COURSE DESCRIPTION CARD - SYLLABUS

Course name
Digital Telecommunication Systems [S1EiT1>CST]

Course

Field of study
Electronics and Telecommunications

Year/Semester
3/6

Area of study (specialization)
–

Profile of study
general academic

Level of study
first-cycle

Course offered in
polish

Form of study
full-time

Requirements
elective

Number of hours

Lecture
30

Laboratory classes
0

Other (e.g. online)
0

Tutorials
15

Projects/seminars
0

Number of credit points

3,00

Coordinators

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Lecturers

Prerequisites

Student has a systematic knowledge and is able to solve basic problems in the area of methematical analysis, algebra and probability Student has ordered and mathematically founded knowledge and is able to solve the problems in the area of the theory of one-dimensional signals necessary for understanding representation and analysis of signals in time and frequency domains Student knows and understands basic concepts anf methods of linear and nonlinear electronic system description and communication systems

Course objective

Presentation of theoretical foundations of digital communication systems containing baseband transmission, digital modulations of sinusoidal carrier and multitone transmission.

Course-related learning outcomes

Knowledge:
He/she has knowledge on the selection of elementary signals and the data symbol formats for baseband transmission, structure of optimal synchronous and non-synsynchronous receivers , digital modulation techniques of single and multicarrier transmission

He/she has knowledge in the area of communications related to criteria and selection of optimum receiver structures for baseband transmission and passband transmission; he/she is able to determine error probability for digital modulations used in channels with additive white Gaussian noise
He/she has basic knowledge on application of the described digital transmission techniques applied in modern and future digital communication systems

Skills:
He/she is able to determine basic parameters of signals applied in baseband transmission and passband transmission; he/she is able to determine parameters of digitl communication systems applying these signals
He/she is able to analyze operation of digital signal receivers and to design operation of basic transmisster and receiver blocks in digital signals in digital transmission

Social competences:
He/she is abe to notice and formulate direction of future development of digital communication systems both in the basic research aspects and the whole systems

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

The tutorials end with a test consisting of 3-4 tasks to be solved and a multiple choice quiz; to pass the test, one must get at least 50% points. Some additional points are granted for voluntary solving the problems on board during the classes.
Written exam covering the topics of lectures and exercises is organized using a special form in which students read the stated problems and write their solutions. The questionnaire contains four problems to be solved. Solution of each of them is evaluated in the range of 0 to 3 points. The exam is considered passed if a student has obtained at least 7 points. If the number of obtained points is between 5 and 6.5 the student participates in an additional meeting in which he/she solves two supplementary problems according to the same rules. The satisfactory grade is given for 7, 7.5 or 8 points. The grades increase by a subsequent value (3.5, 4, 4.5 and 5) after obtaining each additional point. Granularity of the evaluation is 0.5 point.

Programme content

Lectures:
1. Overview of basic topics needed to understand the course content:
Signal orthogonality principle and its applications in digital communications, spectral properties of the signals (spectral density, energy density spectrum, power density spectrum e), recalling basic elements of probability theory and stochastic processesapplied in signal analysis and digital communication systems
2. General model of digital communication system
Description of basic functional blocks (message source, source encoder, channel code encoder, modulator, channel, demodulator, channel code and source code decoders, message receipient), basic information on multiple access methods (FDMA, TDMA, CDMA, OFDMA)
3. Source coding methods on the examle of speech coding
PCM, DPCM, ADPCM coding, delta modulation and its improvements, linear predictive coding and using codebooks on the example of cellular radio speech coding, notion of vector quantization
4. Basic knowledge on channel coding
Error detection and correction coding, idea of hard- and soft-decision decoding, block coding and its matrix and polynomial descriptions (parity check matrix, generating matrix, syndrome, generating polynomial), general idea of block code decoding
5. Basic knowledge on channel coding - Part 2
Convolutional codes and their decoding using the Viterbi algorithm, interleaving/deinterleaving, idea of serial and parallel cascade coding, basic information on turbo codes, LDPC and polar codes
6. Baseband transmission:
Power density spectrum and its shaping by selection od elementary pulse shape and data sequence correlation properties by selection of data symbol format (line coding and its representtive examples), optimal synchronous MAP/ML receiver, error probability on the iutput of synchronous receiver. two-and multi-level PAM modulations
7. Digital modulations of sinusoidal carrier:

Synchronous reception of signals with modulated carrier, overview of digital modulations of sinusoidal carrier: ASK, FSK, PSK, QAM, differential encoded modulations, continuous phase modulations. OFDM multi-tone transmission.
8. Digital transmission using multi-tone signals
Basic properties of OFDM signal, selection of OFDM signal parameters on tha basis of available bandwidth, physical properties of transmission channel and data rate requirements, receiver functional blocks with IFFT/FFT pair, example of selection of OFDM transmission parameters.
Exercises (tutorials):
The tutorials cover selected problems related to digital telecommunication systems, including:
1. Representation of deterministic and stochastic signals in the frequency domain.
2. The structure of the transmitter and optimal receiver for the baseband signals.
3. Power spectral density (PSD) of digital signals, including the PSD of the raised cosine pulse, and time-frequency dependency on the roll-off factor.
4. Modulations of a sinusoidal carrier: BPSK, QPSK, 16-QAM - demonstration of the optimal receiver operation (matched filter, sampling and signal quantization).
5.Multi-hop transmission - comparison of analog and digital systems

Teaching methods

Lectures in the form of multimedia presentation, illustrated by additional explanations shown on the bleckboard, in case of pandemic situation presentation of lectures on one of internet platforms with possible access to recorded lectures; presentation in the form of lecture handuts available to the students in the form of PDF files in the university suporting system
Tutorials with solutions of the stated problems

Bibliography

Basic:
1. K. Wesołowski, Podstawy cyfrowych systemów telekomunikacyjnych, Wydawnictwa Komunikacji i Łączności, Warszawa, 2003
2. K. Wesołowski, Introduction to digital communication systems, John Wiley & Sons, Chichester 2009

Additional:
1. S. Haykin, Systemy telekomunikacyjne, t. I i II, Wydawnictwa Komunikacji i Łączności, Warszawa, 1999
2. B. P. Lathi, Z. Ding, Modern Digital and Analog Communication Systems, Oxford University Press, 2010

Breakdown of average student's workload

	Hours	ECTS
Total workload	90	3,00
Classes requiring direct contact with the teacher	55	2,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	35	1,00