The syllabus of the discipline

Fundamentals of information and communication technologies

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Field name	Detailed content, comments
Name of the faculty	Faculty of Infocommunications
Level of higher education	First (bachelor's)
Code and name of the specialty	172 Telecommunications and radio engineering
Type and name of educational program	EPP "Information and Network Engineering"
Name of the discipline	Fundamentals of information and communication technologies
Number of ECTS credits	10
Discipline structure (distribution by types and hours of study)	32 hours - 16 lectures, 12 hours - 6 practical classes, 20 hours - 5 laboratory classes, 8 hours - 4 consultations, 64 hours - homework, **type of control**: exam
Schedule (terms) of studying the discipline	2nd year, III and IV semesters
Prerequisites for studying the discipline	students must study the discipline: electrodynamics, theory of electric circuits, higher mathematics
Competences, knowledge, skills, understanding, which is acquired by the applicant in higher education in the learning process	The discipline is used to form the following competencies: to know general information about telecommunication systems; principles of multichannel communication and their implementation in analog and digital communication systems and be able to determine mathematical models of messages, signals, interference and communication channels; systems efficiency indicators telecommunications and methods of their optimization.
The quality of the educational process	Educational-methodical and material-technical resource provision of the educational program, within the framework of which the discipline is studied, meets the licensing requirements and accreditation conditions of the educational activity of the university. Annual monitoring and revision of the curriculum of the discipline in accordance with the requirements and recommendations of the Ministry of Education and Science, state certification of acquired competencies of graduates, standards of cooperation with employers to ensure a competitive level of training. Adherence to the principles of academic integrity (https://lib.nure.ua/plagiat). Contains public information on the requirements, competencies, level of education within the current educational program.

Description and content of the discipline

The purpose of the discipline - to acquaint students with models of messages, signals, interference, channels and telecommunication systems in general, the basics of information theory in them, methods of analysis and synthesis of modern communication systems and devices for various purposes and principles of their implementation, modulation methods and coding, methods of optimal signal reception against the background of interference, methods of evaluating the effectiveness of communication systems.

Content

Content module 1. Mathematical models of messages, signals and interference in telecommunication systems.

Topic 1. Basic concepts and general information about telecommunication systems. Classification of messages, signals and interference. Qualitative and mathematical description of single-channel and multi-channel information transmission systems. The main characteristics of signals, channels and telecommunication systems in general. Problems of information transfer in telecommunication systems.

Topic 2. Deterministic models of processes in telecommunication systems. Geometric representation of processes in metric, normalized and Hilbert spaces. Continuous and discrete signals. Analog-to-digital signal conversion. Kotelnikov's theorem. Orthogonal signal schedules. Analytical and narrowband processes. Primary codes for data transmission.

Topic 3. Probabilistic models of processes in telecommunication systems. Definition and main characteristics of random processes. Stationary, non-stationary and ergodic random processes. Correlation functions and signal power spectral densities. Wiener-Hinchin theorem. Gaussian processes. Orthogonal schedules of random processes. White noise, Markov and linear processes.

Topic 4. Mathematical models of messages in telecommunication systems. Mathematical model of telephone (voice) message. Mathematical model of a telegraph message. Mathematical models of fax and television messages.

Topic 5. Digital methods of continuous message transmission. Pulse - code modulation (PCM). Differential PCM. Adaptive differential PCM. Delta - modulation. Block diagrams of modems.

Topic 6.Types of modulation in the transmission of messages using media in the form of a sequence of pulses and noise-like signals.

Content module 2. Methods of signal modulation in message transmission in telecommunication systems

Topic 1. Discrete modulation (manipulation) of a harmonic carrier. AM, FM, FM and VFM harmonic media discrete messages. Time and spectral representation of signals with two-level manipulation. Block diagrams of modems

Topic 2. Multilevel phase and relative phase manipulation. Quadrature phase

manipulation. Differential coherent phase manipulation. Signal - code constructions. Noise-like signals (SPS). Block diagrams of modems

Topic 3. Amplitude-phase manipulation (quadrature amplitude manipulation, KAM). KAM-16. KAM with a quaternary shift. KAM with binary offset. Block diagrams of modems.

Topic 4. Multilevel frequency manipulation. Smooth frequency manipulation. Fast frequency manipulation. Frequency manipulation with minimal offset. Frequency manipulation with a continuous phase. Block diagrams of modems.

Topic 5. Digital methods of continuous message transmission. Pulse - code modulation (PCM). Differential PCM. Adaptive differential PCM. Delta - modulation. Block diagrams of modems.

Topic 6. Types of modulation in the transmission of messages using media in the form of a sequence of pulses and noise-like signals.

Content module 3. Mathematical models of message sources and electrical communication channels

Topic 7. Mathematical models and coding of message sources.

Topic 8. Classification of telecommunication channels. Deterministic and probabilistic channel models.

Topic 9.Mathematical models of discrete, discrete-continuous and continuous channels.

Topic 10. Channel input-output models. Transformation of random processes in communication channels. Influence of signals and interferences on linear and nonlinear links of communication channels.

