COURSE DESCRIPTION CARD - SYLLABUS

Course name
Digital Signal Processing [S1MiKC1>CPS]

Course

Field of study
Microelectronics and digital communications

Year/Semester
2/3

Area of study (specialization)
–

Profile of study
general academic

Level of study
first-cycle

Course offered in
Polish

Form of study
full-time

Requirements
compulsory

Number of hours

Lecture
12

Laboratory classes
15

Other
0

Tutorials
0

Projects/seminars
0

Number of credit points

2,00

Coordinators

Lecturers

Prerequisites

Knowledge of basic concepts in mathematical analysis and linear algebra and knowledge acquired in the subject "Fundamentals of Signal Processing", including: basic concepts, definitions and properties of Fourier and Laplace transforms, Fourier series and analog filter design.

Course objective

To introduce students with digital signal processing techniques, in particular with the sampling process, quantization and the theory of discrete linear and time-invariant systems. Students will also learn about transformations, such as the Z-transform and the discrete Fourier transform, and learn how to design FIR and IIR digital filters. In addition, the course covers the analysis of random signals and the implementation of the fast Fourier transform, with particular emphasis on its applications in signal filtration and spectrum estimation.

Course-related learning outcomes

Knowledge:
1. Knows the basic tools of functional analysis used for the analysis of digital signals and systems (Z transform and Fourier transform). (K1_W02)
2. Knows the basic tools of practical spectral analysis of signals. (K1_W02)
3. Knows the basic methods of designing and implementing time-invariant digital linear filters.

(K1_W02))

Skills:
1. Is able to correctly interpret the results of signal or digital system analysis. (K1_U01, K1_U08)
2. Is able to design and implement a linear time-invariant digital filter with given parameters. (K1_U03, K1_U05)
3. Is able to perform spectral analysis of a signal, also for the purpose of examining a digital system. (K1_U03, K1_U07)

Social competences:
1. Understands the need and knows the possibilities of continuous education, improving professional, personal and social competences. (K1_K01, K1_K17)
2. Is aware of the need for a professional approach to solving technical problems and taking responsibility for the technical solutions he proposes. (K1_U02, K1_U06)

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Lecture - written exam, consisting of 8-10 equally scored questions, to which a short answer must be given. Passing threshold: 50%, thresholds for subsequent assessments every 10%. If the answer is close to the threshold, a retake exam may consist of an oral question in the area of knowledge in which the student did not demonstrate in the first attempt.
Laboratory - checking knowledge during exercises, oral and written, written reports on the course of laboratory exercises, 3 colloquia after a series of exercises. Passing: completing all exercises and submitting positively assessed reports, positive assessment of students' knowledge during the laboratories.

Programme content

The course content of "Digital Signal Processing" covers topics related to digital signal processing techniques, including the analysis of sampling, quantization processes, and the properties of discrete systems. Students will learn fundamental mathematical tools, such as the Z-transform and Fourier transform, as well as methods for designing digital filters. The course also includes techniques for signal analysis and synthesis, including fast processing algorithms and spectral estimation of random signals. Through laboratory sessions, students will gain practical skills in designing digital systems and implementing signal processing algorithms.

Course topics

Lecture: The subject includes a comparison of digital and analog signal processing techniques. Issues related to the sampling process and sampling theorems, as well as signal quantization, will be discussed. Students will become familiar with the theory of linear and time-invariant discrete systems, as well as the concept of convolution. The lecture will also discuss the Z-transform and its properties, as well as the inversion of data transforms with rational functions. The discrete-time Fourier transform and the discrete Fourier transform will be presented, with particular emphasis on the deviations of DFT results from the theoretical properties of the Fourier transform. Students will learn about the structures of digital filters and the effects of quantization of digital filter coefficients. They will also deal with the design of FIR filters (including the window method, uniformly waved filters, frequency domain design) and IIR filters (the method of impulse response invariance and bilinear transform). The lecture also covers the fast Fourier transform, its practical implementation and applications in fast filtering and analysis of digital random signals, including nonparametric spectrum estimation.
Laboratory: In the laboratory classes, students will work on sampling and recovery of signals. They will deal with discrete systems, analyzing transfer function, stability and impulse response, as well as designing systems using the zeros and poles method. The discrete Fourier transform, its properties, spectral leakage and application of windows will be discussed. Students will perform noncoherent and coherent averaging of multiple DFT spectra. In addition, they will become familiar with the design and study of properties of FIR and IIR digital filters. In the laboratory classes, they will conduct experiments with coherent averaging of discrete signals (CAV), and also design filters such as a moving average filter (MAV), comb filter, slot filter, digital resonator, digital oscillator and median filter (MED).

Teaching methods

Lecture: multimedia presentation, illustrated with examples given on the board.
Laboratory: Simulation studies are carried out in the Matlab and Simulink programs during the exercises. Before each exercise - a presentation explaining the theoretical and practical context of the current exercise topic. Provision of instructions. Presentation and explanation of the tasks to be performed, presentation of part of the Matlab program code (the rest of the code is completed by students).

Bibliography

Basic:
1. Cyfrowe Przetwarzanie Sygnałów, T. Zieliński, WKŁ, Warszawa, 2009.
2. Lyons R., Wprowadzenie do cyfrowego przetwarzania sygnałów, WKŁ, Warszawa, 2010.

Additional:
1. Mrozek B., Mrozek Z., Matlab i Simulink. Poradnik użytkownika, Helion, Gliwice, 2018.
2. Cyfrowe Przetwarzanie Sygnałów, A.V. Openheim, R.W. Schafer, WKŁ, Warszawa, 1982.

Breakdown of average student's workload

	Hours	ECTS
Total workload	52	2,00
Classes requiring direct contact with the teacher	27	1,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	25	1,00