (for exercises)		Predrag Popović	
ESPB	6	**Status of the course (obligatory (O) /elective (E))**	O

Conditions	
Aim of the course	This course aims to provide students with basic knowledge of multivariate methods and to gain the ability to analyze multidimensional data.
Course outcomes	Upon completion of the course, students should be able to understand and apply the theory of multivariate normal distribution, multivariate analysis of variance and multivariate regression. Student will be able to apply different classification and discrimination, such as methods of cluster analysis and discriminant analysis.
Content of the course	
Theoretical classes	Multidimensional normal distribution. Parameters of višedimezionalne normal distribution. Distribution Uišarta. The distribution of Hotelling. Multiple regression. Probit analysis. MANOVA. Discriminant analysis. Canonical correlation analysis. Factorial MANOVA. Principal components analysis. Factor analysis. Cluster analysis.
Practical classes	Tasks and problems are solved, the practical lessons follow the content of teaching, ie. theoretical instruction. Using statistical software for multivariate analysis.
References	
1	Biljana Popović: Matematička statistika i statističko modelovanje, Prirodno-matematički fakultet, Niš, 2003.
2	Srivastava M. S., Carter E. M.: An introduction to applied multivariate statistics, Elsevier Science Publishing Co., New York, 1983.
3	Härdle W., Simar L.:Applied Multivariate Statistical Analysis, Springer-Verlag, Berlin Heidelberg, 2003.
4	Johnson R. A., Wichern D. W.: Applied Multivariate Statistical Analysis, 4th edition, Prentice Hall, 1998.

The number of contact hours per week during the semester / trimester / year

Lectures	**Exercises**	**DON**	**Research work**	**Other classes**
2	2	----	------	------

Teaching methods	Lectures, exercises, writing the statistical reports

Evaluation of knowledge (maximum score 100)

Pre exam duties	**points**	**Final exam**	**points**
Activity during lectures	5	**Oral exam**	40
Activity during exercises	5		
colloquia	30		
seminars	20		

Specification of the course for the Book of courses

Study program		Applied statistics	
Title of the course		**Regression analysis**	
Teachers (for lectures)		Aleksandar Nastić	
Teacher/fellow teacher (for exercises)		Miodrag Đorđević	
ESPB	6	**Status of the course (obligatory (O) /elective (E))**	O

Conditions	
Aim of the course	The course aims to familiarize students with the basic concepts and techniques in using regression models in scientific research. They should be enabled to perform analysis of their own data, and to interpret and publish the results. They should also understand the basic potentials in using regression models and get some inspiration for a more effective use of regression analysis of real data.
Course outcomes	On completion of this course successful students will be able to understand the objectives of regression analysis and understand the role of the predictor and the response variables in regression relation. The students should also be able to define the simple and the multiple linear regression models and understand the basic idea and the assumptions of the least squares method. They will be able to estimate the coefficients of the model using the least squares method, to make statistical inferences about the model and interpret the results, to forecast future observations of the response variable, to employ the model diagnostics for both simple and multiple linear regression models and finally to use computer statistical packages to perform the calculations required in regression analysis.
Content of the course	
Theoretical classes	Simple linear regression, the method of least squares, multiple linear regression models, model building, diagnostics and model selection, residual analysis, polynomial regression, introduction to time series modeling and forecasting, introduction to a multivariate regression analysis,
Practical classes	Tasks and problems are solved, the practical lessons follow the content of teaching, ie. theoretical instruction. Using statistical software for regression analysis.
References	
1	William Mendenhall, Terry Sincich: A Second Course in Statistics: Regression Analysis, Pearson Education Prentice Hall; 6th edition, 2003.
2	Michael Patrick Allen: Understanding Regression Analysis, Plenum Press, New York, 1997
3	Benjamin Kedem, Konstantinos Fokianos: Regression Models for Time Series Analysis, John Wiley & Sons, 2002.

The number of contact hours per week during the semester / trimester / year

Lectures	**Exercises**	**DON**	**Research work**	**Other classes**
2	2	----	------	------

Teaching methods	Lectures, exercises, writing the statistical reports

Evaluation of knowledge (maximum score 100)

Pre exam duties	**points**	**Final exam**	**points**
Activity during lectures	5	**Oral exam**	40
Activity during exercises	5		
colloquia	30		
seminars	20		

Specification of the course for the Book of courses

Study program		Applied statistics	
Title of the course		**Professional practice 1 – Academic skills**	
Teachers (for lectures)		Jelena Ignjatović	
Teacher/fellow teacher (for exercises)		Ivana Jančić	
ESPB	4	**Status of the course (obligatory (O) /elective (E))**	O

Conditions	
Aim of the course	The aim of this course is to enable students to independently organize and conduct research projects. It introduce students to the management of research that involves the most efficient organization of all research phases, from gathering and organizing literature and data, and planning and monitoring project tasks, to data analysis, report writing and publication of results.
Course outcomes	Students are familiar with the latest findings in management studies and trained to conduct their own research projects.
Content of the course	
Theoretical classes	Establishing technical fundamentals about the research. Manage yourself, your ideas and support structures. Organizing the working environment. Planning and monitoring progress of the project. Electronic communication and networking. Effectively search the literature. Internet search strategies. Collect and organize references. Planning data collection systems management data analysis. Improving the efficiency of writing. Presentation and publication of research results.
Practical classes	Practical work will follow the contents of the lectures. Exercises will focus on analyzing successful and unsuccessful research projects and proposals and research projects. EndNote software for the promotion of research and publication.
References	
1	Phelps, R., Fisher, K. & Ellis, A. (2007). *Organizing and managing your research: a practical guide for postgraduates*. London: Sage.
2	Hunt, A. (2005). *Your Research Project: How to Manage It*. London: Routledge.
3	Tarling, R (2005). *Managing Social Research: A Practical Guide*. London: Routledge.
4	Devine, F. & Heath, S. (1999). *Sociological Research Methods in Context*. Basingstoke: Palgrave.
5	Beins, B. & Beins, A. (2008). *Effective Writing in Psychology: Papers, Posters, and Presentations.* New Jersey: John Wiley & Sons.
6	Bryman, A. (2001). *Social Research Methods, Chapter 25: Conducting a small-scale project*. Oxford: Oxford University Press.

