SIGNAL PROCESSING

Basic Information

This is a course, which contributes to MSc award in Biology

Course period	From February 1st till June 1st, 1 semester
Study credits	5 ECTS credits
Duration	180 hours
Language of instruction	English
Academic requirements	- BSc degree in Biology, Chemistry, Physics or Environmental Sciences or equivalent (transcript of records), - Good command of English (certificate or other official document)

Course Description

«Signal Processing» is an extensive course, which is designed to advance a student's ability to process the raw medical data for the further analysis. It provides the necessary mathematical background for the ability to work with the medical signal of any nature.

The most important part of this course is noise reduction and artifact removal. The students will study to choose and apply the appropriate filter to make the signal more stable and consistent.

The Feature and Event detection part of the course includes the basic techniques to find the characteristics of the signal, which are of the given interest. This will require the parallel learning other courses of the given master program, including the machine learning and classification algorithms.

The course is designed to cover a wide range of possible areas of biology and medicine. Grading this course will help the future specialist to construct and develop the explanation of the observed phenomena.

Course Aims

- To help students to study new discipline or to ameliorate the existing knowledge in signal processing.
- To assist students to manipulate the signal to make it informative in the field of their interest.
- To give students the understanding of how to ameliorate the signal.
- To introduce the basic principles of statistical and mathematical signal processing.
- To give the introduction in machine learning and classification methods and its application to medical signals.

Course Objectives

The course has been designed to:

- ensure that students are familiar with a basic noise reduction routines.
- give students the optimal filtering methods for the given signal.
- give students an appreciation of the averaging algorithms and estimation criteria for signal processing.
- provide students with the basic routines of feature and event detection in the medical signals.
- provide students with the basic routines of medical image processing.
- make students know and understand the principles of the signal processing in the particular cases of the interest.

Learning Outcomes of the Course

By the end of the course, the students will be able to:

- select the method of noise reduction and data compression for the given signal,
- perform the artifact removal from the given signal,
- detect the features and event of the signal,
- apply the machine learning and classification method to the given signal.

Course (module) Structure

Learning Activities	Hours
Lectures	14
Practice sessions / Seminars,	28
Self-study Assignments	102
Final Exam (including preparation)	36
Total study hours	**180**

Course Outline

Week	Lectures	Practice session / Assignments	Hours
1-4	Signal Processing Basics	o Analog and Digital Signals o Continuous and Discrete-time Signals o Data Compression o Home assignment No 1	(4/8/34)
5-8	Signal reprocessing	o Signal Transformation o Signal Filtering o Noise reduction and Averaging o Artifact Removal o Home assignment No 2	(4/8/34)
9-14	Feature and Event Detection	o Statistical Signal Processing o Signal Classification o Image Processing o Machine Learning in Signal Processing o Home assignment No 3	(6/12/34)
		Final Exam	36

Course Instructors and Tutors, Contact Information

Instructor	Contact Information
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Assessment

The final exam is an individual problem in the form of a simulated experimental dataset. The student must demonstrate the abilities in:

• averaging and noise reduction of the given signal (20 points maximum),

• transformation of the given signal – the obligatory ability is to apply wavelet and Fourier transformation, the z-transform is required to get the maximum points (40 points maximum),

• making the electric signal and image reprocessing (40 point maximum).

Grade policy:

A (excellent work)	91-100 %
B (above average work)	81-90 %
C (average work)	71-80 %
D (below average work)	50-70 %
F (failed work)	<50 %

Core reading

1. Rao, K.D. and Swamy, M.N.S. (2018) *Digital Signal Processing*. Springer, Singapore.

2. Goldberger, J.J. and Ng, J. (edt.) (2010) *Practical Signal and Image Processing in Clinical Cardiology*. Springer, London.

3. Gacek, A. and Pedrycz, W. (edt.) (2012) *ECG Signal Processing, Classification and Interpretation*. Springer, London.

4. Li, X. (ed.) (2016) *Signal Processing in Neuroscience*. Springer, Singapore.

5. Wu, Y. (2015) *Knee Joint Vibroarthrographic Signal Processing and Analysis*. Springer, Berlin, Heidelberg.

6. Kumar, A., Shaik, F., Rahim, B.A. and Kumar, D.S. (2016) *Signal and Image Processing in Medical Applications*. Springer, Singapore.