

FACULTY OF ELECTRICAL  
ENGINEERING**SUBJECT CARD**

Name in Polish: **Podstawy automatyki 2**  
 Name in English: **Fundamentals of control engineering 2**  
 Main field of study (if applicable): **Electrical Engineering**  
 Specialization (if applicable):  
 Level and form of studies: **1st level, part-time**  
 Kind of subject: **obligatory**  
 Subject code: **ELR042162**  
 Group of courses: **NO**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU):	20	10	20		
Number of hours of total student workload (CNPS):	108	27	54		
Form of crediting:	examination	crediting with grade	crediting with grade		
For group of courses mark (X) final course:					
Number of ECTS points:	4	1	2		
including number of ECTS points for practical (P) classes :		1	2		
including number of ECTS points for direct teacher-student contact (BK) classes:	2.80	0.70	1.40		

**PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES**

1. Theoretical knowledge concerning dynamics, stability and control of continuous control systems.
2. Practical ability of mathematical modelling, analysis, synthesis, stability evaluation and compensation of linear continuous control systems.
3. Is able to think, analyse and act creatively.
4. Is able to work in a team.

**SUBJECT OBJECTIVES**

- C1. Gaining theoretical knowledge concerning static, dynamic and quality as well as stability of discrete linear and continuous nonlinear control systems.
- C2. Gaining theoretical knowledge concerning compensation allowing to get required parameters of discrete linear and continuous nonlinear control systems.
- C3. Development and progress of abilities of mathematical analysis, synthesis, stability estimation and design of adequate compensation to discrete linear control systems.
- C4. Gaining abilities of practical analysis and synthesis of continuous and discrete, linear and continuous nonlinear control systems.
- C5. Development and progress practical analysis of control system to reach required performance of linear and nonlinear , continuous and discrete systems.

**SUBJECT EDUCATIONAL EFFECTS***relating to knowledge:*

- PEK\_W01 Has knowledge to build models , to estimate and calculate static and dynamic parameters of discrete linear and continuous nonlinear control systems.
- PEK\_W02 Has knowledge concerning analysis, operation and quality of discrete linear and continuous nonlinear control systems.
- PEK\_W03 Has knowledge concerning stability of control systems, development of compensation systems as well as improvement and optimisation of discrete linear and continuous nonlinear control systems.

*relating to skills:*

- PEK\_U01 Is able to work out mathematical analysis and synthesis, check stability and to match adequate compensation to discrete linear control systems.
- PEK\_U02 Is able to make practical analysis and synthesis of simple and complex continuous and discrete linear and nonlinear control systems.
- PEK\_U03 Is able to make practical estimation of stability of control systems and design different types of compensators allowing to reach required performance of continuous and discrete linear and nonlinear control system.

*relating to social competences:*

- PEK\_K01 Is able in a competent way either independently or in cooperation with group to work out engineering project of control system.

## PROGRAMME CONTENT

Form of classes - lecture		Number of hours:
Lec 1	Introduction. Regulations to pass. Structure of discrete control systems. Samplers.	2
Lec 2	Direct and inverse Z transformation, difference equations. Discrete transfer function. Hold elements.	2
Lec 3	Block-diagram algebra of discrete systems. Steady state errors in discrete control systems.	2
Lec 4	Basic stability condition of discrete systems . Bi-linear transformation, use of stability criteria designated for linear continuous control systems. Jury stability criterion.	2
Lec 5	Nyquist stability criterion. Synthesis of discrete systems - fundamentals.	2
Lec 6	Synthesis of discrete systems. Description of continuous time systems with use of state space method.	2
Lec 7	Description of discrete systems with use of state space method. Stability, controllability and observability - fundamentals.	2
Lec 8	Stability, controllability and observability - examples. Introduction to non-linear control systems.	2
Lec 9	Typical non-linearities in non-linear control systems. Analysis of non-linear control systems using the method of describing function.	2
Lec 10	Analysis of non-linear control systems with use of phase-plane trajectories. Non-linear control systems stability analysis.	2
Total hours:		<b>20</b>

Form of classes - class		Number of hours:
Cl 1	Introduction. Rules to pass. Descriptions of discrete control systems using Z transform. Direct and inverse Z transform , discrete transfer function.	2
Cl 2	Difference equations. Hold elements. Block diagram algebra. Steady state errors of discrete control systems.	2
Cl 3	Stability of discrete control systems.	2
Cl 4	Description of continuous and discrete systems using state space method.	2
Cl 5	Pass test.	2
Total hours:		<b>10</b>

