

**DOCTORAL STUDY
COURSE DESCRIPTION**

Course title	Scientific area	Faculty	Department
Speech 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
<p>The course deals with speech signal characteristics, production and perception models, various analysis methods. The speech signal enhancement and restoration, speech recognition (Speech-to-Text) and synthesis (Text-to-Speech) tasks and techniques are introduced during this course.</p> <p>The studies are carried out in the following forms: individual work, seminars and lectures, consultations (as required).</p> <p>The content of the course:</p> <ol style="list-style-type: none"> 1. SPEECH SIGNAL. The acoustics of the speech signal. Production and perception of the speech. The main characteristics of the speech signals. Speech units and sounds. 2. SPEECH MODELING. Production and perception-based models. Parametric and nonparametric models. Spectral analysis of speech signals. Cepstral analysis. 3. SPEECH ENHANCEMENT. Noise and distortions in speech signals. Speech enhancement techniques. Short-time spectral enhancement techniques. Model-based enhancement of speech signals. Adaptive noise cancellation techniques. Speech signal-based enhancement techniques.. Restoration of speech signals. 4. SPEECH SIGNAL CODING. Objective and subjective valuation of coding techniques. Coding techniques. Signal waveform coding. Analysis-synthesis based coding. Techniques of mixed coding. 5. SPEECH SIGNAL SYNTHESIS. Articulatory, formant, and concatenative synthesis techniques. Text normalization. Synthesis process. Prosody generation. 6. SPEECH RECOGNITION. Recognition system. Challenges in speech recognition. Speech signal analysis. Classification. 7. APPLICATIONS OF SPEECH ANALYSIS. Speech emotion recognition. Acoustic analysis of speech for medical purposes. Language recognition. Estimation of speech quality. Speech source separation. Speaker identification and verification. Speech activity detection. Analysis of singing voice. <p>Practical tasks are carried out for the development of speech signal processing skills:</p> <ul style="list-style-type: none"> • Classic analysis techniques in time and frequency domains. • Alternative analysis techniques for speech signals: fractal analysis, wavelet transform, phase-aware analysis, nonlinear analysis. • Development of speech signal-oriented algorithms.

Literature list
J. O. Pickles (2014). <i>An introduction to the physiology of hearing</i> . Emerald, 4-th edition, 430 p.
E. S. Gopi (2014). <i>Digital Speech Processing Using Matlab</i> . Springer, 182 p.
T. F. Quatieri (2001). <i>Discrete-time speech signal processing. Principles and practice</i> . Prentice Hall PTR, 781 p.
J. Benesty, M. M. Sondhi, and Y. Huang (Eds.) (2008). <i>Springer handbook of speech processing</i> . Springer, 1176 p.
B. Gold, N. Morgan, and D. Ellis (2011). <i>Speech and audio signal processing</i> . Wiley, 661 p.
J. R. Deller, J. H. Hansen, and J. G. Proakis (1999). <i>Discrete-time processing of speech signals</i> . Wiley-IEEE Press, 936 p.
J. Xin . Y. Qi (2014). <i>Mathematical Modeling and Signal Processing in Speech and Hearing Sciences</i> . Springer International Publishing, 208 p.
Ph. C. Loizou (2013). <i>Speech enhancement. Theory and practice</i> . CRC Press, 676 p.
T. Bäckström (2017). <i>Speech Coding: with Code-Excited Linear Prediction</i> . Springer International Publishing, 240 p.
B. W. Schuller, A. M. Batliner (2014). <i>Computational Paralinguistics: Emotion, Affect and Personality in Speech and Language Processing</i> . John Wiley & Sons, Ltd, 321 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