RTU Course "Basics of Signal Theory"

13223 Elektronikas pamatu katedra

General data

Code	RTR220
Course title	Basics of Signal Theory
Course status in the programme	Compulsory/Courses of Limited Choice
Course level	Undergraduate Studies
Course type	Academic
Field of study	Electronics and Telecommunications
Responsible instructor	Elmārs Beķeris
Academic staff	Juris Grēve Māris Tērauds Artūrs Āboltiņš Anna Litviņenko
Volume of the course: parts and credits points	1 part, 4.0 Credit Points, 6.0 ECTS credits
Language of instruction	LV, EN, RU
Possibility of distance learning	Not planned
Maximum auditorium capacity	180
Maximum number of students per semester	180
Abstract	Classification of signals, their characteristics, examples of use in communication systems. Continuous-time periodic and non-periodic signals, Fourier transforms, their properties. Discrete-time signals, Discrete Fourier Transforms, digital filtering, FIR and IIR filters. Modulation, AM, FM, PM signals, digital modulation, transformation of modulated signals by narrowband linear systems. Random signals, their main parameters, principles of measurement, noise in electronic systems.
Goals and objectives of the course in terms of competences and skills	To develop understanding of main characteristics of signals and their analysis methods in time and frequency domains. To develop the ability to evaluate main signal parameters and understanding of signal transformations in various systems.
Structure and tasks of independent studies	1. Preparation for lab.works, to write reports and be able to presents them (accomplishment of all activities related to lab.works is controlled). Objective: to promote understanding of lecture material, to develop research skills. 2. Preparation for tests (such tests are offered at every practical lesson). Objective: to stimulate systematical learning during the term. 3. Accomplishment of the specified tasks. Objective: to provide opportunity get acquainted with problems similar to those offered at examination.
Recommended literature	1.Beķeris, E. Signālu teorijas pamatiti. Rīga, 2010. 227 lpp. 2.Haykin, S., Van Veen, B. Signals and Systems. New York etc.: Wiley, 1999. 694 p. 3.Sherrick, J.D. Concepts in Systems and Signals. 2nd ed. Upper Saddle River (N.J.) ; Columbus (O.) : Pearson/Prentice Hall, c2005. 447 p. 4.Баскаков, С. Радиотехнические цепи и сигналы. Москва : Высшая школа – visi izdevumi (1983 – 2005). 5.Сато, Юкио. Обработка сигналов. Первое знакомство. Москва: Додэка XXI, 2002. 176с. 6.Сергиенко, А. Цифровая обработка сигналов. Москва и др. : Питер, 2002.608 с. vai Сергиенко, А. Б. Цифровая обработка сигналов. 2-е изд. Москва [и др.] : Питер, 2006. 750 с. 7.Денисенко, А. Н. Сигналы : Теоретическая радиотехника : справочное пособие. Москва : Горячая линия – Телеком, 2005. 704 с. 8.http://www.complextoreal.com/
Course prerequisites	Mathematics: vector analysis; complex algebra, singularities; derivatives, integration. Circuit theory. Electronic devices.

Course outline

Theme	Hours
Introduction. Classification of signals, power and energy signals.	3
Representation of periodic signals by Fourier series based on orthogonal set of functions. Spectrum.	5
Trigonometric Fourier series. Transformation of periodic signals by linear continuous-time systems	6
Complex exponential Fourier series, Fourier transforms, spectral density.	4
Properties of Fourier transforms.	5
Energy spectrum, Rayleigh's theorem, bandwidth of periodic signals.	4
Representation of a continuous-time signal by its samples, the sampling theorem, sampling in the frequency domain.	4
The Discrete Fourier Transforms.	4
Main principles of digital filtering. Analysis of digital filters in the time and frequency domains, Z-transforms.	6
Modulated signals, Amplitude modulation (AM), transformation of AM signals by bandpass systems, balance and single side	5
Angle modulation: frequency modulated and phase modulated signals.	5

Digital modulation - amplitude, phase and frequency shift keying, M-ary modulation.	2
Random signals: ensemble of sample functions, stationarity, probability density functions.	4
Random signals: autocorrelation function, power spectral density.	3
Transformation of random signals by linear system. Noise in electronic systems.	4

Learning outcomes and assessment

Learning outcomes	Assessment methods
Able to evaluate the average power and energy of various signals, understand how to select proper methods for analysis of their properties.	Tests, exam.
Know how to represent periodic signals by trigonometric and complex exponential Fourier series. Able to calculate spectra of periodic signals.	Tests, presentation of laboratory work reports, exam.
Understand spectral density of signals. Able to apply Fourier transforms for analysis of signals in linear systems, able to evaluate bandwidth of signals, apply properties of Fourier transforms.	Tests, presentation of laboratory work reports, exam.
Able to apply the Sampling Theorem, understand how to use Discrete Fourier Transforms.	Tests, presentation of laboratory work reports, exam.
Able to explain the principles of digital filtering, know how to find impulse and frequency responses of FIR and IIR filters.	Tests, presentation of laboratory work reports, exam.
Able to describe properties of modulated signals: waveforms, spectra.	Tests, presentation of laboratory work reports, exam.
Able to evaluate characteristics of stationary random signals: mean values, probability distribution, autocorrelation function, power spectral density. Understand transformation of random signals.	Tests, exam.

Study subject structure

Part	CP	ECTS	Hours per Week			Tests		
			Lectures	Practical	Lab.	Test	Exam	Work
1.	4.0	6.0	2.0	1.0	1.0		*	