The number of contact hours per week during the semester / trimester / year

Lectures	**Exercises**	**DON**	**Research work**	**Other classes**
2	2	----	------	------

Teaching methods	Lectures, exercises, consultative work

Evaluation of knowledge (maximum score 100)

Pre exam duties	**points**	**Final exam**	**points**
Activity during lectures	10	**Written exam**	40
Activity during exercises	10	**Oral exam**	20
seminars	20		

Specification of the course for the Book of courses

Study program		Applied statistics	
Title of the course		**Linear algebra and calculus**	
Teachers (for lectures)		Dragan Đorđević	
Teacher/fellow teacher (for exercises)		Milica Gligorijević	
ESPB	6	**Status of the course (obligatory (O) /elective (E))**	E

Conditions	none
Aim of the course	The aim of the course is to acquaint students with the mathematical apparatus necessary for the understanding of statistical analysis. The specific task of the course is to introduce students to the application of complex mathematical device for real problems in order to achieve functional knowledge .
Course outcomes	After mastering the content of this course, students will be able to follow courses in the field of statistics. They will understand the application of complex mathematical apparatus that includes matrix calculus, differentiable and integral calculus of functions of one or more variables to real problems. Students will be able to apply apparatus of mathematical analysis to statistical analysis.
Content of the course	
Theoretical classes	Matrix calculus (operations on matrices, inverse matrix, characteristic roots and vectors). Functions of one variable (limit, continuity, differentiability, integrability). Functions of several variables (partial derivatives; conditional extremes). Optimization problems.
Practical classes	The content of practical training follows the theory. Real examples will be presented with special emphasis on the use of mathematical software to solve problems.
References	
1	Ljubiša Kočinac, Linearna algebra i analitička geometrija, Prosveta, Niš, 1997.
2	B. Šešelja, A. Tepavčević, Algebra 1, University of Novi Sad, Faculty of Science, 2004
3	Hughes-Hallett, Deborah: Calculus, New York [etc.]: John Wiley & Sons, Inc., 2002
4	Stewart, James: Calculus, Belmont: Thomson, 2006

The number of contact hours per week during the semester / trimester / year

Lectures	**Exercises**	**DON**	**Research work**	**Other classes**
3	1	----	------	------

Teaching methods	The material is presented using video projector, combined with classical methods and interaction with students. Students knowledge is assessed through five tests. At the oral part of the examination the students demonstrate a comprehensive understanding of the above materials.

Evaluation of knowledge (maximum score 100)

Pre exam duties	**points**	**Final exam**	**points**
Activity during lectures and exercises	10	**Oral exam**	40
colloquia	50		

Specification of the course for the Book of courses

Study program		Applied statistics	
Title of the course		**Basics of Economics**	
Teachers (for lectures)		Branislav Mitrović	
Teacher/fellow teacher (for exercises)			
ESPB	6	**Status of the course (obligatory (O) /elective (E))**	E

Conditions	
Aim of the course	The goal of course is to introduce students to the fundamentals of the economy, and to the field of microeconomics and macroeconomics. Students will acquire knowledge necessary to understand application of statistics in the economy and to successfully attend courses in the economic module.
Course outcomes	Students will understand the concepts of microeconomics and macroeconomics. They will be able to demonstrate knowledge of basic economic terminology, understand the socio-economic processes, know the basic economic laws, demonstrate knowledge of basic market principles and competition. They will acquire the knowledge necessary to understand the economic model whose parameters are being assessed by econometrics.
Content of the course	
Theoretical classes	Supply and demand (the market and welfare); economy public sector enterprise behavior, labor market economy, the real economy in the long run, money and prices in the long run, macroeconomics of open economy, economic fluctuations in the short run.
Practical classes	Practical instruction follows the theoretical teaching content. Students will analyze real examples in order to achieve better functional knowledge.
References	
1	N. Gregory Mankiw: Osnovi ekonomije,3. izdanje, Mate, 2006. (in Serbian)
2	A. Koutsoyiannis: Moderna Mikroekonomija, 2. izdanje,Mate,1979. (in Serbian)
3	N. Gregory Mankiw: Makroekonomija,5. izdanje, Cekom books, 2003. (in Serbian)

The number of contact hours per week during the semester / trimester / year

Lectures	**Exercises**	**DON**	**Research work**	**Other classes**
3	1	----	------	------

Teaching methods	a combination of classical (frontal) lectures and interactive methods (i.e. dialog); preparation of seminar papers

Evaluation of knowledge (maximum score 100)

Pre exam duties	**points**	**Final exam**	**points**
Activity during lectures	5	**Oral exam**	50
Activity during exercises	5		
seminars	40		

Specification of the course for the Book of courses

Study program		Applied statistics	
Title of the course		**Social medicine**	
Teachers (for lectures)		Aleksandar Višnjić	
Teacher/fellow teacher (for exercises)			
ESPB	6	**Status of the course (obligatory (O) /elective (E))**	E

Conditions	none
Aim of the course	To familiarize students with the methodology of assessment of health status, health care organizations and the possibilities and ways of collecting data needed to conduct research in medicine.
Course outcomes	Knowledge, application and calculation of the required indicators needed to assess health status of the population, as well as knowledge of assessment methodology.
Content of the course	
Theoretical classes	Indicators of health of population. Assessment of health and the health status of the population. Social inequalities in health and achieving health care. Quality of life. Communication in healthcare. Health for All Strategy in the XXI century. The health care systems. Health care and factors affecting health care. Quality health care. Economic analysis.
Practical classes	Collection of data required to analyze the health status. Indicators for the calculation of health (vital demographic indicators, morbidity, organization and operation of health services) Analysis of health of certain territories.
References	
1	Jakovljević Dj, Grujić V, editors. Social medicine. Textbooks: 33, University of Novi Sad: Faculty of Medicine, Novi Sad, 1995. (in Serbian).
2	Stamatović M, Jakovljević Dj, Legetić B, Martin M Cvejin. Health care and insurance. Novi Sad: Institute for textbooks and teaching aids, 1996. (in Serbian).
3	Detels R, Holland WW, McEwen J, Omenn GS. Oxford textbook of Public Health, Oxford University Press, New York, 2004