Form of classes - laboratory		Number of hours:
Lab 1	Safety and internal regulations of the lab. Rules to pass. Introductory presentations of laboratory stands.	2
Lab 2	Analysis methods of linear continuous control systems.	2
Lab 3	Analogue compensation of linear continuous control systems.	2
Lab 4	Investigation of industrial controllers.	2
Lab 5	Modelling of control systems with use of MATLAB package.	2
Lab 6	Analysis and synthesis of combinatorial and sequential logic circuits.	2
Lab 7	Control of electric motor with use of PLC.	2
Lab 8	Investigation of linear discrete control systems.	2
Lab 9	Analysis of non-linear control systems.	2
Lab 10	Reserve term. Summary of the laboratory exercises.	2
Total hours:		<b>20</b>

## TEACHING TOOLS USED

- N1. Informative lecture.
- N2. Classes.
- N3. Didactic models of control systems.
- N4. Simulative program.
- N5. Report on the performed laboratory exercise.
- N6. Student's own work.

EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT		
Evaluation <i>F – forming (during semester) P – concluding (at semester end)</i>	Educational effect number	Way of evaluating educational effect achievement
F1(w)	PEK_W01 PEK_W02 PEK_W03	Presence at the lectures
F2(w)	PEK_W01 PEK_W02 PEK_W03	Written or oral examination
P(w)	$P=0,1F1+0,9F2$	
F1(c)	PEK_U01 PEK_U02 PEK_U03	Activity at the classes
F2(c)	PEK_U01 PEK_U02 PEK_U03	Results of short tests
F3(c)	PEK_U01 PEK_U02 PEK_U03	Crediting test
P(c)	$P=0,2F1+0,2F2+0,6F3$	
F1(L)	PEK_U01 PEK_U02 PEK_U03 PEK_K01	Activity at the laboratory
F2(L)	PEK_U01 PEK_U02 PEK_U03 PEK_K01	Marks of the reports for the laboratory assignments
P(L)	$P=0,3F1+0,7F2$	

PRIMARY AND SECONDARY LITERATURE
<b>PRIMARY LITERATURE:</b> [1] Greblicki W., „Podstawy automatyki”, Wydawnictwo Politechniki Wrocławskiej, 2006 [2] Kaczorek T., „Podstawy teorii sterowania”, WNT, Warszawa, 2009 [3] Mazurek J., Vogt H., Żydanowicz W., „Podstawy automatyki”, Wydawnictwo Politechniki Warszawskiej, 2006 [4] Staszewski J., „Skrypt zadań z Podstaw Automatyki” * [5] Wiszniewski A. (pod red.), „Podstawy automatyki. Ćwiczenia laboratoryjne”, skrypt Politechniki Wrocławskiej, Wrocław 2000  *position [4] available from the teacher  <b>SECONDARY LITERATURE:</b> [1] Horla D., „Podstawy automatyki. Ćwiczenia rachunkowe. Cz.1”, Wydawnictwo Politechniki Poznańskiej, 2004 [2] Mazur E., Sosnowski M.; „Podstawy automatyki. Zbiór zadań”, Wydawnictwo Politechniki Częstochowskiej, 2006.

SUBJECT SUPERVISOR
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MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT  
**ELR042162 - Fundamentals of control engineering 2**  
AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY **Electrical Engineering**

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	K1ETK_W27	C.1 C.2	Lec1 Lec2 Lec6 Lec7 Lec8 Lec9 Lec10	N.1 N.6
PEK_W02	K1ETK_W27	C.1 C.2	Lec3 Lec5 Lec6 Lec9 Lec10	N.1 N.6
PEK_W03	K1ETK_W27	C.1 C.2	Lec3 Lec4 Lec5 Lec7 Lec8 Lec10	N.1 N.6
PEK_U01	K1ETK_U24	C.3	CI1 CI2 CI3 CI4 CI5	N.2 N.6
PEK_U02	K1ETK_U14 K1ETK_U24	C.4	Lab1 Lab2 Lab5 Lab6 Lab8	N.3 N.4 N.5 N.6
PEK_U03	K1ETK_U14 K1ETK_U24	C.5	Lab1 Lab3 Lab4 Lab7 Lab9	N.3 N.4 N.5 N.6
PEK_K01	K1ETK_K05	C.3 C.4 C.5	CI1 CI2 CI3 CI4 CI5 Lab1 Lab2 Lab3 Lab4 Lab5 Lab6 Lab7 Lab8 Lab9 Lab10	N.2 N.3 N.4 N.5 N.6