DESCRIPTION OF THE COURSES

- Course code: ***ELR1314***
- Course title: ***O.4. Advanced Signal Processing Methods***
- Language of the lecturer: *English*

Course form	***Lecture***	***Classes***	***Laboratory***	***Project***	***Seminar***
*Number of hours/week**	*2*	*1*			
*Number of hours/semester**	*30*	*15*			
Form of the course completion	*Test*	*Test*			
ECTS credits	***3***	***2***			
Total Student's Workload	***90***	***60***			

- Level of the course (basic/advanced): ***Advanced***
- Prerequisites: ***Mathematics, Linear Algebra, Complex Function, Basic Circuit Theory***
- Name, first name and degree of the lecturer/supervisor: ***Łobos Tadeusz, professor***
- Names, first names and degrees of the team's members: ***Leonowicz Zbigniew, PhD***

  Sikorski Tomasz, PhD
- Year:......***2***.......... Semester:.....***III***................
- Type of the course (obligatory/optional): ***Optional***
- Aims of the course (effects of the course):
  Effect of the course: review of nowadays advanced signal processing methods, knowledge about the ideas of non-parametric and parametric estimation of signal parameters, examples of application in power systems engineering .
- Form of the teaching (traditional/e-learning): ***Traditional***
- Course description:
  The course introduces bases of advanced signal processing methods in electrical engineering. Introducing lectures provide ideas of discrete representations of continuous signal with basic functions and signal orthogonal projection. Next stage of the course concerns continuous representations of deterministic signals. Introduced definitions allow passing into nonparametric time-frequency representations. Then, follow the time-scale representations with wavelets. Backgrounds of statistical signal processing are introduced with outlined parameter estimation, optimal filtering, linear modelling and estimation. Finally, various methods of parametric spectrum estimation are outlined. Examples of application in electrical engineering are presented.

- Lecture:

Particular lectures contents	*Number of hours*
1. The backgrounds of deterministic signal representations. Basic parameters of signals. Deterministic signal space. Linear space, metric space, normed linear space, Banach space, inner product.	2h
2. Basic functions and signals orthogonal projection. Discrete representations of	3h

continuous signal. Orthogonal basic functions of real and complex Fourier series.	
3. Continuous representations of deterministic signals. Kernel of the transformation. Laplace, Fourier, Hilbert, Mellin transforms.	2h
4. Nonparametric time-frequency representations – introduction. Relations between time domain and frequency domains. Energy conservation law and Heisenberg's time-frequency atom. Short Time Fourier Transform and Gabor representation.	2h
5. Generalized equation of nonparametric time-frequency representations. The influence of the kernel function. Wigner-Ville, Choi-Williams and related distributions.	2h
6. Time-scale signal representations. Filter banks, wavelets and multiresolution signal processing.	2h
7. Continuous wavelet and short-time Fourier transforms and frames. Discrete-time bases and filter banks. The Haar and sinc cases. Overcomplete expansions. Discretizations.	3h
8. Backgrounds of Statistical Signal Processing. Estimation of parameters, moments.	2h
9. Optimal filtering. FIR and IIR cases. Recursive filtering. Kalman filtering. Wold decomposition	3h
9. Linear modelling and estimation of model parameters from data. Least-squares principle. AR, ARMA models. Examples	3h
10. Parametric spectrum estimation. Subspace methods. Advanced topics (array processing, higher-order spectra, etc.)	4h
11. Applications in power system engineering.	2h

- Classes – the contents:

1. Parameters of the signal in time domain (mean value, moments and its interpretation) Inner product, norm.
2. Discrete representation of signals. Orthogonal basic functions of real and complex Fourier series.
3. Continuous representation of signals (Laplace, Fourier, Hilbert, Mellin transforms).
4. Short Time Fourier Transform, Wigner distribution.
5. Filter banks and wavelets.
6. AR, ARMA, MA modelling.
7. Parametric spectrum estimation. Subspace methods.

- Basic literature:

[1] S. Haykin, B. Van Veen – ***Signals and Systems***, John Wiley & Sons, Inc., 1999.
[2] S. M. Kay – ***Modern Spectral Estimation***, Prentice Hall, Signal Processing Series, Englewood Cliffs, 1988.
[3] S. Qian, D. Chen – ***Joint Time-Frequency Analysis. Methods and Applications***, Prentice Hall, Upper Saddle River, 1996.
[4] D. F. Elliot – ***Handbook of Digital Signal Processing***, Academic Press, Inc., 1987.

- Additional literature:

[1] C.W. Therrien – ***Discrete Random Signals and Statistical Signal Processing***, Englewood Cliffs, Prentice Hall, 1992.
[2] M. Vetterli, J. Kovacevic - ***Wavelets and Subband Coding***, Englewood Cliffs, Prentice

Hall, 1994.

- Conditions of the course acceptance/credition: ***Passed test in classes***

  Passed test in lectures

***** - depending on a system of studies