The number of contact hours per week during the semester / trimester / year

Lectures	**Exercises**	**DON**	**Research work**	**Other classes**
3	1	----	------	------

Teaching methods	Lectures, exercises, the analysis of health status

Evaluation of knowledge (maximum score 100)

Pre exam duties	**points**	**Final exam**	**points**
Activity during lectures	5	**Oral exam**	40
Activity during excercises	15		
seminars	40		

Specification of the course for the Book of courses

Study program		Applied statistics	
Title of the course		**General psychology**	
Teachers (for lectures)		Jelisaveta Todorović	
Teacher/fellow teacher (for exercises)		Ivana Simić	
ESPB	6	**Status of the course (obligatory (O) /elective (E))**	E

Conditions	
Aim of the course	This course will familiarize students with basic and general psychological processes related to receiving, processing, storage and use of information in biological systems. The emphasis will be on the most developed biological cognitive system (human) but there will also be a comparative review of the relevant animal species. When studying each process, perception, learning, memory, problem solving, language and action, parallels with artificial systems will be drawn. The course practical exercises will help students to distinguish between an abstract level functions (eg. collection of audio information from the environment) and the implementation of the shifts in biological systems (hearing in humans or owl) or artificial (microphone).
Course outcomes	- Understanding and reproduction of knowledge about the basic problems of cognitive psychology; - Understanding and application of relevant methods in psychophysics; - Understanding of relevant methods in the modeling of cognitive processes; - Reproduction knowledge of psychological and physiological basis of sensory systems (hearing, vision) and cognitive systems (memory, language) - Understanding of the leading theories and models that explain cognition; - Basics of writing research reports.
Content of the course	
Theoretical classes	I Object and principles of perception and cognition; gathering information from the environment, fitness senses environmental conditions; II Psychophysics and limits of cognition, measurement of cognitive psychology; detection signal; Information Theory, III Physiology and anatomy of the senses, sensory-neural pathways and cortical structures; IV Psychological ways of transferring relevant information in the cognitive system, coding of information, format information in the cognitive system; V Learning in humans and animals. Principles of adoption of information that arrived with the senses. VI Memory, systematization and categorization of information collected, the information holder; Biological systems as opposed to databases; VII Problem solving, modeling of cognitive functions, logical and psychological explanations; VIII Languages, natural and artificial symbolic systems; IX Development of cognitive function, normal maturation and development; maturation versus learning.
Practical classes	Conducting the experiment as the basis for the development of the research paper. Activities include data collection, data processing and determination psychophysical and cognitive parameters, review the literature related to the studied phenomenon. SUPERLAB computer program will be used .
References	
1	Zdravković S. (2008). Perception. GNB "Zarko Zrenjanin", Zrenjanin. (in Serbian)
2	Kostić, A. (2006). Cognitive Psychology. Beograd Institute for textbooks and teaching aids. (in Serbian).
3	Sternberg, R. J. (2003). The fourth edition psychologist's companion: A guide to scientific writing for students and researchers (4th ed.). New York, USA: Cambridge University Press.

The number of contact hours per week during the semester / trimester / year

Lectures	**Exercises**	**DON**	**Research work**	**Other classes**
2	2	----	------	------

Teaching methods	Lectures, exercises, discussion groups, research reports

Evaluation of knowledge (maximum score 100)

Pre exam duties	**points**	**Final exam**	**points**
Activity during lectures	10	**written exam**	25
Colloquia	25	**Oral exam**	20
Seminars	20		

Specification of the course for the Book of courses

Study program		Applied statistics	
Title of the course		**Econometrics**	
Teachers (for lectures)		Vesna Janković-Milić	
Teacher/fellow teacher (for exercises)			
ESPB	6	**Status of the course (obligatory (O) /elective (E))**	E (Obligatory in Module Statistics in Economy)

Conditions	
Aim of the course	Introduction of concepts and methods of modern econometric analysis. Attention is paid to problems of formulation of regression models in terms of covering relationship of interdependence of economic phenomena and knowledge in the field of evaluation, testing and interpretation of econometric models of various types.
Course outcomes	Functional knowledge of regression methods, conditions of applicability, and their main advantages and disadvantages. The ability to define and practical application of appropriate model for the type of problem.
Content of the course	
Theoretical classes	The basics of econometrics. One-dimensional regression. Multidimensional regression. Ratings and statistical significance. Omission of relevant variables. Inclusion of irrelevant variables. Heteroscedasticity. Autocorrelation.
Practical classes	Tasks and problems are solved, practical lessons follow the content of teaching, ie. theoretical instruction. Usage of statistical software.
References	
1	G.S. Maddala: Introduction to econometrics, John Wiley & Sons, 3rd edition, 2001.
2	W.H.Greene: Econometric analysis, 5th ed., Prentice Hall, 2003.
3	Kiš T. Et al, Quantitative Methods in Economics, Faculty of Economics, Subotica, 2005 (in Serbian).
4	Baltagi, B. H., Econometrics, Springer, 2002

The number of contact hours per week during the semester / trimester / year

Lectures	**Exercises**	**DON**	**Research work**	**Other classes**
2	2	----	------	------

Teaching methods	lectures, exercises, analysis of examples with applications, writing reports about statistical analysis

Evaluation of knowledge (maximum score 100)

Pre exam duties	**points**	**Final exam**	**points**
Activity during lectures	5	**Oral exam**	40
Activity during exercises	5		
colloquia	30		
seminars	20		

Specification of the course for the Book of courses

Study program		Applied statistics	
Title of the course		**Mathematical models in finance**	
Teachers (for lectures)		Miljana Jovanović	
Teacher/fellow teacher (for exercises)		Marija Krstić	
ESPB	6	**Status of the course (obligatory (O) /elective (E))**	E (Obligatory in Module Statistics in Economy)

