COURSE DESCRIPTION CARD - SYLLABUS

Course name
Digital Modulations [S1Teleinf1>MCYFR]

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 (e.g. online)
0

Tutorials
15

Projects/seminars
0

Number of credit points

3,00

Coordinators

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Lecturers

Prerequisites

A student starting this course should have a basic knowledge of the foundations of telecommunications, signal theory and probability theory. He/she should have the ability to perform calculations using a mathematical apparatus in the field of mathematical analysis and probability calculus, and to obtain information from the indicated sources. He/she should also understand the need to expand his/her competences. In addition, in the field of social competences, the student must present attitudes such as honesty, responsibility, perseverance, cognitive curiosity, creativity, personal culture, respect for other people

Course objective

1. Provide students with basic knowledge in the field of: theoretical foundations of digital modulation used in ICT systems. 2. Developing students' skills to solve basic computational problems related to digital modulations used in ICT systems. 3. Shaping students' skills in acquiring knowledge about currently implemented digital modulation solutions in ICT systems

Course-related learning outcomes

Knowledge:

1. A student is able to determine the basic parameters of digital modulation and the parameters of the physical layer of teleinformation systems that use these modulations
2. A student is able to analyze the operation of signal receivers with digital modulations and design the basic blocks of the transmitter and receiver in ICT systems

Skills:
1. A student has knowledge of the selection of elementary signals and data symbol format for digital transmission in the baseband, the structures of the optimal synchronous receiver, digital modulation techniques
2. A student has knowledge of the structures of receivers optimal for digital passband transmission and he/she is able to determine the error probability for digital modulation
3. The student has a basic knowledge of the application of the discussed digital modulation techniques in modern and future ICT systems

Social competences:
1. A student is able to see and formulate directions of development of digital telecommunications systems with digital modulations, 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:

Learning outcomes presented above are verified as follows:
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, basic elements of probability calculus and stochastic processes,
2. Baseband digital transmission as an introduction to digital modulation
Presentation of the spectral properties of a data sequence in the baseband, shaping the properties of the power density spectrum by selecting the shape of elementary signals and selecting the format of data symbols, Nyquist theorem, avoiding inter-symbol interference by selecting the shape of an elementary pulse, optimal synchronous reception of binary and multivalued signals, error probabilities for basic types of receivers and elementary signals
3. Digital modulations of sinusoidal carrier
Synchronous reception, review of discrete sinusoidal carrier modulations with appropriate receivers: ASK, FSK, PSK, DPSK (differential phase modulation), QAM modulation, continuous phase modulation - CPM, multi-tone modulation - OFDM modulation, examples of carrier frequency and phase synchronization methods, Viterbi detector - an example of sequential detection
4. Transmission of digital signals using multi-tone signals
Basic properties of OFDM signals, 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. An example project of an OFDM system
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.

Teaching methods

.1. lecture: multimedia presentation, supplemented with current examples and additional explanations on the blackboard, in the case of an online lecture on an IT platform - optional recordings of lectures and their sharing in the university's didactic IT system, similarly for the PDF version of the presentation
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