

FACULTY OF ELECTRICAL  
ENGINEERING**SUBJECT CARD**

Name in Polish: **Cyfrowe Techniki Sterowania**  
 Name in English: **Digital Control Techniques**  
 Main field of study (if applicable): **Electrical Engineering**  
 Specialization (if applicable): **Control in Electrical Power Engineering**  
 Level and form of studies: **2nd level, full-time**  
 Kind of subject: **obligatory**  
 Subject code: **ELR032132**  
 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):	90		30		
Form of crediting:	crediting with grade		crediting with grade		
For group of courses mark (X) final course:					
Number of ECTS points:	3		1		
including number of ECTS points for practical (P) classes :			1		
including number of ECTS points for direct teacher-student contact (BK) classes:	2.10		0.70		

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

1. Knowledge of basics of continuous control systems.
2. Knowledge of basics synthesis and analysis of digital systems.
3. Basic knowledge of MATLAB / Simulink software.
4. Practical skills of using MATLAB: writing programs.
5. Is capable of implementing digital algorithms based on difference equations.

**SUBJECT OBJECTIVES**

- C1. Acquaintance of knowledge related to: function of analogue filtering in the context of proper operation of digital systems, digital signal processing, representation methods of discrete-time systems, appropriate sampling time selection, effect of pole location on system response.
- C2. Practical skills to analyze and design of both finite and infinite impulse response filters.
- C3. Practical skills to: PID digital controller tuning, design of digital controller dedicated to particular object, design of state variable feedback controller and state observer.

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

- PEK\_W01 Possesses knowledge related to processing of continuous signals, their discretization and processing of digital signals.
- PEK\_W02 Has a basic knowledge of structure of digital control systems and their design methods.
- PEK\_W03 Possesses knowledge related to design of digital filters and various types of digital regulators.

*relating to skills:*

- PEK\_U01 Is able to select appropriate sampling time, represent continuous control system with use of transfer function and state space model, retrieve difference equation of digital model of continuous plant and implement this equation.
- PEK\_U02 Is able to design and perform analysis of digital filters.
- PEK\_U03 Is able to tune as well as design digital controller of a given output transient performance indices.

*relating to social competences:*

- PEK\_K01 Is able to carry out a complex engineering project in a competent way, unaided as well as to cooperate with a team if required

## PROGRAMME CONTENT

Form of classes - lecture		Number of hours:
Lec 1	Introduction. Setting rules of course crediting. Tasks, structures and interface circuits of digital control system.	2
Lec 2	Classification of plants in digital control, basic notions used in analysis and design of real time control systems.	2
Lec 3	Classification of plants in digital control, basic notions used in analysis and design of real time control systems.	2
Lec 4	Digital models of continuous plants.	2
Lec 5	Processing of the plant output signals by interface circuits.	2
Lec 6	Processing of input digital signals – digital filtration, design of recursive digital filters based on analog lowpass filters transformation.	2
Lec 7	Processing of input digital signals – digital filtration, design of recursive digital filters based on analog lowpass filters transformation.	2
Lec 8	Processing of input digital signals – digital filtration, design of nonrecursive digital filters.	2
Lec 9	Design of nonrecursive digital filters using the Fourier transformation.	2
Lec 10	Digital PID regulators.	2
Lec 11	Design of the dedicated digital regulator for the determined plant and for predetermined transfer function of the closed-loop system $K(z)$ .	2
Lec 12	Robust digital regulators.	2
Lec 13	Design methods of state variable feedback controller.	2
Lec 14	Digital controller with a state observer.	2
Lec 15	Pass test.	2
Total hours:		<b>30</b>

Form of classes - laboratory		Number of hours:
Lab 1	Introduction. Setting rules of course crediting. Acquaintance with lab stands, safety rules and available software.	2
Lab 2	Design and analysis of recursive digital filters based on analog lowpass filters transformation.	2
Lab 3	Design and analysis of recursive digital filters based on analog lowpass filters transformation.	1
Lab 4	Design of nonrecursive digital filters using the inverse DFT.	2
Lab 5	Tuning of the digital PID regulator.	2
Lab 6	Design of dedicated and robust digital regulators.	2
Lab 7	Design of state variable feedback controller.	2
Lab 8	State variable feedback controller with a state observer.	2
Total hours:		<b>15</b>

## TEACHING TOOLS USED

- N1. Project presentation.  
 N2. Informative lecture.  
 N3. Presentation of the reports.  
 N4. Matlab program.

## EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

Evaluation <small>F - forming (during semester) P - concluding (at semester end)</small>	Educational effect number	Way of evaluating educational effect achievement
F1(W)	PEK_W01 PEK_W02 PEK_W03	Participation in the course
F2(W)	PEK_W01 PEK_W02 PEK_W03	Pass test
P(W)	$P = 0,1F1 + 0,9F2$	
F1(L)	PEK_U01 PEK_U02 PEK_U03 PEK_K01	Activity during the classes
F2(L)	PEK_U01 PEK_U02 PEK_U03	Presentation of the reports done
P(L)	$P = 0.7F1 + 0.3F2$	

## PRIMARY AND SECONDARY LITERATURE

### PRIMARY LITERATURE:

- [1] Digital Control Systems – the lecture outline, provided by subject supervisor.

### SECONDARY LITERATURE:

- [1] Kuo B.C.: Digital Control Systems, Hold. Reinhard and Winston Inc. 1981.  
 [2] Bozic S. M.: Digital and Kalman Filtering, Edward Arnold Publishers, London 1984.  
 [3] Astrom K.J., Wittenmark B.: Computer Controlled Systems, Printice Hall, London 1989.  
 [4] Iserman R.: Digital Control Systems, Springer-Verlag, Berlin 1988.  
 [5] Vaccaro R.J.: Digital Control, A State Space Approach, McGraw-Hill, New York 1995.

## SUBJECT SUPERVISOR

Daniel Bejmert, daniel.bejmert@pwr.edu.pl

### MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT **ELR032132 - Digital Control Techniques** AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY **Electrical Engineering** AND SPECIALIZATION **Control in Electrical Power 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	S2CPE_W01	C.1	Lec1 Lec2 Lec3 Lec4 Lec5	N.1 N.2 N.4
PEK_W02	S2CPE_W01	C.1 C.3	Lec1 Lec10 Lec11 Lec12 Lec13 Lec14	N.1 N.2 N.4
PEK_W03	S2CPE_W01	C.1 C.3	Lec5 Lec6 Lec7 Lec8 Lec9 Lec10 Lec11 Lec12 Lec13 Lec14	N.1 N.2 N.4
PEK_U01	S2CPE_U01	C.2 C.3	Lab3 Lab4 Lab5 Lab7	N.3 N.4
PEK_U02	S2CPE_U01	C.2 C.3	Lab2 Lab3 Lab4	N.3 N.4
PEK_U03	S2CPE_U01	C.2 C.3	Lab4 Lab5 Lab6 Lab8	N.3 N.4
PEK_K01	K2ETK_K02 S2CPE_K01 S2CPE_K02	C.1 C.2 C.3	Lec15 Lab1 Lab2 Lab3 Lab4 Lab5 Lab6 Lab7 Lab8	N.3 N.4