Conditions	
Aim of the course	Introduction to the techniques of financial mathematics.
Course outcomes	Acquiring knowledge about the fundamental concepts of financial mathematics: bank accounts, credits, securities and other financial instruments
Content of the course	
Theoretical classes	Bank accounts and credits. Decursive simple and compound interest rates. Simple and complex anticipatory interest rates. Credits. The impact of inflation on capital value. Examples of banking practices. Bonds. Types of bonds. Basic concepts: nominal value, coupon, coupon period, interest has grown, the current yield, yield to maturity, annual yield portfolio. Calculate the selling price of bonds, the mean time the bonds, convexity, immunization of bond portfolios. Trade bonds on the domestic stock market. Trade bonds on world markets. Actions. Trading in shares of domestic and world markets. Averages and indices as indicators of the industrial economy. Secondary financial instruments and financial derivatives. Participants in financial markets, arbitrage. Forwards and futures: forvardna and fjučersna price, interest-bearing futures, index futures, forwards and futures in foreign currencies, commodity futures and forwards. Options: types of options, the volatility of prices substrate, determining the lower and upper limit values of European and American options, the protection of portfolio risk using the options, sales and purchasing power parity, the market strategy.
Practical classes	Tasks and problems are solved, the practical lessons follow the content of teaching, ie. theoretical instruction. Using of statistical software.
References	
1	Cvjetičanin M.,"Burzovno trgovanje, Priručnik za investitore i analitičare", Masmedia, Zagreb, 2004.
2	Hull J.C., „Option, Futures, and Other Derivatives", (4th edn), Prentice Hall, 2000.
3	Ivović M., „Finansijska matematika", Ekonomski fakultet, Beograd, 2003.

The number of contact hours per week during the semester / trimester / year

Lectures	**Exercises**	**DON**	**Research work**	**Other classes**
2	2	----	------	------

Teaching methods	lectures, exercises, analysis of examples with applications, writing reports about statistical analysis

Evaluation of knowledge (maximum score 100)

Pre exam duties	**points**	**Final exam**	**points**
Activity during lectures	5	**Oral exam**	40
Activity during exercises	5		
colloquia	30		
seminars	20		

Specification of the course for the Book of courses

Study program		Applied statistics	
Title of the course		**Theory of modeling and Monte Carlo method**	
Teachers (for lectures)		Branimir Todorović	
Teacher/fellow teacher (for exercises)		Dejan Mančev	
ESPB	6	**Status of the course (obligatory (O) /elective (E))**	E (O in Module Engineering)

Conditions	
Aim of the course	The goal of course is the introduction and understanding of the principles, techniques and methodologies of complex computational methods in statistics, particularly Monte Carlo method.
Course outcomes	Students will know and be able to use complex computer techniques in statistical conclusions which include Monte Carlo method, Markov chains, bootstrep methods, EM algorithms.
Content of the course	
Theoretical classes	Monte Carlo experiment: evaluation using a (pseudo) random samples obtained by computer experiments, bias and variance assessment, variance reduction, control variables, the causality, the significance of the sample; generators of pseudo-random numbers with uniform and non-uniformly distributed. Simulation of stochastic processes, generate trajectories of Markov processes and discrete event systems; properties assessment using simulations, the variance of ratings and reduction of variance, Markov chain Monte Carlo and simulations. Bootstrapping and computer intensive techniques. Bootstrapping for assessing standard errors and confidence intervals, hypothesis testing and prediction errors.
Practical classes	Practical classes include practicing content of theoretical training, using appropriate software environment.
References	
1	M. H. Kalos and P. A. Whitlock: Monte Carlo Methods (2nd ed.), Wiley-VCH, 2008
2	C. P. Robert and G. Casella: Introducing Monte Carlo Methods with R, Springer, 2010
3	J. S. Liu : Monte Carlo Strategies in Scientific Computing, Springer, 2001
4	W.R. Gilks, S. Richardson and D. J. Spiegelhalter: Markov Chain Monte Carlo in Practice, Chapman and Hall/CRC Interdisciplinary Statistics, 1995

The number of contact hours per week during the semester / trimester / year

Lectures	**Exercises**	**DON**	**Research work**	**Other classes**
2	2	----	------	------

Teaching methods	Lectures, exercises, writing the seminar papers, individual work

Evaluation of knowledge (maximum score 100)

Pre exam duties	**points**	**Final exam**	**points**
Activity during lectures	5	**Oral exam**	40
Activity during exercises	5		
colloquia	20		
seminars	30		

Specification of the course for the Book of courses

Study program		Applied statistics	
Title of the course		**Statistical quality control**	
Teachers (for lectures)		Miomir Stanković	
Teacher/fellow teacher (for exercises)			
ESPB	6	**Status of the course (obligatory (O) /elective (E))**	E (O in Module Engineering)

Conditions	
Aim of the course	The aim of this course is to introduce students to the importance of quality control for successful operations and to enable students to apply complex statistical analysis for quality management.
Course outcomes	Following the successful completion of this course students will be able to -Explain the importance of quality in business, -Explain the role of statistical quality control within the wider context, such as Total Quality Management -Apply methods and techniques of statistical quality control, -Conduct Studies or project in the field of statistical quality control and interpret the results -Demonstrate motivation and responsibility to advocate for quality in business
Content of the course	
Theoretical classes	Conclusions about process quality. Operating curve. Basic methods of statistical process control and analysis of the benefits. Methodology. Control charts for numeric features. Control charts for attribute feature. "CUSUM" charts for the mean. "EWMA" charts for the mean. Control chart of serial correlated data. Multivariate quality control process
Practical classes	Practical classes include practicing of content from lectures, using the statistical software environment.
References	
1	Montgomery, D. C. (2005). Introduction to Statistical Quality Control, Fifth Edition, John Wiley & Sons, Inc., USA
2	Bass, I. (2007). Six Sigma Statistics with Excel and Minitab, Mc Graw Hill, New York
3	Besterfield, D.H. (2009). Quality Control (8th Edition). Pearson / Prentice Hall
4	E.L. Grant and R.S. Leavenworth: Statistical Quality Control, 6th edition, McGraw-Hill.

