COURSE DESCRIPTION CARD - SYLLABUS

Course name
Digital Telecommunication Systems [S1Teleinf1>CST]

Course

Field of study
Teleinformatics

Year/Semester
2/4

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
0

Tutorials
15

Projects/seminars
0

Number of credit points

3,00

Coordinators

prof. dr hab. inż. Krzysztof Wesołowski
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Lecturers

Prerequisites

A student starting the course should possess basic knowledge in the area of telecommunications, signal and probability theory. He/she should be able to perform calculations using mathematical methods of mathematical analysis and probability calculations. He/she should be able to acquire information from the indicated sources. He/she should be also aware of necessity of extending his/her competence. In the area of social competences a student has to show such attitudes as honesty, responsibility, persistence, cognitive curiosity, creativity, personal culture and respect for other people.

Course objective

1. Provide students with basic knowledge in the field of: theoretical foundations of digital telecommunications and ICT systems. 2. Developing students' skills in solving basic computational problems related to digital telecommunications and ICT systems. 3. Shaping students' skills in acquiring knowledge about currently implemented digital ICT sys tems solutions

Course-related learning outcomes

Knowledge:
1. The student is able to determine the codewords of a block and convolution code on the basis of its

given properties and determine the basic parameters of signals used in passband transmission and the parameters of the physical layer of teleinformation systems using these signals.
2. The student is able to analyze the operation of digital signal receivers and design the basic transmitter and receiver blocks in digital transmission systems.

Skills:
1. The student has knowledge about the construction of a typical digital transmission system and its functional blocks as well as the multi-access methods used. Has a basic knowledge of source coding, especially speech signals and channel coding. He knows the rules of digital modulation used in transmission with a single carrier frequency and in multi-tone systems.
2. He/she has a basic knowledge of the application of the discussed digital transmission techniques in modern and future ICT systems.

Social competences:
1. The student is able to perceive and formulate directions for the development of digital telecommunication systems, both in terms of basic research and entire systems

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

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Formative assessment:
a) in terms of exercises:
• based on the assessment of the current progress in the implementation of tasks,
Summative assessment:
a) in the field of lectures, verification of the assumed learning outcomes is carried out by:
• assessment of the knowledge demonstrated during the exam. The exam consists in solving four tasks / problems of theoretical and computational nature. The tasks are scored in the range of 0 to 3 points. A minimum of seven (7) points is required to obtain a 3.0 grade,
• if it is necessary due to on-line teaching, verification of the knowledge acquired on lectures using an ICT system: implementation of a multiple-choice test (each student randomly draws 20 questions out of more than 60 ones with a random ordering of possible answers)
b) in the field of exercises, verification of the assumed learning outcomes is carried out by:
• substantive evaluation of the performance of assigned problems for individual solution
• continuous assessment during each class (oral answers)
• the grade obtained on the final test
• obtaining additional points for activity during the training classes

Programme content

Classes within the module are conducted in the form of a lecture (30 hours) and auditorium exercises (15 hours)
Lectures:
1. Repetition of the introductory information necessary for the rest of the course
The property of orthogonality and its applications, sets of orthogonal functions,
2. Repetition of the introductory information necessary for the further part of the course - part 2
Basic elements of probability calculus and stochastic processes,
3. General model of digital transmission system
Overview of basic functional blocks (message source, source encoder, channel code encoder, modulator, channel, demodulator, channel and source code decoders, message recipient), basic information about multiple access methods (FDMA, TDMA, CDMA, OFDMA)
4. Source coding methods on the example of digital speech signal coders
PCM, DPCM, ADPCM coding, delta modulation and its improvements, coding with linear prediction and "codebooks" on the example of coding in mobile telephony, the concept of vector quantization
5. Basic knowledge about channel coding
Division of codes into detection and correction codes, the idea of hard and soft decoding, block coding and its matrix and polynomial description (parity check matrix, generator matrix, syndrome, generating polynomial), general idea of decoding of block codes
6. Basic knowledge of channel coding - part 2
Convolutional codes and their decoding using the Viterbi algorithm, the principle of interleaving, the

idea of cascade coding - serial and parallel, basic information about turbo-codes, LDPC and polarization codes
7. Digital modulations
Synchronous reception, review of discrete sinusoidal carrier modulations with appropriate receivers: ASK, FSK, PSK, DPSK (differential phase modulation), QAM modulation, continuous phase modulation - CPM, modulated signal constellations, multi-tone modulations - OFDM modulation
8. Transmission of digital signals by means of multi-carrier signals
Basic OFDM signal properties, selection of OFDM signal parameters based on the available bandwidth, physical properties of the transmission channel and transmission speed requirements, transmitter and receiver implementation using the IFFT / FFT pair.
9. Examples of digital telecommunications systems
Basic information on ADSL and VDSL technologies, the idea of cellular systems and their brief description (basic functional blocks and transmission methods)
Auditorium exercises:
Exercises cover selected problems of digital telecommunications systems, such as:
1. Introduction to the elements of a digital communication system.
2. Block codes - overview, creating codewords, correction capabilities, determining the syndrome.
3. PAM - modulation levels, a compromise between the number of bits per symbol and the average energy per symbol.
4. Power density spectra of digital modulation signals in the baseband - the spectrum of a raised cosine pulse, time-frequency relations when modifying the pulse roll-off factor.
5. Amplitude quadrature modulation, differential encoding of PSK and QPSK modulations - waveforms in the time domain, methods of receiving such signals.
6. OFDM signals - selection of system parameters on the example of LTE system.

Course topics

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Teaching methods

1. lecture: multimedia presentation, supplemented with current examples and additional explanations on the white board or presentation on the internet platform, access to the presentation in the university IT system, possible access to recordings of lectures (optional, depending on the pandemic situation)
2. auditorium exercises: solving problems.

Bibliography

Basic:
Wesołowski K., Podstawy cyfrowych systemów telekomunikacyjnych, WKŁ, 2003
Zieliński. T., Korohoda, P., Rumian R., Cyfrowe przetwarzanie sygnałów w telekomunikacji, PWN, 2014
Wesołowski K., Systemy radiokomunikacji ruchomej, WKŁ, 2000

Additional:
1. S. Haykin, Systemy telekomunikacji analogowej i cyfrowej, WKŁ, 1998
2. B. P. Lathi, 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	49	2,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	41	1,00