

FACULTY OF ELECTRICAL  
ENGINEERING**SUBJECT CARD**

Name in Polish: **Zaawansowane metody przetwarzania sygnałów**  
 Name in English: **Advanced Signal Processing Methods**  
 Main field of study (if applicable): **Electrical Engineering**  
 Specialization (if applicable): **Renewable Energy Systems**  
 Level and form of studies: **2nd level, full-time**  
 Kind of subject: **optional**  
 Subject code: **ELR041335**  
 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:	examination	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. Basic knowledge in the fields of calculus and linear algebra
2. Basic knowledge of the C language
3. Ability of systematic work and individual problem solving

**SUBJECT OBJECTIVES**

- C1. Understanding and proper application of digital signal processing methods  
 C2. Presentation of tools for description and analysis of digital systems in time and frequency domain  
 C3. Ability to design and implement simple digital systems

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

- PEK\_W01 knows mathematical methods for description and analysis of digital systems in time and frequency domain  
 PEK\_W02 knows algorithms for digital filter design

*relating to skills:*

- PEK\_U01 is able to provide a spectral analysis of a signal  
 PEK\_U02 is able to design a simple digital filter

*relating to social competences:*

- PEK\_K01 creativity in searching for the solution of a given problem

PROGRAMME CONTENT		
Form of classes - lecture		Number of hours:
Lec 1	Discrete signal and systems – examples, mathematical notation, sampling, aliasing. Part I.	2
Lec 2	Discrete signal and systems – examples, mathematical notation, sampling, aliasing. Part II.	2
Lec 3	Description and analysis of digital systems in time domain: difference equation, convolution, impulse response, block schemes, state space variables, system classification. Part I.	2
Lec 4	Description and analysis of digital systems in time domain: difference equation, convolution, impulse response, block schemes, state space variables, system classification. Part II.	2
Lec 5	Z transform: definition of Z transform, the correlation of Z transform to Laplace transform, basic properties of Z transform , inverse Z transform (methods and computational examples), the area of convergence and its meaning, computations. Part I.	2
Lec 6	Z transform: definition of Z transform, the correlation of Z transform to Laplace transform, basic properties of Z transform , inverse Z transform (methods and computational examples), the area of convergence and its meaning, computations. Part II.	2
Lec 7	Applications of the Z transform: solving of difference equations, the transfer function, causality and stability of systems. Part I.	2
Lec 8	Applications of the Z transform: solving of difference equations, the transfer function, causality and stability of systems. Part II.	2
Lec 9	Discrete Fourier transform: Definition of DFT (introduction, examples, properties), correlation of DFT to Z transform, inverse DFT, elimination of leakage with the window method, resolution of FFT. Part I.	2
Lec 10	Discrete Fourier transform: Definition of DFT (introduction, examples, properties), correlation of DFT to Z transform, inverse DFT, elimination of leakage with the window method, resolution of FFT. Part II.	2
Lec 11	Digital filters: introduction, methods of description, examples, classification. Finite impulse response filters -FIR. Design of FIR, window method. Part I.	2
Lec 12	Digital filters: introduction, methods of description, examples, classification. Finite impulse response filters -FIR. Design of FIR, window method. Part II.	2
Lec 13	Fast Fourier transform FFT. Correlation between FFT and DFT. Part I.	2
Lec 14	Fast Fourier transform FFT. Correlation between FFT and DFT. PartII.	2
Lec 15	Algorithm for FFT: computational scheme, implementation example, butterfly structures for FFT	2
Total hours:		<b>30</b>

Form of classes - class		Number of hours:
Cl 1	Mathematical description, generation and sampling for discrete signals. Part I.	2
Cl 2	Mathematical description, generation and sampling for discrete signals. Part II.	2
Cl 3	Z transform, Inverse Z transform. Part I.	2
Cl 4	Z transform, Inverse Z transform. Część II.	2
Cl 5	Transfer function, impulse response, difference equation, block scheme. Part I.	2
Cl 6	Transfer function, impulse response, difference equation, block scheme. Part II.	2
Cl 7	Fourier Transform - implementation. Part I.	2
Cl 8	Fourier Transform - implementation. Part II.	1
Total hours:		<b>15</b>

TEACHING TOOLS USED
N1. Lecture with multimedia presentations
N2. Classes with problems for individual solving

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	exam
P(W)	P=F1	
F1(C)	PEK_U01 PEK_U02 PEK_K01	written final test
P(C)	P=F1	

## PRIMARY AND SECONDARY LITERATURE

### PRIMARY LITERATURE:

- [1] S. Haykin, B. Van Veen – Signals and Systems, John Wiley & Sons, Inc., 1999
- [2] D. F. Elliot – Handbook of Digital Signal Processing, Academic Press, Inc., 1987
- [3] S. M. Kay – Modern Spectral Estimation, Prentice Hall, Signal Processing Series, Englewood Cliffs, 1988

### SECONDARY LITERATURE:

- [1] M. Vetterli, J. Kovacevic - Wavelets and Subband Coding, Englewood Cliffs, Prentice Hall, 1994

## SUBJECT SUPERVISOR

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### MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT **ELR041335 - Advanced Signal Processing Methods** AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY **Electrical Engineering** AND SPECIALIZATION **Renewable Energy Systems**

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	S2RES_W17	C.1	Lec1 Lec2 Lec3 Lec4 Lec5 Lec6 Lec7 Lec8	N.1
PEK_W02	S2RES_W17	C.2 C.3	Lec9 Lec10 Lec11 Lec12 Lec13 Lec14 Lec15	N.1
PEK_U01	S2RES_U19	C.1	CI1 CI2 CI3 CI4	N.2
PEK_U02	S2RES_U19	C.2 C.3	CI5 CI6 CI7 CI8	N.2
PEK_K01	K2ETK_K06	C.1 C.2 C.3	CI1 CI2 CI3 CI4 CI5 CI6 CI7 CI8	N.2