The number of contact hours per week during the semester / trimester / year

Lectures	**Exercises**	**DON**	**Research work**	**Other classes**
2	2	----	------	------

Teaching methods	The introduction of the theory through lectures, practical work, exercises and independent work.

Evaluation of knowledge (maximum score 100)

Pre exam duties	**points**	**Final exam**	**points**
Activity during lectures	5	**Oral exam**	40
Activity during exercises	5		
colloquia	20		
seminars	30		

Specification of the course for the Book of courses

Study program		Applied statistics	
Title of the course		**Survival analysis**	
Teachers (for lectures)		Zoran Milošević	
Teacher/fellow teacher (for exercises)			
ESPB	6	**Status of the course (obligatory (O) /elective (E))**	E (Obligatory in Module Biomedicine)

Conditions	
Aim of the course	The aim of this course is to introduce students to the distributions appearing in survival analysis, the length of the components and the functions of survival. Understanding the specifics of the distribution and statistical analysis of such phenomena.
Course outcomes	Students will be able to apply statistical machine connected to the analysis of survival in research or in decision making. Students will understand the complex statistical analysis of several models that describe survival.
Content of the course	
Theoretical classes	The function of survival. Censored Data. Nonparametric methods for evaluating the function of survival. Nonparametric methods for comparing survival distributions. Parametric survival distribution and application. Methods for evaluation of parametric survival distributions. Parametric methods for regression models and determination of prognostic factors. Determination of prognostic factors for survival time: Cox proportional hazards model, nonproportional hazards model.
Practical classes	Understanding research in the analysis of survival through the analysis of technical and scientific papers that use models of survival analysis. Usage of statistical software. Application of survival analysis in problems in medicine.
References	
1	D. Collett: Modeling Survival Data in Medical Research, 2nd Edition, Chapman & Hall/CRC, 2003.
2	J. D. Kalbfleisch R. L. Prentice: The Statistical Analysis of Failure Time Data, Wiley-Interscience; 2nd edition, 2002.
3	T. M. Therneau P. Grambsch: Modeling Survival Data: Extending the Cox Model (Statistics for Biology and Health), Springer Verlag, 2000.
4	P. D. Allison: Survival Analysis Using the SAS System: A Practical Guide, SAS Publishing, 1995.
5	E.T. Lee, J.W. Wang: Statistical Methods for Survival Data Analysis, 3rd edition, Wiley, 2003.

The number of contact hours per week during the semester / trimester / year

Lectures	**Exercises**	**DON**	**Research work**	**Other classes**
2	2	----	------	------

Teaching methods	Lectures, exercises, analysis of examples with applications, writing reports.

Evaluation of knowledge (maximum score 100)

Pre exam duties	**points**	**Final exam**	**points**
Activity during lectures	5	**Oral exam**	40
Activity during exercises	5		
colloquia	20		
seminars	30		

Specification of the course for the Book of courses

Study program		Applied statistics	
Title of the course		**Biostatistics**	
Teachers (for lectures)		Zoran Milošević	
Teacher/fellow teacher (for exercises)			
ESPB	6	**Status of the course (obligatory (O) /elective (E))**	E (Obligatory in Module Biomedicine)

Conditions	
Aim of the course	The aim of this course is to master the basic concepts and understanding of the principles, techniques and methods of biostatistics and to apply them in biology, medicine and related fields.
Course outcomes	This subject enables students to understand the principles of statistics in biology, medicine and related disciplines, and to apply the appropriate statistical technique in order to solve specific problems. Students will be trained to use appropriate statistical software that is specific for use in these areas and will be introduced to the corresponding characteristic examples.
Content of the course	
Theoretical classes	Hypothesis testing in the case of one, two or more samples: analysis of variance. Test differences between pairs. Multiple comparisons. Analysis of variance in the case of two-dimensional and multi-dimensional classification. Transformation of data. Nonparametric methods of analysis of variance. Hierarchical analysis of variance. Simple linear regression, comparison of simple regression models. Multiple regression and correlation: Polynomial regression. Logistic regression. Comparison of observed frequencies with the theoretical distribution. Categorical data and χ^2 – test. Dichotomous variables. Testing randomness
Practical classes	Presentation of models and methods characteristic for biostatistics. Solving of characteristic problems. Getting known specific software.
References	
1	Zar, J. H. (2009). Biostatistical Analysis, Prentice Hall
2	Chernick, M. R., Friis, R. (2003). Introductory Biostatistics for the Health Sciences Modern Applications Including Bootstrap, Princeton, New Jersey
3	GP Quinn and MJ Keough, 2002. *Experimental Design and Data Analysis for Biologists*. Cambridge: Cambridge University Press
4	Dawson and Trapp: Basic and Clinical Biostatistics, 4th edition. Lange Medical Books, 2004.

The number of contact hours per week during the semester / trimester / year

Lectures	Exercises	DON	Research work	Other classes
2	2	----	------	------

Teaching methods	Lectures, exercises, analysis of examples with applications, writing reports.

