FACULTY OF ELECTRICAL ENGINEERING

SUBJECT CARD

Name in Polish:	**Identyfikacja obiektów sterowania**
Name in English:	**Control object identification**
Main field of study (if applicable):	**Control Engineering and Robotics**
Specialization (if applicable):	**Automation of Machines, Vehicles and Apparatus**
Level and form of studies:	**2nd level, full-time**
Kind of subject:	**obligatory**
Subject code:	**ARR042511**
Group of courses:	**NO**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU):	30		15		
Number of hours of total student workload (CNPS):	60		30		
Form of crediting:	crediting with grade		crediting with grade		
For group of courses mark (X) final course:					
Number of ECTS points:	2		1		
including number of ECTS points for practical (P) classes :			1		
including number of ECTS points for direct teacher-student contact (BK) classes:	1.40		0.70		

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Knowledge of algebra at the basic level.
2. Knowledge of mathematical analysis at the basic level.
3. Knowledge of stochastic processes.
4. Knowledge of problems of control theory.
5. Abilities of developing computer programs and performing calculation in the Matlab environment.

SUBJECT OBJECTIVES

C1. Knowing methods of control object identification.
C2. Acquiring proficiency in solving problems of control object identification.
C3. Familiarising with software used for solving problems of control object identification.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEK_W01 The student has knowledge related to identification of parametric static models.
PEK_W02 The student has knowledge related to identification of parametric dynamic models.
PEK_W03 The student has knowledge related to identification of non-parametric stationary models.

relating to skills:

PEK_U01 The student is able to plan identification process.
PEK_U02 The student is able to solve identification problem.
PEK_U03 The student is able to perform identification calculation in the Matlab environment.

relating to social competences:

PEK_K01 The student can independently solve identification problems.

PROGRAMME CONTENT		
Form of classes - lecture		**Number of hours:**
Lec 1	Introduction. Basic terms and definition: dynamic systems, models of dynamic systems, identification, interpretation of identified model, identification process.	2
Lec 2	Identification of static models the least squares method: a principle of the method, a recursive algorithm, a deterministic criterion for assessing model correctness.	2
Lec 3	Statistical analysis of the results of identification of static models with use of the least squares method.	2
Lec 4	The identification experiment in the case of dynamic models: general characteristics, choice of sampling time, choice of input signals.	2
Lec 5	Identification of parametric dynamic models: the essence of identification, models ARX, ARMAX, estimation of parameters of models by the least squares method, the instrumental variable method and the maximum likelihood method.	2
Lec 6	Validation of parametric dynamic models.	2
Lec 7	Identification of non-stationary parametric dynamic models.	2
Lec 8	Comparison of identification of static and dynamic parametric models. Test.	2
Lec 9	Identification of time-series models: time-series concept, properties of time-series (stationarity, stability), properties of time-series models (causality, stability, reversibility), process of identification of time-series models, stochastic time-series models (stationary and non-stationary models) and their properties.	2
Lec 10	Identification of the impulse response: recursive and non-recursive methods.	2
Lec 11	Identification of power spectral density: description of a signal in the frequency domain, classical and modern identification methods	2
Lec 12	Identification of the amplitude and phase characteristics with use of non-parametric methods: purpose of the identification, identification methods (frequency analysis, frequency analysis using correlation methods, spectral analysis), coherence function, input signals.	2
Lec 13	Identification of static and dynamic models with use of the stochastic approximation: the principle of the stochastic approximation, an algorithm of identification.	2
Lec 14	Identification of the models of feedback control systems: identifiability conditions, the problem of partial unfulfilment of identifiability conditions.	2
Lec 15	A summary of the methods for control object identification. Test.	2
	Total hours:	**30**

Form of classes - laboratory		**Number of hours:**
Lab 1	An introduction, the laboratory program. Mathematical models of control objects.	2
Lab 2	Identification of static models the least squares method.	2
Lab 3	Identification of static models the least squares method: Statistical analysis of the results of identification	2
Lab 4	Identification of static models planning of active identification experiments.	2
Lab 5	Identification of dynamic models the ARX model.	2
Lab 6	Identification of the impulse response.	2
Lab 7	Identification of the amplitude and phase characteristics.	2
Lab 8	Identification of static models the stochastic approximation.	1
	Total hours:	**15**

TEACHING TOOLS USED
N1. Multimedia presentation.
N2. Information lecture.
N3. Preparation in the form of reports.
N4. he MATLAB/Simulink programming environment.

