

# Digital signal processing - course description

General information	
Course name	Digital signal processing
Course ID	06.0-WE-ELEKTD-DigSigProc-Er
Faculty	<a href="#">Faculty of Computer Science, Electrical Engineering and Automatics</a> .
Field of study	Electrical Engineering
Education profile	academic
Level of studies	Second-cycle Erasmus programme
Beginning semester	winter term 2017/2018

Course information	
Semester	3
ECTS credits to win	4
Course type	obligatory
Teaching language	english
Author of syllabus	<ul style="list-style-type: none"><li>dr inż. Mirosław Kozioł</li></ul>

Classes forms					
The class form	Hours per semester (full-time)	Hours per week (full-time)	Hours per semester (part-time)	Hours per week (part-time)	Form of assignment
Lecture	30	2	-	-	Credit with grade
Laboratory	30	2	-	-	Credit with grade

## Aim of the course

- To familiarize students with basic notions of digital signal processing.
- To provide basic knowledge about fundamentals of spectral analysis and digital filtration of discrete signals.
- To give skills in practical implementation of spectral analysis and filtration of discrete signals.
- To provide knowledge about digital filters design.

## Prerequisites

- Programming languages
- Selected issues of circuit theory I
- Selected issues of circuit theory II

## Scope

Fundamentals of signal theory. Notion of signal. Classifications of signals. Mathematical models of selected signals. Fourier series and Fourier transform for continuous time signals. Fourier series and Fourier transform properties. An influence of a signal observation in finite time interval on its spectrum.

Analog-to-digital and digital-to-analog conversion. Chain of signal processing during analog-to-digital and digital-to-analog conversion. Sampling, quantization and coding. Quantization error. Spectrum of a sampled signal. Aliasing. Sampling theorem. Anti-aliasing filter. Recovery of an analog signal from samples.

Discrete Fourier transform (DFT). Derivation of amplitude and phase spectrum. Leakage. Parametric and non-parametric spectral windows. Spectrum resolution improvement by zero padding. Examples of spectral analysis of discrete-time signals and their interpretation.

Fast Fourier transform (FFT). Butterfly computation schema in radix-2 FFT algorithm. Computational profit. Computation of inverse DFT using FFT.

Linear and causal time-invariant (LTI) systems. Definitions of discrete, linear and time-invariant system. Convolution. Stability of LTI systems in BIBO sense. Definition of causal system. Difference equation.

Z-transform. The Z-transform definition. Region of convergence of Z-transform. The inverse Z-transform and methods of its determination. Z-transform properties. The transfer function. Poles and zeros of transfer function. Pole locus and stability of system.

Digital filters. Finite and infinite impulse response filters. Processing discrete-time signals by digital filters. Basic structures of digital filters. Determination and interpretation of the frequency response of digital filters. Significance of linear phase response in the processing of signal. Group delay.

IIR digital filter design by bilinear transformation method. FIR digital filter design by method based on the windowed Fourier series.

## Teaching methods

- Lecture: conventional/traditional lecture with elements of discussion.
- Laboratory: laboratory exercises, work in groups with elements of discussion.

## Learning outcomes and methods of theirs verification

Outcome description	Outcome symbols	Methods of verification	The class form
---------------------	-----------------	-------------------------	----------------

Outcome description	Outcome symbols	Methods of verification	The class form
Student can design the infinite and finite impulse response digital filter.		<ul style="list-style-type: none"> <li>an ongoing monitoring during classes</li> </ul>	<ul style="list-style-type: none"> <li>Laboratory</li> </ul>
Student can describe a discrete system using differential equations and transmittance.		<ul style="list-style-type: none"> <li>an evaluation test</li> </ul>	<ul style="list-style-type: none"> <li>Lecture</li> </ul>
Student can write programs in C language, which make spectral analysis of signals and their filtering with the application of digital filters with finite and infinite impulse response.		<ul style="list-style-type: none"> <li>an ongoing monitoring during classes</li> </ul>	<ul style="list-style-type: none"> <li>Laboratory</li> </ul>
Student can use digital signal processing to analyze discrete signals, perform its spectral analysis, and interpret the obtained graphs of spectra.		<ul style="list-style-type: none"> <li>an ongoing monitoring during classes</li> <li>carrying out laboratory reports</li> </ul>	<ul style="list-style-type: none"> <li>Laboratory</li> </ul>

## Assignment conditions

- Lecture: to receive a final passing grade student has to receive positive grade from written tests conducted at least once a semester.
- Laboratory: to receive a final passing grade student has to receive positive grades in all laboratory exercises provided for in the laboratory syllabus.

Calculation of the final grade = lecture 45% + laboratory 55%

## Recommended reading

- Lyons R.G.: Understanding Digital Signal Processing, Prentice Hall, 2004
- Mitra S.: Digital Signal Processing: A Computer-Based Approach, McGraw-Hill, 2005
- Orfanidis S.J.: Introduction to *Signal Processing*, Prentice Hall, 1999
- Oppenheim A.V., Schafer R.W., Buck J.R.: *Discrete-Time Signal Processing*, Prentice Hall, 1999

## Further reading

- Oppenheim A.V., Willsky A.S., Nawab H.: *Signals & Systems*, Prentice Hall, 1997
- Owen M.: *Practical signal processing*, Cambridge University Press, 2007
- Smith S.W.: Digital Signal Processing: A Practical Guide for Engineers and Scientists, Newnes, 2002

## Notes

Modified by dr hab. inż. Radosław Kłosiński, prof. UZ (last modification: 02-05-2017 20:33)

Generated automatically from SylabUZ computer system