# Digital Signal Processing
# Course Syllabus

## Basic Information

**This course contributes to the requirements for the Degree of MSc in Computer Science**

| | |
|---|---|
| **Title of the Academic Program** | Master's Degree Programs in English "Digital signal processing" |
| **Type of the course** | core /mandatory |
| **Course period** | 2,3 semester<br>from October 1st till June 1st (36 weeks) |
| **Study credits** | 8 ECTS credits |
| **Duration** | 288 hours |
| **Language of instruction** | English |
| **Academic requirements** | – BSc degree in Computer Science or equivalent (transcript of records),<br>– good command of English (certificate or another official document) |

## Course Overview

## Description

"Digital signal processing" is an core course.

Course starts from the basic concepts of discrete-time signals and proceed to learn how to analyze data via the Fourier transform, how to manipulate data via digital filters and how to convert analog signals into digital. The solid theoretical bases are complemented by applied examples in Matlab. Design and lab exercises are also significant components of the course.

## Special Features of the Course

In order to facilitate learning process, the Matlab Simulink software is used throughout the course. Some practical or almost actual environment problems and solutions are provided.

## Course Aim

**The aim** of the course is to introduce the basic principles, techniques, and applications of digital signal processing and to motivate and prepare students to apply them for research projects and for further study within advanced courses in professional fields.

## Course Objectives

- To introduce students basic techniques in designing and implementing digital signal processing systems.
- To learn basic methods of spectral analisis.
- To explore the data communication systems.
- To teach students to design digital filters.

## Learning Outcomes of the Course (module)

By the end of the course, students will know:

- how to design digital filters;
- how to extract features from digital signals and manipulate them;

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

- programming in Matlab script language.
- use Matlab and Simulink tools.

By the end of the course, students will possess:

- to develop DSP applications completely themselves using professional tools.

## Course Structure

| Learning Activities | Hours |
|---|---|
| Lectures | 36 |
| Practice sessions / Seminars, | 36 |
| Self-study Assignments | 180 |
| Final Exam (including preparation) | 36 |
| **Total study hours** | **288** |

## Detailed Schedule

| Week | Lectures | Practice sessions / Assignments | Hours[1] Lec/Lab/HA |
|---|---|---|---|
| Semester 1 | | | |
| 1-4 | **Basics of Digital Signal Processing**<br>Sampling and Quantization, Kotelnikov / Nyquist–Shannon sampling theorem.<br>Amplitude, phase, frequency.<br>Periodic signals, aliasing. | Sampling and quantization.<br>Matlab Simulink tools overview. | 4/4/18 |
| 5-10 | **Inroduction to The Fourier Transform**<br>Properties of the Fourier Transform.<br>Digital Fourier transform, | Using the Matlab Signal Processing Toolbox in spectral analysis task. | 4/4/18 |
| 11-14 | **Fast Fourier Transform algorithms**<br>FIT, DIT. Window functions. | Digital window Fourier transform,<br>Using window functions. | 4/4/18 |
| 15-16 | **Correlation Analysis**<br>Cross Correlation and Autocorrelation | DSP System toolbox functions | 2/0/6 |
| 17-18 | **Wavelet transform**<br>Wavelet digital transform, Wavelet continuous transform. Orthogonal basis.<br>Types of wavelets. | Introduction to the Matlab Wavelet Toolbox | 2/4/12 |
| Semester 2 | | | |
| 19-23 | **Discrete Time Systems**<br>Filter classification in the frequency domain, FIR and IIR filters.<br>Transfer function, Impulse Response, Convolution.<br>Design of filters by windowing. | Processing signals with a digital filter via Matlab functions.<br>Displays amplitude frequency characteristics. | 6/6/36 |
| 24-26 | **The Z-transform**<br>Properties of the z transform. Poles, Zeros.<br>Pole-zero diagram and frequency response. | Lowpass filter design in Matlab Filter design toolbox<br>Displays the poles and zeros of the transfer function. | 4/4/18 |
| 27-32 | **Modulation and demodulation**<br>Amplitude and Angle Modulation.<br>Quadrature modulation. Deviation.<br>Spectral characteristics. | Generate the modulated carrier signal using AM, FM, PM. | 4/4/18 |
| 33-36 | **Digital Communication Systems**<br>PWM, Keying, Symbol rate, Constellation and Scatter plots. QAM. Filter shaping.<br>Sigma-Delta modulation | Manipulate digital data for transmission. | 6/6/36 |
| | **36** | **36** | **252** |
| **36** | **Final Exam** | | **36** |

[1] Hours designed for Classroom sessions, Web-sessions, Home Assignments etc.

## Course Instructor and Tutor, Contact information

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Google Scholar page:
https://scholar.google.ru/citations?hl=ru&user=3ruWMfQAAAAJ

## Assessment

| Assessment strategy | Points, max | Evaluation criteria |
|---|---|---|
| Tests | 30 | Test questions |
| Lab works | 40 | Practical questions |
| Final exam | 30 | 2 questions that require preparatory reading and knowledge of the concepts explained |

Grading policy for final assessment is:

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

## Attendance Policy

Students are expected to attend classes regularly. In case of missing an in-lab activity a student should perform additional work submitted to the instructor within a week after a class was missed.

Every topic involves an assignment. A written report on the assignment should be submitted within two weeks from the moment students received a list of problems. The final mark will rely on the same grading policy as for the final exam.

## Web page of the course

Course materials and required reading materials are available on the webpage of the course **Digital signal processing**, SibFU E-learning portal, www.e.sfu-kras.ru . You must be logged in to access this course. https://e.sfu-kras.ru/course/view.php?id=31454

## Core reading

1. Richard G. Lyons. Understanding Digital Signal Processing, Third Edition, Pearson Education, Inc, 2012. p.667. ISBN-13: 978-0-13-702741-5, ISBN-10: 0-13-702741-9
2. A. V. Oppenheim and R. W. Schafer. Discrete-Time Signal Processing (Prentice-Hall Signal Processing Series) 3rd Edition, 2021. p.861, ISBN-13: 978-0131988422, ISBN-10: 0131988425
3. Dick Blandford, John Parr. Introduction to Digital Signal Processing. Pearson Education, Inc, 2013, ISBN: 978-0-13-139406-3

4. Jonathan (Y) Stein. Digital Signal Processing: A Computer Science Perspective. John Wiley & Sons, Inc ISBN:9780471295464
5. Michael Weeks. Digital Signal Processing Using MATLAB & Wavelets. Jones & Bartlett Publishers, 2011. p.492

## Facilities, Equipment and Software

**Software:**

Matlab
MS Office® / Libre Office®;