

**FACULTY OF PURE AND APPLIED MATHEMATICS
SUBJECT CARD**

Name in Polish Teoria estymacji

Name in English: Estimation theory

Main field of study (if applicable): Applied Mathematics

Specialization (if applicable): Mathematics for Industry and Commerce

Level and form of studies: ~~1st~~/ 2nd* level, full-time / ~~part-time~~*

Kind of subject: ~~obligatory~~-/ optional / ~~university-wide~~*

Subject code MAT1550

Group of courses YES / ~~NO~~*

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30		30		
Number of hours of total student workload (CNPS)	90		60		
Form of crediting	Examination / crediting with grade*	Examination / crediting with grade*	Examination / crediting with grade*	Examination / crediting with grade*	Examination / crediting with grade*
For group of courses mark (X) final course	X				
Number of ECTS points	3		2		
including number of ECTS points for practical (P) classes			2		
including number of ECTS points for direct teacher-student contact (BK) classes	1,5		1,5		

*delete as applicable

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Student knows how to use statistical packages
2. Student has a basic knowledge of mathematical statistics.
3. Student has a basic knowledge of mathematical analysis and functional analysis
4. Student has basic programming skills.

SUBJECT OBJECTIVES

- C1 Learning of statistical criteria for assessing the quality of statistical estimation
- C2 Learning basic parametric estimation methods and their properties.
- C3 Learning basic non-parametric estimation methods and their properties.
- C4 Ability to program advanced statistical methods.
- C5 Ability to carry out simulation studies.
- C6 Ability to evaluate properties of statistical methods based on simulation studies.
- C7 Mastering of English vocabulary in the field of estimation methods .
- C8 Report writing skills in English.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

- PEK_W01 knows the basic parametric estimation methods.
- PEK_W02 knows the basic non-parametric estimation methods.
- PEK_W03 knows the basic criteria for assessing the quality of the estimation.
- PEK_W04 knows the theoretical basis of statistical simulation.
- PEK_W05 knows English in the extent necessary for the creation of simulation reports.
- PEK_W06 knows Programming Languages enable to carry out the simulation study.

relating to skills:

- PEK_U01 able to apply advanced statistical methods to analyze real data.
- PEK_U02 can use programming languages to program the high-order complex statistical methods and simulation tests and to carry out simulation studies.
- PEK_U03 able to assess the properties of statistical methods based on simulation studies.
- PEK_U04 can develop a report in English summarizing the results of simulation studies.

relating to social competences:

- PEK_K01 can benefit from the scientific literature in English, including reaching the source materials and review them.
- PEK_K02 understands the need for systematic work to improve knowledge

PROGRAMME CONTENT

Form of classes - lecture		Number of hours
Lec 1	Basic concepts of estimation theory: bias, variance, mean square error matrix of Fisher information, efficiency, asymptotic normality	2
Lec 2	Theoretical basis of simulation methods and replication	2
Lec 3	Bias and variance estimation - bootstrap, Jackknife, the delta method	2
Lec 4	Construction of confidence intervals - classic and bootstrap intervals	2
Lec 5	Nonparametric density estimation - histogram and its properties	2
Lec 6	Nonparametric density estimation - kernel estimator and its properties	2
Lec 7	Selection of bandwidth in the kernel estimator	2
Lec 8	Modifications of kernel estimator - variable bandwidth, higher-order kernels	2
Lec 9	Estimation of density through orthogonal expansions	2
Lec 10	Estimation of density - local likelihood function and maximum likelihood method with smoothing	2
Lec 11	Nonparametric regression function estimation - estimation of kernel	2

Lec 12	Selection of the bandwidth and modification of the kernel estimator of regression function.	2
Lec 13	Hazard function estimation - parametric and non-parametric methods.	2
Lec 14	Empirical Bayesian methods - Stein estimator	2
Lec 15	Test	2
	Total hours	30