Topic 11. Models of channel states. Representation of linear and nonlinear dynamic channels. Examples of determining the equations of state of stationary channels.

Content module 4. Fundamentals of information theory

Topic 12. Transmission of information on a discrete channel without interference. Information characteristics. Coding of discrete sources. Shannon's theorems on efficient coding in a discrete channel without interference.

Topic 13. Transmission of information on a discrete channel with interference. Information characteristics. Coding in a discrete channel with interference. Shannon's theorems on noise-protected coding in a discrete channel.

Topic 14. Transmission of information through a continuous channel. Information characteristics. Coding of a continuous source with a given quality criterion. Shannon's theorem on noise-protected coding in a continuous channel.

Content module 5. Methods and means of noise-tolerant coding of messages

Topic 15. Assignment and classification of codes. Codes are effective and noise-proof, block and continuous, separate and inseparable, systematic and non-systematic. Principles of noise-protected coding. Basic code parameters.

Topic 16. Linear binary block codes. Mathematical description of encoding and decoding processes. Generating and testing matrices. Features of systematic linear codes. Hamming codes. Structural and functional schemes of codecs.

Topic 17. Cyclic codes. Mathematical description of coding and decoding

processes by polynomial theory methods. Bose-Chowdhury-Hawkingham codes. Structural and functional schemes of codecs

Topic 18. Generalization of coding theory into non-binary codes. Reed-Solomon codes. Iterative and cascading codes. Interleaving.

Topic 19. Continuous (recurrent) codes. Fink-Hagelbarger chain code. Convolutional codes. Decoding in a symmetric channel without memory by the method of maximum likelihood. Viterbi algorithm. Perforated codes. Turbo codes. Structural and functional schemes of codecs.

Content module 6. Interference protection of modern telecommunication systems

Topic 20. Basic concepts of the theory of potential noise immunity. Statement of the problem of synthesis of optimal receivers of discrete messages. Criteria for optimal reception.

Topic 21. Optimal algorithms for coherent reception of known signals against the background of fluctuation noise such as white Gaussian noise. Block diagrams of optimal coherent receivers (quadratic receiver, correlation receiver and receiver with matched filters).

Topic 22.Optimal algorithms for receiving signals with random parameters (initial phases and amplitudes) against the background of interference such as white Gaussian noise. Block diagrams of optimal receivers.

Topic 23. Analysis of noise immunity of telecommunication systems with different types of modulation and methods of receiving discrete messages.

Topic 24. Optimal reception of continuous messages. Criteria of optimality. Algorithms of operation and schemes of receivers at estimation and filtering of parameters of a signal.

Content module 7. Principles of multichannel communication.

Topic 25. Methods of multichannel messaging. Fundamentals of signal separation theory. Bandwidth and noise immunity of multichannel telecommunication systems. Advantages and disadvantages, areas of application of different types of modulation in multichannel systems.

Content module 8. Efficiency of telecommunication systems.

Topic 26. Indicators of information, energy and frequency efficiency of telecommunication systems. Analysis of the efficiency of analog and digital telecommunication systems.

Topic 27. Principles of a systematic approach to research and development of telecommunication systems. Methods of optimization of telecommunication systems.

Learning outcomes of higher education

As a result of studying the discipline, students must:

KNOW: modern information technologies, quality of service in infocommunications, the concept of global information infrastructure.

BE ABLE TO: assemble an information system from ready-made components, support the

work of information systems and technologies, adapt applications to new requirements.

Assessment system according to each task for passing the test / exam

A written (combined) exam is used as a form of final control for the discipline. With this type of control, the final grade Pp is calculated by the formula: $Pp = 0,6 \times Q_{sem} + 0.4 \times Q_{isp}$, where Q_{sem} - grade for the semester in a 100-point system, Q_{isp} - grade for the exam in a 100-point system.

The ticket for the exam consists of 2 theoretical questions and a task.

Theoretical questions are evaluated at 40 points, and the task - at 20 points (in total - 100 points).

Part 1

Type of lesson / control measure																		
	Lb №1	**Lb №2**	**Lb №3**	**Lb №4**	**Lb №5**	**Pr№1**	**Pr №2**	Control testing 1	Control testing 1	Checkpoint 1	**Lb №6**	**Pr №3**	Control testing 2	Control testing 2	Checkpoint 2	**Pr №4**	**Pr №5**	Control testing 3	Control testing 3	Checkpoint 3
Weighting factor	**0,1**	**0,1**	**0,1**	**0,1**	**0,1**	**0,05**	**0,05**	**0,1**	**0,3**		**0,27**	**0,13**	**0,2**	**0,4**		**0,17**	**0,17**	**0,26**	**0,4**	

Part II

Type of lesson / control measure																	
	Lb №7	**Lb №8**	**Lb №9**	**Pr №6**	Control testing 4	Checkpoint 4	**Lb №10**	**Lb №11**	**Pr №7**	Control testing 5	Checkpoint 5	**Lb №12**	**Pr №8**	**Pr №9**	**Pr №10**	Control testing 6	Checkpoint 6
Weighting factor	**0,2**	**0,2**	**0,2**	**0,4**	**0,25**		**0,3**	**0,3**	**0,4**	**0,25**		**0,4**	**0,2**	**0.2**	**0,2**	**0,5**	

Qualitative evaluation criteria in the national scale and ECTS

Satisfactory, D, E (60-74). Show the required minimum of theoretical knowledge. Know the ways and methods of solving practical problems and be able to use them in practice.