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(W)	PEK_W01 PEK_W02 PEK_W03	activity at the classes
F2(W)	PEK_W01 PEK_W02 PEK_W03	average of the grades from tests
P(W)	P=0.1F1 + 0.9F2	
F1(L)	PEK_U01 PEK_U02 PEK_U03	activity at the classes
F2(L)	PEK_U01 PEK_U02 PEK_U03	reports from the classes
P(L)	P=0.3 F1 + 0.7 F2	

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Królikowski A., Identyfikacja obiektów sterowania, Wyd. Pol. Poznańskiej, Poznań 2005.
[2] Królikowski A., Horla D., Identyfikacja obiektów sterowania: metody dyskretne, Wyd. Pol. Poznańskiej, Poznań 2005.
[3] Mańczak K., Nahorski Z., Komputerowa identyfikacja obiektów dynamicznych, PWN, Warszawa 1983.
[4] Pr. zb., Dynamika i identyfikacja obiektów. Zbiór zadań, Wyd. Pol. Poznańskiej, Poznań 1980.
[5] Pr. zb. pod red. Kasprzyk J., Identyfikacja procesów, Wyd. Pol. Śląskiej, Gliwice 2002.
[6] Zimmer A., Englot A., Identyfikacja obiektów i sygnałów. Teoria i praktyka dla użytkowników MATLABA, Wyd. Pol. Krakowskiej, Kraków 2005.

SECONDARY LITERATURE:

[1] Mańczak K., Metody identyfikacji wielowymiarowych obiektów sterowania, WNT, Warszawa 1979.
[2] Milkiewicz F., Wstęp do metod optymalizacji i identyfikacji obiektów przemysłowych, Wyd. Pol. Gdańskiej, Gdańsk 1979.
[3] Sawicki J., Królikowski A., Florek A., Dynamika i identyfikacja obiektów sterowania. Zbiór zadań, PWN, Warszawa 1986.
[4] Zimmer A., Identyfikacja obiektów i sygnałów. Teoria i praktyka dla użytkowników MATLABA, Wyd. Pol. Krakowskiej, . Kraków 1998.

SUBJECT SUPERVISOR

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MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT
ARR042511 - Control object identification
AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY **Control Engineering and Robotics**
AND SPECIALIZATION **Automation of Machines, Vehicles and Apparatus**

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	K2AiR_W04	C.1	Lec1 Lec2 Lec3 Lec13	N.1 N.2
PEK_W02	K2AiR_W04	C.1	Lec4 Lec5 Lec6 Lec7 Lec8 Lec9 Lec10 Lec13 Lec14	N.1 N.2
PEK_W03	K2AiR_W04	C.1	Lec11 Lec12 Lec13	N.1 N.2
PEK_U01	K2AiR_U03	C.2 C.3	Lab1 Lab4	N.3 N.4
PEK_U02	K2AiR_U03	C.2 C.3	Lab2 Lab4 Lab8	N.3 N.4
PEK_U03	K2AiR_U03	C.2 C.3	Lab1 Lab2 Lab3 Lab4 Lab5 Lab6 Lab7 Lab8	N.3 N.4
PEK_K01	K2AiR_K02	C.2 C.3	Lec15 Lab1 Lab2 Lab3 Lab4 Lab5 Lab6 Lab7 Lab8	N.3 N.4