Evaluation of knowledge (maximum score 100)

Pre exam duties	points	Final exam	points
Activity during lectures	5	**Oral exam**	40
Activity during exercises	15		
colloquia	20		
seminars	20		

Specification of the course for the Book of courses				
Study program			Applied statistics	
Title of the course			**Epidemiology**	
Teachers (for lectures)			Dragan Bogdanović	
Teacher/fellow teacher (for exercises)				
ESPB		6	**Status of the course (obligatory (O) /elective (E))**	E (Obligatory in Module Biomedicine)
Conditions				
Aim of the course	The aim of this course is to introduce application of statistical analysis in the field of epidemiology. Specifics of applying statistics to assess the spread of epidemics and other problems.			
Course outcomes	Students will be able to understand the problem and to define an appropriate model for its solution by applying the statistical apparatus that has been developed and adapted to problems in epidemiology.			
Content of the course				
Theoretical classes	Research of epidemic. Measures of mortality. The incidence (new cases of disease) and prevalence (total number of affected individuals). Measures of risk. Biological variability. Screening. Case-control (retrospective) study. Cohort (prospective) studies. Randomized clinical trials. Understanding articles in epidemiological studies.			
Practical classes	Understanding research in epidemiology through the analysis of technical and scientific papers. Application of statistical software in the field of epidemiology. Solving problems in epidemiology and production of seminar papers			
References				
1	J.R. Hebel, R.J. McCarter: Study guide to Epidemiology and Biostatistics, 6th edition, Jones and Bartlett Publishers, 2006.			
2	Robert Friis: Epidemiology for Public Health Practice, Jones & Bartlett Publishers			
3	Jos W. R. Twisk, Jos W. Twisk: Applied Longitudinal Data Analysis for Epidemiology: A Practical Guide, Cambridge University Press			
The number of contact hours per week during the semester / trimester / year				
Lectures	**Exercises**	**DON**	**Research work**	**Other classes**
2	2	----	------	------
Teaching methods	Lectures, exercises, analysis of examples with applications, writing reports.			
Evaluation of knowledge (maximum score 100)				
Pre exam duties		**points**	**Final exam**	**points**
Activity during lectures		5	**Oral exam**	40
colloquia		5		
seminars		50		

Specification of the course for the Book of courses	
Study program	Applied statistics
Title of the course	**Analysis of categorical data**
Teachers (for lectures)	Vladimir Hedrih
Teacher/fellow teacher (for exercises)	

ESPB	6	**Status of the course (obligatory (O) /elective (E))**	E (O in module)	
Conditions				
Aim of the course	The aim of this course is to introduce students to the analysis of categorical data, the types of distribution, their treatment and approximation, and usage of loglinear models.			
Course outcomes	Upon completion of this course, students should be able to understand the nature and distribution of categorical data and their possible transformation. Also, students should be competent to apply different types of loglinear models, and to interpret the results of these statistical procedures.			
Content of the course				
Theoretical classes	Introduction to the binomial and polynomial distribution. Marginal and conditional distribution. Approximation of normal distribution. Evaluation and testing of categorical data. Delta method for determining the asymptotic variance. Contingency tables. The treatment of incomplete or missing data. Structural parameterization. Conditional probability ratio (conditional odds ratio). The structure of associations and generalization of independence. Loglinear models. Regression models in loglinear interpretation.			
Practical classes	Practical classes include practicing content from lectures using the R statistical software environment. Students will use the ready-made examples, but they themselves will prepare categorical data on which to perform statistical analysis.			
References				
1	Agresti, A. (2002). *Categorical Data Analysis*. New Jersey: Wiley.			
2	Bishop, Y. M., Fienberg, S. E., & Holland, P. W. (2007) *Discrete Multivariate Analysis: Theory and Applications*. New York: Springer.			
3	Rudas, T. (1998). *Odds Ratios in the Analysis of Contingency Tables*. Thousand Oaks: Sage.			
4	Fienberg, S. E. (2007). *The Analysis of Cross Classified Categorical Data*. New York: Springer.			
The number of contact hours per week during the semester / trimester / year				
Lectures	**Exercises**	**DON**	**Research work**	**Other classes**
2	2	----	------	------
Teaching methods	Lectures, exercises, writing the statistical reports, consultative work			

Evaluation of knowledge (maximum score 100)			
Pre exam duties	**points**	**Final exam**	**points**
Activity during lectures	10	**Written exam**	30
Activity during exercises	20	**Oral exam**	20
seminars	20		

Specification of the course for the Book of courses

Study program		Applied statistics	
Title of the course		**Structural equations**	
Teachers (for lectures)		Vladimir Hedrih	
Teacher/fellow teacher (for exercises)			
ESPB	6	**Status of the course (obligatory (O) /elective (E))**	E (O in Module)

Conditions	
Aim of the course	To introduce structural equations as a kind of general information processing model that allows testing the proposed relationships between variables through a set of verifiable mathematical equations. Starting from the basic concepts of correlation and regression analysis of the path as a continuation of multiple regression analysis and simple method of measurement, students are introduced to more complex models of measurement, structural models with latent variables, the models that include testing of means of latent variables and structural equation modeling with longitudinal data .
Course outcomes	Students will be familiar with the method of structural equation and are trained to implement it.
Content of the course	
Theoretical classes	Basic concepts of correlation and regression. Basic concepts of structural modeling. Path analysis and decomposition of effects. Introduction to AMOS program. Simple models of measurement and confirmative factor analysis. Use of indicators in model identification and problem identification. Complex models of measurement. Using a group of items within the scales instead of individual items-pros and cons. Equality of factor variance and covariance. Structural models with latent variables. Specifications and estimates. Fit indices. Modifications of the model. Tests of parameters. Non-normal data. "Bootstrapping". Statistical power. Modeling means. Modeling with multiple groups. Structural equation modeling with longitudinal data. Comparison of structural equation and hierarchical linear modeling.
Practical classes	In the practical work a specialized statistical program AMOS for structural equation modeling will be used. The exercises will follow the contents of the lectures.
References	
1	Kline, R. B. (2005). Principles and practice of structural equation modeling (2nd). New York: Guilford Press
2	Byrne, B. B. (2010). Structural equation modeling using AMOS. Basic concepts, applications, and programming (2nd). New York: Routledge
3	Curran, P. J. (2003). Have multilevel models been structural models all along? *Multivariate Behavior Research, 38,* 529-569.
4	Hancock, G. R., & Mueller, R. D. (Eds.). (2006). Structural equation modeling: A Second Course. Greenwich, CT: Information Age Publishing.
5	Preacher, K. J., Wichman, A. L., MacCallum, R. C., & Briggs, N. E. (2008). Latent growth curve modeling. Thousand Oaks: Sage Publications.

