

FACULTY OF ELECTRONICS					
SUBJECT CARD					
Name in Polish Modelowanie i identyfikacja					
Name in English Modeling and identification					
Main field of study (if applicable): Control Engineering and Robotics					
Specialization (if applicable): ---					
Level and form of studies: 2nd level, full-time					
Kind of subject: obligatory					
Subject code AREU002					
Group of courses YES					
	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		90		
Form of crediting	Crediting with grade		Crediting with grade		
For group of courses mark (X) final course	X				
Number of ECTS points	6				
including number of ECTS points for practical (P) classes	-		2		
including number of ECTS points for direct teacher-student contact (BK) classes	1		2		

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

SUBJECT OBJECTIVES

- C1. Gaining the knowledge about generation of pseudo-random numbers
- C2. Gaining the knowledge about foundations of estimation theory and assessment of estimation quality
- C3. Learning parametric and nonparametric methods of estimation of the probability density function and the regression function
- C4. Learning identification methods of linear dynamic systems excited and disturbed by random signals
- C5. Learning the least squares method, its properties, scope of applicability and numerical procedures
- C6. Learning the instrumental variables method, and procedures of generation of instruments
- C7. Learning selected method of identification of block-oriented (Hammerstein and Wiener)

systems

C8. Introduction to 'System Identification Toolbox' of Matlab

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEK_W01 – knows the methods of computer modeling of random environment

PEK_W02 – knows parametric and nonparametric algorithms of synthesis of linear and nonlinear systems on the basis of uncertain data

PEK_W03 – knows computer realizations of typical methods of system identification

PEK_W04 – knows the methods of generation of random numbers

PEK_W05 – knows selected methods of identification of block-oriented (Hammerstein and Wiener) systems

relating to skills:

PEK_U01 – can use measurement data for building and testing models of linear and nonlinear plants under various prior knowledge

PEK_U02 – can forecast time series on the basis of collected data

PEK_U03 – can select suitable model for data

PEK_U04 – can conduct experimental analyses using dedicated software

relating to social competences:

PEK_K01 – is aware of the importance of the ability of data searching and analysis,

PEK_K02 – understand the necessity of further self-education and broadening knowledge and skills,

PROGRAMME CONTENT

Form of classes – lecture		Number of hours
Lec 1	Random number generation by the inversion method	2
Lec 2	Random number generation by the rejection method	2
Lec 3	Estimation theory, quality of the estimate, limit theorems, types of probabilistic convergence. Parametric and nonparametric approach	2
Lec 4	Nonparametric estimation of the distribution function	2
Lec 5	Nonparametric estimation of the probability density function	2
Lec 6	Regression function estimation – kernel method	2
Lec 7	Regression function estimation – orthogonal expansion method	

Lec 8	Identification of linear dynamic systems. Least squares method - synthesis.	2
Lec 9	Least squares method – properties	2
Lec 10	Least squares method – recursive version	
Lec 11	Linear system excited by random signal. Cross-correlation analysis. Inverse filtering. Gauss-Markov estimate.	2
Lec 12	Instrumental variables method	2
Lec 13	Computational algorithms of the least squares method (spectral analysis, LU and SVD decomposition)	2
Lec 14	Hammerstein and Wiener systems	2
Lec 15	Summary	2
	Total hours	30

Form of classes – laboratory		Number of hours
Lab 1	Generation of random numbers – inverse method	2
Lab 2	Generation of random numbers – rejection method	2
Lab 3	Estimation, limit theorems, mean and sample median and their properties	2
Lab 4	Nonparametric identification of distribution function	2
Lab 5	Nonparametric identification of probability density function	2
Lab 6	Regression function estimation. Kernel method	2
Lab 7	Regression function estimation. Orthogonal expansion method	2
Lab 8	Identification of linear systems by the least squares method	2
Lab 9	Recursive least squares method	2
Lab 10	Cross-correlation analysis, inverse filtering. Gauss-Markov estimate	2
Lab 11	Instrumental variables method	2
Lab 12	Computational algorithms of the least squares method (spectra analysis, LU and SVD decomposition)	2
Lab 13	Hammerstein system	2
Lab 14	Wiener system	2
Lab 15	Summary	2
	Total hours	30

