DOCTORAL STUDY

COURSE DESCRIPTION

Course title	Scientific area	Faculty	Department
Digital signal processing	Informatics Engineering (T 007)	Faculty of Mathematics and Informatics	Institute of Data Science and Digital Technologies

Methods of studies	Credits, ECTS	Methods of studies	Credits, ECTS
Lectures	1 (autumn sem.)	Consultation	1
Individual work	4	Seminars	1

Course summary

The main goal of course study is to deepen knowledge in digital signal processing. The course provides basic and highly specialized knowledge of digital signals and systems analysis, enabling a thorough analysis of peculiar one-dimensional and two-dimensional signals and systems. Along with classical spectral analysis techniques, alternative and modern techniques are introduced and studied.

The studies are carried out in the following forms: individual work, seminars and lectures, consultations (as required). Theoretical analysis is enhanced by experimental tasks: different one-dimensional and two-dimensional signal processing tasks are solved, various methods of analysis are formulated and modified.

The content of the course:

1. SIGNALS AND SYSTEMS. Signal concept. Types and classes of signals. Characteristics of the signals. System concept. Types of systems. Stability and causality of the systems.
2. SIGNAL DIGITIZATION. Sampling. Nyquist sampling theorem. Quantization. Coding. Signal interpolation.
3. ANALYSIS OF SIGNALS IN TIME DOMAIN. Operations and manipulations with signals. Correlation. Convolution. Difference equations.
4. FREQUENCY ANALYSIS OF SIGNALS. The concept of the signal transform. Fourier transform. Discrete Fourier transform. Fast Fourier transform. Frequency characteristics of signals and systems. The concept of cepstrum. Cepstral analysis of signals and systems.
5. ALTERNATIVE ANALYSIS TECHNIQUES OF SIGNALS. Hartley transform. Sinusoidal and cosinusoidal transforms. Wavelet theory and transform. Laplace transform. Walsh-Hadamard transform. Haar transform. Karhunen-Loeve transform. Hilbert transform. Fractal analysis of signals.
6. RANDOM SIGNAL ANALYSIS. Random variables and processes. Random signals. Ergodicity and stationarity of random signals. Statistical characteristics of random signals. Estimation of statistical characteristics. Parametric and non-parametric analysis techniques of random signals.
7. Z-TRANSFORM. Convergence of z-transform. Properties of z-transform. Z-transform of signals and systems. Rational z-transforms. The inverse z-transform.
8. FILTERS. DESIGN OF FILTERS. Filter concept. Characteristics of filters. Infinite impulse response (IIR) and finite impulsive response (FIR) filters. Adaptive filters. Design of IIR filters. Design of FIR filters.

Literature list
Gopi, E. S (2018). *Multi-disciplinary digital signal processing: a functional approach using Matlab.* Springer International Publishing, 200 p.
O. Gazi (2018). *Understanding Digital Signal Processing*. Springer, Singapore, 303 p.
J. G. Proakis, D. G. Manolakis (2014). *Digital signal processing: principles, algorithms, and applications.* 4th edition, 1156 p.
M. Corinthios (2009). *Signals, systems, transforms, and digital signal processing with MATLAB*. CRC Press, 1316 p.
A. Antoniou (2005). *Digital signal processing. Signals, systems, and filter*. Mc-Graw Hill, 965 p.
M. N. Bandyopadhyay (2005). *Introduction to Signals and Systems and Digital Signal Processing*. PHI Learning Pvt. Ltd., 396 p.

Consulting persons	Scientific degree	Key publications
Gintautas Tamulevičius	D. Sc.	http://www.elaba.mb.vu.lt/dmsti/?aut=Gintautas+Tamulevi%C4%8Dius
Gražina Korvel	D. Sc.	http://www.elaba.mb.vu.lt/dmsti/?aut=Gra%C5%BEina+Korvel
Povilas Treigys	D. Sc.	http://www.elaba.mb.vu.lt/dmsti/?aut=Povilas+Treigys