COURSE DESCRIPTION CARD - SYLLABUS

Course name
Fundamentals of signal processing [S1MiKC2>PPS]

Course

Field of study
Microelectronics and Digital Communication

Year/Semester
1/2

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
24

Laboratory classes
30

Other
0

Tutorials
0

Projects/seminars
0

Number of credit points

4,00

Coordinators

dr hab. inż. Damian Karwowski
damian.karwowski@put.poznan.pl

Lecturers

Prerequisites

A student starting this subject should have systematic knowledge of mathematical analysis, algebra, trigonometry and basic knowledge of physics. Student should be able to apply integral and differential calculus for functions of one and two variables, be able to analyze the course of variability of functions and operate on complex numbers. Additionally, student should be able to calculate the limits of functions and examine the convergence of a geometric series.

Course objective

Gaining knowledge of the basics of signal analysis and processing. In particular, this knowledge includes Fourier analysis of periodic and non-periodic signals, introduction to linear systems, introduction to the issues of signal transmission by linear systems, and sampling of continuous signals. The aim of the course is to acquire skills in solving basic problems of signal analysis and processing, which are typical for modern ICT systems.

Course-related learning outcomes

Knowledge:
1. Student has structured and mathematically based knowledge of one-dimensional signal theory

necessary for proper understanding of aspects of signal representation and analysis in the time and frequency domains [K1_W02].
2. Student knows and understands basic concepts related to the description of linear systems in the time and frequency domains. Understands how the properties of linear systems affect the way in which these systems process signals [K1_W02].

Skills:
1. Student is able to solve typical tasks/problems related to the analysis and processing of signals in the time and frequency domain [K1_U03].

Social competences:
1. Student understands the need for continuous learning and understands the meaning and necessity of constantly improving one's own competences [K1_K01].

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

1. Lecture
Written and/or oral assessment. The assessment consists of several to a dozen or so questions (depending on the nature and scope of the questions adopted) and concerns the content presented during the lectures. The exact nature of the assessment questions will be presented to students during one of the last lectures.
Passing threshold: 50% of all points.
2. Laboratories
Tests (at least two) during the semester, checking the degree of mastery of a selected part of the material. Each of the tests consists of several questions referring to problems/tasks that were previously the subject of the laboratories.
Passing threshold: 50% of the total number of points from all tests.
For lecture and laboratory credits, the following percentage thresholds apply to individual grades: 2.0 (<

50%), 3.0 (50%-59%), 3.5 (60%-69%), 4.0 (70%-79%), 4.5 (80%-89%), 5.0 (90% and more).

Programme content

Signals and mathematical models of signals. Selected properties and parameters of signals. Frequency analysis of periodic and non-periodic signals. Selected aspects of signal processing, including signal processing by linear systems. Sampling and quantization of signals.

Course topics

1. Lecture
Signals and models (deterministic, continuous and discrete, analog and quantized signals).
Properties of periodic and non-periodic signals. Real and complex harmonic signals. The concept of a constant component and a variable component.
Power and energy of continuous signals, the concept of effective value.
Analysis of periodic signals using an orthogonal series (The concept of orthogonality of signals, orthogonal series and functional series, trigonometric Fourier series and its properties, complex form of Fourier series, spectrum of a real signal, consequences of signal symmetry for the coefficients of a complex Fourier series, the effect of a signal shift in time on the coefficients and spectrum of the signal, spectrum of the sum and product of periodic signals, the effect of the signal shape on its spectrum, convergence of Fourier series, Gibbs effect). Parseval's theorem for Fourier series.
Fourier integral transform and its properties (definition of the transform, linearity of the Fourier transform, influence of signal symmetry on the form of its Fourier transform for real and complex signals). Theorems illustrating the properties of the Fourier transform (on symmetry, on change of scale, on shift in the time domain, on modulation, i.e. shift in the frequency domain, on value at zero, on differentiation in the time domain, on integration in the time domain). Parseval's theorem for the Fourier transform. Energy density spectrum. Generalization of the Fourier transform: spectra of power signals. Fourier transform from a periodic signal.
Transmission of signals through linear systems with fixed parameters (concept of the LTI system, static and dynamic systems, impulse response of the LTI system, response of the LTI system to arbitrary

excitation, linear convolution, convolution theorems for the Fourier transform). Transfer function of the LTI system. Frequency characteristics of LTI systems. Response of LTI circuit to excitation by periodic signal. Ideal filters and their properties.
Discrete signals (definition of discrete signal, spectrum of discrete signal, signal sampling and reconstruction from a sequence of samples, Shannon's sampling theorem).
2. Laboratories
Simple operations on signals (amplitude change, shift on the time axis, time axis rescaling, sum of signals, product of signals, etc.).
Average value, energy and power of signals. RMS value of signal, constant component of signal. Parseval's theorem for periodic signals. Analysis of periodic signals using orthogonal series. Trigonometric and complex Fourier series. Signal spectrum.
Examples of signal processing methods. Transmission of signals by linear systems with fixed parameters (LTI systems). Signal filtering.

Teaching methods

1. Lecture
Classes with distinct elements of traditional lecture and problem-based lecture (discussion with students of a specific problem), depending on the content of the presented material. Selected lecture content is presented on a multimedia projector or board. The discussion of issues is accompanied by information about their practical application.
2. Laboratories
Solving problems given by the instructor on computers using a selected software package. Interpretation of the obtained solution and formulation of conclusions. Discussion of the possibilities of practical application of the methods/calculations that are the subject of the laboratory.

Bibliography

Basic:
1. J. Wojciechowski, "Sygnały i Systemy", WKiŁ, 2008.
2. K. Snopek, J. Wojciechowski, "Sygnały i systemy. Zbiór zadań", O.Wyd. PW, 2009.
3. M. Tadeusiewicz, M. Ossowski, "Sygnały i systemy. Zadania", Wyd. PŁ.
4. M. Pasko, J. Walczak, "Teoria Sygnałów", Wyd. P.Śl., 1999.
5. J. Izydorczyk, G. Płonka, G. Tyma, "Teoria Sygnałów. Wstęp", Helion, 2006.
6. E. Szabatin, "Wprowadzenie do teorii sygnałów", WNT.

Additional:
1. R. Gabel, R. Roberts, "Sygnały i systemy liniowe", WKiŁ.
2. R. Lathi, "Sygnały i systemy telekomunikacyjne", WNT.
3. A. Papoulis, "Sygnały i obwody", WKiŁ.
4. A. Oppenheim, A. Wilsky, I. Young, "Signals and Systems", Prentice Hall.
5. R. Biernacki, B. Butkiewicz, J. Szabatin, B. Świdzińska, "Zbiór zadań z teorii sygnałów i teorii informacji:, Of. Wyd. PW, 2003.

Breakdown of average student's workload

	Hours	ECTS
Total workload	104	4,00
Classes requiring direct contact with the teacher	54	2,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	50	2,00