Well, C (75-89). Firmly know a minimum of theoretical knowledge. Demonstrate the ability to solve a practical problem and justify all stages of the proposed solution.

Excellent, A, B (90-100). Show complete knowledge of basic and additional theoretical material. Unmistakably solve a practical problem, explain and justify the chosen method of solution.

Assessment scale: national and ECTS

The sum of points for all types of educational activities	ECTS assessment	Score on a national scale	
		for exam, course project (work), practice	for offset
90 – 100	**A**	perfectly	credited
82-89	**B**	fine	
74-81	**C**		
64-73	**D**	satisfactorily	
60-63	**E**		
35-59	**FX**	unsatisfactory with the possibility of reassembly	not credited with the possibility of re-assembly
0-34	**F**	unsatisfactory with mandatory re-examination	not credited with compulsory re-study of the discipline

Methodical support

Basic literature

1. Omelchenko V.O, Sannikov V.H. Teoriia elektrychnoho zviazku. Ch. 1, 2, 3. - K.: ISDO, 1994, 1995, 1997.
2. Ziuko A.H., Klovskyi D.D., Korzhyk V.Y., Nazarov M.V. Teoryia elektrycheskoi sviazy / Pod red. D.D.Klovskoho. - M.: Radyo y sviaz, 1999.
3. Klovskyi D.D., Shylkyn V.A. Teoryia elektrycheskoi sviazy: Sb. zadach y uprazhnenyi. - M.: Radyo y sviaz, 1990.

Supporting literature

1. Ziuko A.H., Klovskyi D.D., Nazarov M.V., Fynk L.M. Teoryia peredachy syhnalov. - M.: Radyo y sviaz, 1986.

2. Klovskyi D.D., Shylkyn V.A. Teoryia peredachy syhnalov v zadachakh. - M.: Sviaz, 1978.
3. Banket V.L., Dorofeev V.M. Tsyfrovye metody v sputnykovoi sviazy. - M.: Radyo y sviaz, 1988.
4. Prokys Dzh. Tsyfrovaia sviaz. - M.: Radyo y sviaz, 2000.
5. Feer K. Besprovodnaia tsyfrovaia sviaz. Metody moduliatsyy y rasshyrenyia spektra. - M.: Radyo y sviaz, 2000.

Methodical instructions for different types of classes

6. Robocha prohrama, kontrolni zavdannia ta metodychni vkazivky do samostiinoi roboty z dystsypliny "Teoriia elektrychnoho zviazku" dlia studentiv zaochnoi formy navchannia z napriamku "Telekomunikatsii" / Uporiad. Yu.M. Bidnyi, V.A. Zolotarov. Kharkiv: KhNURE, 2005.
7. Metodychni vkazivky do laboratornykh robit z dystsypliny "Teoriia elektrychnoho zviazku" (chastyna 1) dlia studentiv usikh form navchannia spetsialnostei napriamku "Telekomunikatsii" / Uporiad. V.M. Bezruk, Yu.M. Bidnyi, A.V.Omelchenko. - Kharkiv: KhNURE, 2004.
8. Metodychni vkazivky do laboratornykh robit z dystsypliny "Teoriia elektrychnoho zviazku" (chastyna 2) dlia studentiv usikh form navchannia spetsialnostei napriamku "Telekomunikatsii" / Uporiad. V.M. Bezruk, Yu.M. Bidnyi, A.V.Omelchenko, O.Iu. Miroshnychenko. - Kharkiv: KhNURE, 2004.
9. Metodychni vkazivky do praktychnykh zaniat z dystsypliny "Teoriia elektrychnoho zviazku" (Ch.1) dlia studentiv vsikh form navchannia spetsialnostei napriamku "Telekomunikatsii" / Uporiad.: I.M. Presniakov, Yu.M. Bidnyi, A.A. Astrakhantsev, O.V. Fedorov - Kharkiv: KhNURE, 2005.
10. Metodychni vkazivky do praktychnykh zaniat z dystsypliny "Teoriia elektry noho zviazku" (Ch.2) dlia studentiv vsikh form navchannia spetsialnostei napriamku "Telekomunikatsii" / Uporiad.: A.A. Astrakhantsev, Yu.M. Bidnyi, I.M. Presniakov. - Kharkiv: KhNURE, 2005.
11. Metodychni vkazivky do kursovoho proektuvannia z dystsypliny "Teoriia elektrychnoho zviazku" dlia studentiv usikh form navchannia spetsialnostei napriamku "Telekomunikatsii" / Uporiad. Yu.M. Bidnyi, V.A. Zolotarov, A.V.Omelchenko. - Kharkiv: KhNURE, 2004.

Information support

1. Microsoft Office 2000 / XP / 2003
2. A package of applied programs for laboratory work in the discipline "Telecommunication Theory", developed at the Department of "Communication Networks".