COURSE DESCRIPTION CARD - SYLLABUS

Course name

Signal theory

Course

Field of study	Year/Semester
Electronics and Telecommunications	1/2
Area of study (specialization)	Profile of study
	general academic
Level of study	Course offered in
First-cycle studies	Polish
Form of study	Requirements
full-time	compulsory

Number of hours

Lecture	Laboratory classes	Other (e.g. online)
30		
Tutorials	Projects/seminars	
30	0	

Number of credit points

5

Lecturers

Responsible for the course/lecturer:

dr inż. Damian Karwowski

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Responsible for the course/lecturer:

Prerequisites

The student starting this course should have systematized knowledge of mathematical analysis, algebra, trigonometry and knowledge of physics. He should be able to use integral and differential calculus for functions of one and two variables, be able to analyze the function variability and operate on complex numbers. In addition, he should be able to calculate the limits of a function and examine the convergence of a geometric sequence.

Course objective

Gaining knowledge in the field of Fourier analysis of periodic and non-periodic signals, introduction to linear systems, introduction to the problems of signal transmission through linear systems, sampling of continuous signals. Skills in solving basic signal theory problems for cognitive purposes and for practical purposes in research and design of analog signal processing systems in telecommunications.

Course-related learning outcomes

Knowledge

1. Has an ordered and mathematical knowledge of the theory of one-dimensional signals necessary to understand the representation and analysis of signals in the time and frequency domains.

2. Knows and understands the basic concepts related to the description of linear systems in the time and frequency domains. Understands how the properties of linear systems influence the spectrum of signals processed by them.

Skills

Can solve typical problems related to the analysis of signals in the time and frequency domains.

Social competences

Student is open to the possibilities of continuous training and understands the need to improve professional competences.

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

1. Tutorials

Two tests during the semester - more or less after the 8th and 14th week of the semester. Each of the tests consists of 3 or 4 computational tasks. Passing threshold: 50% of points.

2. Lecture

Written and / or oral exam. The exam consists of a few or a dozen questions (depending on the accepted nature of the questions) and concerns the content presented during the lectures. The exact nature of the exam questions will be presented to students during one of the last lectures. Test passing threshold: 50% of points.

Programme content

1. Lecture

Signals and models (deterministic and stochastic, continuous and discrete, analog and quantized signals). Properties of periodic and non-periodic signals. Real and complex harmonics. The concept of a constant component and a variable component. Power and energy of continuous signals, the concept of RMS value, calculation of the shape factor and peak coefficient for signals.

Analysis of periodic signals using an orthogonal series (The concept of orthogonality of signals and norms, orthogonal functional sequences and series, trigonometric Fourier series and its properties, complex Fourier series, harmonic spectrum of the real signal, signal symmetry consequences for complex Fourier series coefficients, influence of the signal shift in time on coefficients and signal spectrum, spectrum of sum and product of periodic signals, influence of signal shape on its spectrum, Fourier series convergence, Gibbs effect). Parseval's theorem for Fourier series.

Integral Fourier transform (transform) and its properties (definition of the transformation, linearity of 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 (symmetry, scale shift, time domain shift, modulation or frequency shift, zero value, time domain differentiation, time domain integration). Parseval's theorem for Fourier transform. Energy density spectrum. Generalization of the Fourier transform: spectrum of power signals. Fourier transform of a periodic signal.

Signal transmission through linear systems with constant parameters (LTI concept, static and dynamic systems, LTI system impulse response, LTI system response to any stimulation, linear convolution, convolution theorems for Fourier transform). LTI system transmittance. Frequency characteristics of LTI circuits. The response of the LTI system for a periodic signal. Ideal filters and their properties.

Correlation (functions of cross-correlation and autocorrelation of finite energy signals, Wiener-Chinese theorem, correlation functions for power signals, autocorrelation functions versus signal power and energy, correlation of input and output signal in a linear system).

Discrete signals and systems (definition of a discrete signal, spectrum of a discrete signal, sampling and reconstruction from a series of samples, Shannon's sampling theorem, DFT transform, processing of a discrete signal by a discrete LTI system, discrete convolution)

1. Exercises

Simple signal operations (amplitude shift, timeline shift, timeline scaling, signal sum, signal product, etc.).

Average value, energy and signal strength. RMS value of the signal, constant component of the signal. Parseval's theorem for periodic signals.

Periodic signal analysis with orthogonal series. Trigonometric and complex Fourier series. Signal spectrum. Parseval's theorem for Fourier transform.

Signal transmission through linear systems with fixed parameters (LTI systems). Perfect filters.

Teaching methods

1. Lecture

Classes with clear elements of a traditional lecture, problem lecture (discussion with students of a specific problem) and seminar lecture (mobilizing students to discuss a specific topic), depending on the content of the presented material. Selected content of the lecture is presented on a multimedia projector or a blackboard. The discussion of the issues is accompanied by information on their practical application.

2. Tutorials

Auditorium exercises. Solving the tasks given by the teacher. Interpretation of the obtained solution and formulation of conclusions. Discussion of the possible practical application of the issues / theorems being the subject of the exercises.

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	125	5,0
Classes requiring direct contact with the teacher	70	3,0
Student's own work (literature studies, preparation for tutorials, preparation for tests/exam, project preparation) [1]	55	2,0

[1] delete or add other activities as appropriate