The number of contact hours per week during the semester / trimester / year

Lectures	Exercises	DON	Research work	Other classes
2	2	----	------	------

Teaching methods	Lectures, exercises, writing the seminar papers, individual work

Evaluation of knowledge (maximum score 100)

Pre exam duties	points	Final exam	points
Activity during lectures	10	**Written exam**	40
Exercises	40		
seminars	10		

Specification of the course for the Book of courses

Study program		Applied statistics	
Title of the course		**Advanced linear modeling**	
Teachers (for lectures)		Vladimir Hedrih	
Teacher/fellow teacher (for exercises)			
ESPB	8	**Status of the course (obligatory (O) /elective (E))**	E (O in Module)

Conditions	Introduction to linear models
Aim of the course	The aim of this course is to introduce students to complex linear models. Starting from the basic theoretical methods of analysis of variance, analysis of variance and linear regression, the obstacles and risks in linear modeling, students are gradually introduced to the most complex procedures for linear modeling. The fixed and random effects, nonlinearity and interaction for comparison and critical analysis of the model, the additive process, additive models and generalized additive models, techniques, polishing and setting parameters and their distribution.
Course outcomes	Upon completion of this course, students should be able to apply various advanced techniques of linear modeling, and to interpret the structure of the results obtained using these techniques.
Content of the course	
Theoretical classes	Repetitoria: analysis of variance, analysis of covariance, linear regression. Obstacles and risks in the linear modeling I: interactions, collinearity, nonlinearity, and high adherence (overfitting). Obstacles and risks in the linear modeling II: the missing data and data reduction. Criticism of the model: simplification, validation, re-sampling and comparison of models. Linear mixed effects I: the fixed effects versus random effects. Linear mixed effects II: nonlinearity and interactions (fixed-fixed and fixed-random). Linear mixed effects III: determination of significance, comparing models, model criticism. Linear mixed effects IV: Understanding compression values (shrinkage), the presentation and discussion of the results. Generalized additive models I: additive models and generalized additive models. Generalized additive models II: Techniques ironing. Generalized additive models III: determination of parameters and their distribution. Generalized additive models IV: presentation and discussion of the results.
Practical classes	Practicing the content from lectures, analysis of examples and preparing data for analysis of linear models using the R statistical software environment.
References	
1	Faraway, J. J. (2006).*Extending the Linear Model with R: Generalized Linear, Mixed Effects and Nonparametric Regression Models*. Boca Raton: Chapman & Hall/CRC.
2	Pinheiro, J. C. & Bates, D. M. (2004). *Mixed-Effects Model in S and S-PLUS*. New York: Springer.
3	Wood, S. N. (2006).*Generalized Additive Models: An Introduction with R*. Boca Raton: Chapman & Hall/CRC.
4	Harrell, F. E. (2001). *Regression Modeling Strategies*. New York: Springer.

The number of contact hours per week during the semester / trimester / year

Lectures	**Exercises**	**DON**	**Research work**	**Other classes**
2	2	----	------	------

Teaching methods	Lectures, exercises, writing the statistical reports, consultative teaching

Evaluation of knowledge (maximum score 100)

Pre exam duties	**points**	**Final exam**	**points**
Activity during lectures	10	**Written exam**	30
Activity during exercises	20	**Oral exam**	20
seminars	20		

Specification of the course for the Book of courses

Study program		Applied statistics	
Title of the course		**Data mining**	
Teachers (for lectures)		Branimir Todorović	
Teacher/fellow teacher (for exercises)		Dejan Mančev	
ESPB	6	**Status of the course (obligatory (O) /elective (E))**	E

Conditions	
Aim of the course	The goal of course is introduction and understanding of the principles, techniques and methodologies of data analysis and neural networks.
Course outcomes	Students will understand and be able to use a wide range of techniques of data analysis. They will acquire the ability to select and use techniques and tools depending on the type and complexity of the problem.
Content of the course	
Theoretical classes	Fisher and Bayes estimation of linear regression models, introduction to information theory, linear classifiers, perceptron, support vector machine, the principle of entropy maximization artificial neural networks, error back propagation algorithm, recurrent neural networks, error propagation back in time, recurrent learning in real-time estimation of Bayesian neural networks and Kalman filter, the weighted probability density function and the expectation maximization algorithm, continuous latent variables and analysis of main components, hidden Markov model.
Practical classes	Practical classes include practising content from lectures, using appropriate software environment.
References	
1	Hastie T., Tibshirani R., and Friedman J.: The Elements of Statistical Learning: Data Mining, Inference and Prediction, Springer-Verlag, 2001.
2	Christopher M. Bishop, Pattern recognition and machine learning, Springer 2006
3	Han, Jiawei: Data mining, Amsterdam [etc.]: Morgan Kaufmann Publishers, 2006
4	Haykin, Simon: Neural Networks, Upper Saddle River: Prentice-Hall, 1999
5	I. Witten and E. Frank. Data Mining: Practical Machine Learning Tools and Techniques (2nd Edition), Morgan Kaufmann, 2005

The number of contact hours per week during the semester / trimester / year

Lectures	**Exercises**	**DON**	**Research work**	**Other classes**
2	2	----	------	------

Teaching methods	Lectures, exercises, writing the statistical reports, consultative teaching

Evaluation of knowledge (maximum score 100)

Pre exam duties	**points**	**Final exam**	**points**
Activity during lectures	5	**Oral exam**	40
Activity during exercises	5		
colloquia	20		
seminars	30		

Specification of the course for the Book of courses

Study program		Applied statistics	
Title of the course		**Decision theory**	
Teachers (for lectures)		Miroslav Ćirić	
Teacher/fellow teacher (for exercises)		Zorana Jančić	
ESPB	6	**Status of the course (obligatory (O) /elective (E))**	E