TEACHING TOOLS USED

1. Traditional lecture with the use of videoprojector
2. Laboratory
3. Consultations

4. Individual job – preparing to laboratory, processing of the results, written reports
5. Individual job – preparing to final test

EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

Evaluation (F – forming (during semester), C – concluding (at semester end))	Educational effect numer	Way of evaluating educational effect achievement
F1	PEK_U01 ÷ PEK_U04 PEK_K01 ÷ PEK_K02	Written tests, Observationn on the laboratory, Written reports,
F2	PEK_W01 ÷ PEK_W05	Final test

$$C = 0,8 * F2 + 0,2 * F1$$

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

- [1] Gajek, Kałuszka — ”Wnioskowanie statystyczne dla studentów”
- [2] Greblicki, Pawlak – „Nonlinear system identification”, Cambridge 2008.
- [3] Kielbasiński, Schwetlick — ”Numeryczna algebra liniowa — wprowadzenie do obliczeń zautomatyzowanych”
- [4] Kincaid, Cheney — ”Analiza numeryczna”, WNT Warszawa, 2006.
- [5] Ljung “System Identification - Theory For the User”
- [6] Nahorski, Mańczak — ”Komputerowa identyfikacja obiektów dynamicznych”
- [7] Söderström, Stoica — ”Identyfikacja systemów”
- [8] Niederlinski — ”Systemy komputerowe automatyki przemysłowej”
- [9] <http://diuna.ict.pwr.wroc.pl>

SECONDARY LITERATURE:

- [1] Magiera — ”Modele i metody statystyki matematycznej”, wyd. GiS, Wrocław, 2002.
- [2] Stanisław — ”Przystępny kurs statystyki w oparciu o pakiet STATISTICA”
- [3] Klonecki — ”Statystyka matematyczna dla inżynierów”
- [4] Krysicki, Włodarski — ”Statystyka matematyczna”
- [5] Jakubowski, Stencel — ”Wstęp do teorii prawdopodobieństwa”, wyd. Script, Warszawa, 2004.
- [6] Trybuła — ”Statystyka matematyczna z elementami teorii decyzji”, Ofic. Wyd. PWr., 2002.

[7] Fisz — "Rachunek prawdopodobieństwa i statystyka matematyczna"

[8] Feller — "Wstęp do rachunku prawdopodobieństwa"

[9] Chow, Teicher — "Probability theory"

[10] Strang — "Introduction to linear algebra"

[11] Hannan, Deistler — "The statistical theory of linear systems"

[12] Greblicki — "Podstawy automatyki"

[13] Łysakowska, Mzyk — "Komputerowa symulacja układów automatycznej regulacji w środowisku Matlab/Simulink"

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

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MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR
SUBJECT
Modeling and identification
AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY
Control Engineering and Robotics
AND SPECIALIZATION---

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)	K2AIR_W06	C1..C8	Lec1..Lec15	1,3,5
PEK_W02	K2AIR_W06	C2,C3	Lec4..Lec7	1,3,5
PEK_W03	K2AIR_W06	C5,C8	Lec12	1,3,5
PEK_W04	K2AIR_W06	C1	Lec1,Lec2	1,3,5
PEK_W05	K2AIR_W06	C7	Lec13,14	1,3,5
PEK_U01 (skills)	K2AIR_U03	C1..C8	Lab1..Lab15	2,3,4
PEK_U02	K2AIR_U03	C3,C4	Lab8..Lab11	2,3,4
PEK_U03	K2AIR_U03	C2,C3,C5,C6	Lab8,Lab9, Lab13,Lab14	2,3,4
PEK_U04	K2AIR_U03	C5,C8	Lab1..Lab15	2,3,4
PEK_K01, PEK_K02 (competences)	K2AIR_K01 K2AIR_K02		Lec1÷Lec15 Lab1÷Lab15	1,2,3,4,5