Form of classes – laboratory		Number of hours
Lab 1	Parametric estimation - method of maximum likelihood. Bias, variance, mean square error - estimation using computer simulations.	4
Lab 2	Estimation of bias, variance and construction of confidence intervals using the method of substitution and replication methods (bootstrap, jackknife). Estimating the quality of estimators based on simulation studies.	4
Lab 3	Estimating the several parameters - asymptotic covariance matrix, the covariance matrix estimation using the method of substitution and replication methods. Estimating the quality of estimators based on simulation studies.	4
Lab 4	Nonparametric estimation of density - the histogram, method of the nearest neighbor, kernel estimator, orthogonal expansions. Smoothing parameter selection. Quality rating based on simulation studies.	6
Lab 5	Nonparametric estimation of the regression function. Estimators: kernel, local polynomial, the nearest neighbor, the smooth spline functions. Construction of confidence intervals and bands using the bootstrap method. Smoothing parameter selection. Quality rating based on simulation studies.	6
Lab 6	Estimation of survival function and hazard function with parametric and nonparametric methods. Construction of confidence intervals through approximation with the normal distribution and the bootstrap method. Quality rating based on simulation studies.	4
Lab 7	Empirical Bayesian methods. Quality assessment using simulation studies.	4
	Total hours	30

TEACHING TOOLS USED

- N1. Lecture problem - computer presentation and traditional method
- N2. Laboratory - self development of programs for simulation, reports from analyses
- N3. Consultations
- N4. Student's self work – preparation for the laboratory

EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

Evaluation (F – forming (during semester), P – concluding (at semester end))	Educational effect number	Way of evaluating educational effect achievement
F1	All subject effects of the course	Reports and activity during the laboratory.
F2	PEK_W01 PEK_W02 PEK_W03 PEK_W04 PEK_W05	Test

$$P=0,75 * F1 + 0,25 * F2$$

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

- [1] L. Devroye, A Course in Density Estimation
- [2] B. Efron, R. Tibshirani, Introduction to the Bootstrap
- [3] B. Silverman, Density Estimation for Statistics and Data Analysis.
- [4] W. Härdle, Smoothing Techniques with implementation in S
- [5] A.W.Bowman and A. Azzalini, Applied Smoothing Techniques for Data Analysis, The kernel approach with S-Plus Illustrations
- [6] P.J. Green and B.W.Silverman, Nonparametric regression and Generalized Linear Models

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

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MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR
SUBJECT
ESTIMATION THEORY MAT1550
AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY
APPLIED MATHEMATICS
AND SPECIALIZATION MATHEMATICS FOR INDUSTRY AND
COMMERCE

Subject educational effect	Correlation between subject educational effect and educational effects defined for main field of study and specialization (if applicable)**	Subject objectives***	Programme content***	Teaching tool number***
PEK_W01 (knowledge)	K2MIC_W04, K2MIC_W15, K2MIC_W16, K2MIC_W18	C2	Lec 1-Lec 4, Lec 13, Lec 14 Lab 1-Lab 3, Lab 6, Lab 7	1-4
PEK_W02	K2MIC_W04, K2MIC_W15, K2MIC_W16, K2MIC_W18	C3	Lec 5-Lec 4, Lab 4-Lab 7	1-4
PEK_W03	K2MIC_W04, K2MIC_W15, K2MIC_W18	C1	Lec 1-Lec 14, Lab 1-Lab 7	1-4
PEK_W04	K2MIC_W04, K2MIC_W18	C5,C6	Lec 2-Lec 14, Lab 1-Lab 7	1-4
PEK_W05	K2MIC_W13	C7, C8	Lec 1-Lec 14, Lab 1-Lab 7	1-4
PEK_W06	K2MIC_W12, K2MIC_W18	C4, C5, C6	Lec 2-Lec 14, Lab 1-Lab 7	1-4
PEK_U01 (skills)	K2MIC_U11, K2MIC_U12	C1-C4	Lec 1-Lec 14, Lab 1-Lab 7	1-4
PEK_U02	K2MIC_U20,	C4-C6	Lab 1-Lab 7	2, 3, 4
PEK_U03	K2MIC_U11, K2MIC_U21	C5-C6	Lec 2, Lab 1-Lab 7	1-4
PEK_U04	K2MIC_U02, K2MIC_U12	C7-C8	Lab 1-Lab 7	2, 3, 4
PEK_K01 (competences)	K2MIC_K06	C4-C8	Lab 1-Lab 7	2, 3, 4
PEK_K02	K2MIC_K01	C1-C8	Lec 1-Lec 14, Lab 1-Lab 7	1-4

** - enter symbols for main-field-of-study/specialization educational effects

*** - from table above