Conditions	
Aim of the course	The goal of course is introduction and understanding of the principles, techniques and methodologies of decision making.
Course outcomes	Students will understand and be able to use a wide range of techniques of decision making. They will acquire the ability to select and use techniques and tools depending on the type and complexity of the problem.
Content of the course	
Theoretical classes	Logic of decisions, decision technology, optimization, outranking, evaluation. Individual decision making. Multi-person decision making, games, group decision making. Multi-criteria decision making: multi-objective decision making, multi-attribute decision making. Multi-stage decision making: dynamic programing, linear and nonlinear programming. Decision support systems. Decision making in fuzzy environments. Statistical decision making.
Practical classes	Practical classes include practising content from lectures, using appropriate software environment.
References	
1	Hans J. Zimmermann, Fuzzy Sets, Decision Making, and Expert Systems, Kluwer, 1987.
2	G. J. Klir, B. Yuan, Fuzzy Sets and Fuzzy Logic, Theory and Application, Prentice-Hall, Englevood Cliffs, NJ, 1995.
3	G. Parmigiani, L. Inoue, Decision Theory – Principles and Approaches, John Wiley & Sons, Ltd, 2009.
4	J. O. Berger, Statistical Decision Theory and Bayesian Analysis, Springer, 1980.
5	F. Liese, K-J. Miescke, Statistical Decision Theory – Estimation, Testing and Selection, Springer, 2008.
6	I. Gilboa, Theory of Decision under Uncertainty, Cambridge University Press, 2009.

The number of contact hours per week during the semester / trimester / year

Lectures	**Exercises**	**DON**	**Research work**	**Other classes**
2	2	----	------	------

Teaching methods	Lectures, exercises, writing the statistical reports, consultative teaching

Evaluation of knowledge (maximum score 100)

Pre exam duties	**points**	**Final exam**	**points**
Activity during lectures	5	**Oral exam**	40
Activity during exercises	5		
colloquia	20		
seminars	30		

Specification of the course for the Book of courses

Study program		Applied statistics	
Title of the course		**Cluster analysis**	
Teachers (for lectures)		Jelena Ignjatović	
Teacher/fellow teacher (for exercises)		Ivana Jančić	
ESPB	6	**Status of the course (obligatory (O) /elective (E))**	E

Conditions	
Aim of the course	The goal of course is introduction and understanding of the principles, techniques and methodologies of cluster analysis.
Course outcomes	Students will understand and be able to use a wide range of techniques of cluster analysis. They will acquire the ability to select and use techniques and tools depending on the type and complexity of the problem.
Content of the course	
Theoretical classes	Clusters and clusterings. Clustering algorithms: connectivity based clustering (hierarchical clustering), centroid-based clustering (k-means algorithm), distribution-based clustering, density-based clustering, subspace-based clustering, group-based clustering, graph-based clustering. Evaluation of clustering results. Fuzzy clustering: fuzzy c-means clustering, clustering methods based on fuzzy equivalence relations, fuzzy pattern recognition, fuzzy image processing. Applications of clustering.
Practical classes	Practical classes include practising content from lectures, using appropriate software environment.
References	
1	B. S. Everitt, S. Landau, M. Leese, D. Stahl, Cluster Analysis, 5th edition, John Wiley & Sons, Ltd, 2011.
2	J. Abonyi, B. Feil, Cluster Analysis for Data Mining and System Identification, Birkhauser Verlag, AG, 2007.
3	H. Charles Romesburg, Cluster Analysis for Researchers, Lulu Press, North Carolina, 2004.
4	W. Pedrycz, Knowledge-Based Clustering – From Data to Information Granules, John Wiley & Sons, Ltd, 2005.
5	F. Hoeppner, F. Klawonn, R. Kruse, T. Runkler, Fuzzy Cluster Analysis – Methods for Classification, Data Analysis and Image Recognition, John Wiley & Sons, Ltd, 2000.
6	G. J. Klir, B. Yuan, Fuzzy Sets and Fuzzy Logic, Theory and Application, Prentice-Hall, Englevood Cliffs, NJ, 1995.

The number of contact hours per week during the semester / trimester / year

Lectures	**Exercises**	**DON**	**Research work**	**Other classes**
2	2	----	------	------

Teaching methods	Lectures, exercises, writing the statistical reports, consultative teaching

Evaluation of knowledge (maximum score 100)

Pre exam duties	**points**	**Final exam**	**points**
Activity during lectures	5	**Oral exam**	40
Activity during exercises	5		
colloquia	20		
seminars	30		

Specification of the course for the Book of courses

Study program		Applied statistics	
Title of the course		**Econometrics 2**	
Teachers (for lectures)		Vinko Lepojević	
Teacher/fellow teacher (for exercises)			
ESPB	6	**Status of the course (obligatory (O) /elective (E))**	E (Obligatory in Module Statistics in Economy)

Conditions	Econometrics 1
Aim of the course	Understanding the concepts microeconometrics and time series analysis.
Course outcomes	Students will acquire functional knowledge of methods of microeconometrics and time series analysis, the conditions of applicability, and their main advantages and disadvantages. The ability to define and to apply appropriate model for given type of problem.
Content of the course	
Theoretical classes	Binary and censored regression (probit, logit, tobit). Components of time series (horizontal component, time trend, seasonality, cycles). Moving averages and filters. Predictions. Stationarity. Autocorrelation. The basic models of time series. Methods of evaluation and diagnosis.
Practical classes	Tasks and problems are solved, the practical lessons follow the content of teaching, ie. theoretical instruction. Using of statistical software
References	
1	G.S. Maddala: Introduction to econometrics, John Wiley & Sons, 3rd edition, 2001.
2	W.H.Greene: Econometric analysis, 5th ed., Prentice Hall, 2003.
3	Kiš T. et al, Quantitative Methods in Economics, Faculty of Economics, Subotica, 2005 (in Serbian).
4	Baltagi, B. H., Econometrics, Springer, 2002

The number of contact hours per week during the semester / trimester / year

Lectures	Exercises	DON	Research work	Other classes
2	2	----	------	------

Teaching methods	lectures, exercises, analysis of examples with applications, writing reports about statistical analysis

Evaluation of knowledge (maximum score 100)

Pre exam duties	points	Final exam	points
Activity during lectures	5	**Oral exam**	40
Activity during exercises	5		
colloquia	30		
seminars	20		