Study program: Electrical and Computing Engineering – Module: Remote Control			
Type and level of studies: Master studies (second level of studies)			
Course unit: Advanced Signal Processing			
Teacher in charge: Radojka Krneta			
Language of instruction: English			
ECTS: 6			
Prerequisites: -			
Semester: Winter			

Course unit objective

- knowledge of advanced signal processing techniques (spectral estimation and prediction, adaptive filtering) and their use in modern control systems
- using a combination of theory and software implementations to solve signal processing problems
- gaining skills for using mathematic and software tools, such as Matlab an LabView, for solving the problems.

Learning outcomes of Course unit

After the course, each student is expected to be able to:

• describe and analyze discrete time stationary stochastic signals, in terms of their autocorrelation sequence and spectral density, and to determine how these properties are affected by linear filtering.

• know how to perform sampling and reconstruction and describe how these operations affect both deterministic and stochastic signals, in the time and frequency domain.

• estimate the spectral density of a signal, based on a limited number of noise samples, especially:

– implement and use non-parametric methods for spectral estimation

– implement and use parametric methods for spectral estimation,

– estimate parameters in the models, using MMSE and least squares methods.

– use the models with the estimated parameters in applications such as spectral estimation and prediction.

• know how to perform image processing

• use a combination of theory and software implementations to solve signal processing problems

Course unit contents

Theoretical classes

1. A/D and D/A conversions, correlation and convolution, spectral analysis with DFT and FFT, use of Laplace and *z*-transforms in system analysis and design, filter design and quantization and round-off effects).
2. Theory of spectral estimation and prediction.
3. Adaptive filtering (Least-Mean-Square Algorithm, Frequency-Domain Adaptive Filters, Recursive Least-Squares Algorithm, Tracking of Time-Varying Systems).

Practical classes

Laboratory and computer sessions, web discussions via forum and e-mail, case study

Literature

[1] John G. Proakis. Dimitris G. Manolakis, Digital signal processing: Principles, algorithms and applications, Prentice-Hall, 2006,
[2] K. Sam Shanmugan and Arthur M. Breipohl, Random Signals: Detection, Estimation and Data Analysis. John Wiley & Sons, 1988,
[3] Simon Haykin, Adaptive filter theory (fourth edition.) Prentice-Hall, 2001.
[4] Alexander D. Poularikas and Zayed M. Ramadan, Adaptive Filtering Primer with Matlab. John Wiley& Sons, 1988,
[5] Dimitris G. Manolakis, Vinay K. Ingle, Stephen M. Kogon, Adaptive filter theory, John Wiley & Sons, 1969.
[6] Maurice Bellanger, Statistical and Adaptive Signal Processing: Spectral Estimation, Artech House. 2005.
[7] John J. Komo, Random Signal Analysis in Engineering Systems, Academic Press, Inc. 1987.
[8] Murray R. Spiegel, John Schiller, R. Alu Srinivasan, Probability and statistics (second edition), McGraw Hill, Schaum's outlines, 2000.

Number of active teaching hours				**Other classes**
Lectures: 2	*Practice: 2*	*Other forms of classes:* Mentoring system	*Independent work:* Case study	

Teaching methods: consultations, independent individual work

Examination methods (maximum 100 points)			
Exam prerequisites	**No. of points:**	**Final exam**	**No. of points:**
Student's activity during lectures	**5**	oral examination	
Practical classes	**20**	written examination	**55**
Seminars/homework	**20**	....	
Project			

Grading system

Grade	**No. of points**	**Description**
10	**91-100**	Excellent
9	**81-90**	Exceptionally good
8	**71-80**	Very good

7	**61-70**	Good
6	**51-60**	Passing
5	**less than 50**	Failing