Signal processing using digital signal processors - course description

General information

Course name	Signal processing using digital signal processors
Course ID	06.5-WE-ELEKTP-SPUDSP-Er
Faculty	Faculty of Computer Science, Electrical Engineering and Automatics
Field of study	Electrical Engineering
Education profile	academic
Level of studies	First-cycle Erasmus programme
Beginning semester	winter term 2022/2023

Course information

Semester	5
ECTS credits to win	5
Course type	optional
Teaching language	english
Author of syllabus	• dr hab. inż. Krzysztof Sozański, prof. UZ

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	-	-	Exam
Laboratory	30	2	-	-	Credit with grade

Aim of the course

- to familiarize students with basic concepts, methods, description and analysis of discrete systems;

- to familiarize with methods of description and analysis of multirate digital circuits;

- to mastery by students ability to apply theory of digital filters;

- introduction to theory and mastery of the basic methods of discrete simulation of digital circuits;

- to give basic skills of observation of the behavior and take of characteristics of electric circuits;

- to give basic skills in the design and realization of digital circuits using digital signal processors;

Prerequisites

Circuit Theory, Microprocessor Systems, Computer Science

Scope

Analog and digital signal processing. Properties of signals. Analog (continuous-time) signals, discrete time signals. Signal parameters.

Analog signal processing. Analog circuits, linear two-port network. Continuous-time filters. Filter parameters. Introduction to analog filter design.

Signal discretization. Uniform and non-uniform signal sampling. Analog-to-digital (A/D) and digital-to-analog (D/A) signal conversion. A/D and D/A signal converters. Examples of multimedia and measurements data signal conversions.

Linear time-invariant (LTI) circuit. Discrete Fourier transform (DFT). Leakage effects. Widows. Properties of DFT. Fast Fourier transform (FFT). Z transform. Properties of Z transform.

Multirate digital signal processing. Decimation and interpolation. Implementation of multirate digital signal processing algorithms. Applications of multirate signal processing: noise shaping technique in delta-sigma modulator (DSM) used in A/D and D/A converters.

Digital modulations: pulse width modulation (PWM), pulse density modulation PDM, pulse code modulation PCM, differential pulse code modulation.

Digital filters: linear and nonlinear filters, multirate filters, filter banks, multidimensional filters. Properties of digital filters: finite impulse response filter (FIR), infinite response filter (IIR). Design of digital filters.

Round off effects in digital filters. Implementation of digital filters using digital signal processors.

Switched Capacitor (SC) filters.

Signal processing of random processes. Adaptive systems.

Subband coding. Design of filter banks. Wavelet transform.

Teaching methods

Lecture, laboratory exercises.

Learning outcomes and methods of theirs verification

Outcome description	Outcome symbols	Methods of verification	The class form
Knows fundamentals of digital signal processing useful in multimedia systems. Knows specifics of energy signals into audio conversion. Knows hardware for algorithm implementation of digital signal processing		• an exam - oral, descriptive, test and other • an ongoing monitoring during classes	• Lecture • Laboratory
Can design, implement and test a digital filter for signals. Can design and test signal processing digital algorithm. Can design a system converting signals from analogue to digital and vice versa.		• an ongoing monitoring during classes	• Laboratory
Is aware of the dynamic development of signal processing methods. Can establish the basic parameters of the signal recorded using a digital oscilloscope		• an exam - oral, descriptive, test and other	• Lecture

Assignment conditions

Lecture – in order to get a credit it is necessary to pass all of the required tests (oral or written).

Laboratory – the main condition to get a pass are sufficient marks for all exercises and tests conducted during the semester.

Calculation of the final grade: lecture 60% + laboratory 40% .

Recommended reading

1. Proakis J. G., Manolakis D. M., *Digital Signal processing, Principles, Algorithms, and Applications*, Third Edition, Prentice Hall Inc., Engelwood Cliffs, New Jersey 1996.

2. Lyons R., *Understanding digital signal processing*, Prentice Hall, 2004.

3. Oppenheim A. V., Schafer R. W., *Discrete-time signal processing*, Prentice Hall, New Jersey, 1999.

4. Stallings W., *Computer Organization and Architecture*, Pearson, 2015.

5. Vaidyanathan P. P., *Multirate Systems and Filter Banks*, Prentice Hall Inc., Engelwood Cliffs, New Jersey 1992.

6. Wanhammar L., *Digital Filters*, Linkoping University, 1996.

7. K. Sozanski, Digital Signal Processing in Power Electronics Control Circuits, second edition, Springer-Verlag London, 2017.

8. Embree P. M., Kimble B., *C Language Algorithms for Digital Signal Processing*, Prentice Hall, 1991.

Further reading

1. Dahnoun N., Multicore DSP: From Algorithms to Real-time Implementation on the TMS320C66x SoC, Wiley, 2018

2. P. S. R. Diniz, Adaptive Filtering Algorithms and Practical Implementation, Springer, 2020.

3. McFarland G., *Microprocessor Design (Professional Engineering)*, McGraw-Hill Professional, 2006.

Notes

Modified by dr hab. inż. Krzysztof Sozański, prof. UZ (last modification: 21-04-2022 23:15)