MINISTRY OF SCIENCE AND HIGHER EDUCATION OF THE RUSSIAN FEDERATION
FEDERAL STATE AUTONOMOUS EDUCATIONAL INSTITUTION OF HIGHER EDUCATION
"NORTH CAUCASUS FEDERAL UNIVERSITY"

SUGGESTIONS FOR TEACHING

on the organization and conduct of independent work in the discipline "Information Theory and Coding"
for students of the field of study
11.03.02 Infocommunication Technologies and Communication Systems
"Intelligent Data Processing in Infocommunication Systems and Networks"

Stavropol 2026

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INTRODUCTION

1. Purpose and objectives of mastering the discipline (module)

The purpose of mastering the discipline: the formation of students' general professional competencies in the field of transmitting and receiving information using telecommunication devices.

Objectives of mastering the discipline:

1) Systematization of fundamental knowledge in the theory of signals, in the theory of noise resistance and coding, in the principles of building monochannel communication systems, the formation of skills to correctly use the knowledge gained in practice.

2) Acquisition of skills in modeling the main types of signals used in telecommunication systems, the processes of modulation and demodulation, coding and decoding, in the use of methods and ways to increase noise immunity in analog and discrete communication channels.

2. The place of the discipline (module) in the structure of the educational program

The discipline "Information Theory and Coding" belongs to the compulsory disciplines of Block 1 of the Discipline (modules).

3. List of planned learning outcomes in the discipline (module), correlated with the planned results of the development of the educational program

Code, formulation of competence	Indicator code, wording	Planned learning outcomes in the discipline (module), characterizing the stages of the formation of competencies, indicators
OPK-4. Able to understand the principles of modern information technologies and use them to solve problems of professional activity	ID-1 $_{OPK-4}$ uses information and communication technologies when searching for the necessary information.	Uses information and communication technologies when searching for the necessary information.
	ID-3 $_{OPK-4}$ understands modern interactive software systems and basic methods of processing experimental data, including the use of standard software, general and special-purpose software packages.	Understands modern interactive software systems and basic methods of processing experimental data, including the use of standard software, general and special purpose software packages.
	ID-4 $_{OPK-4}$ uses the capabilities of computer technology and software to solve problems of control and algorithmization of information processing processes.	It uses the capabilities of computer technology and software to solve problems of control and algorithmization of information processing processes.

4. Volume of the academic discipline (module) and forms of control

Scope of classes: total: 5 EC 180 acad.h.	OFO, In acad. hours
Contact work:	32.00/0
Lectures/from them practical training	0
Laboratory work/from them practical training	0
Practical training/of which practical training	32.00/0
Independent work	148.00
Forms of control	
Exam	-
Credit	Yes
Credit with a grade	-
Course work	no

5. The content of the discipline (module), structured by topics (sections) with an indication of the number of hours and types of classes

№	Section (topic) of the discipline and summary	Emerging competencies, indicators	Full-time				Current Forms control Academic Performance
			Contact work of students with the teacher / of them in the form of practical training, hours			Independent work, hours	
			Lectures	Practical exercises	Practical work		
Semester 5							
1	**General information about telecommunication facilities.** Introduction to the theory of electrical communication. Information, messages, signals and interference. General principles of building communication systems. Interference and distortion in the communication channel. Characteristics of information transmission systems. Study of the characteristics of deterministic signals. Practical work 1. Study of the characteristics of signals essential for their transmission through communication channels	OPK-4 ID-1 $_{OPK-4}$ ID-3 $_{OPK-4}$ ID-4 $_{OPK-4}$		2.00		12.00	Interview
2	**Mathematical models of signals and interference.** Mathematical description of signals and interference. Frequency representation of signals. Mathematical representation of random signals and interference. Graphical and geometric representation of signals. Study of spectral analysis and synthesis of signals. Study of correlation characteristics of signals. Study of statistical characteristics of narrowband stochastic processes. Practical Work 2. Study of Signal Characteristics in Their Vector Representation	OPK-4 ID-1 $_{OPK-4}$ ID-3 $_{OPK-4}$ ID-4 $_{OPK-4}$		2.00		12.00	Interview
3	**Analytical and discrete signal representation.** Analytical representation of the signal. Discretization of signals in time. Study of Continuous Signal Sampling.	OPK-4 ID-1 $_{OPK-4}$ ID-3 $_{OPK-4}$ ID-4 $_{OPK-4}$		2.00		12.00	Interview

	Practical Work 3. Study of Discretization of Continuous Signals						
4	**Fundamentals of Modulation and Detection Theory** Amplitude modulation. Amplitude detection. Frequency and phase modulation. Phase and frequency detection. Study of amplitude modulation and detection of AM signals. Study of frequency-modulated radio signals. Practical work 4. Study of spectral analysis and synthesis of periodic signals	OPK-4 ID-1 $_{OPK-4}$ ID-3 $_{OPK-4}$ ID-4 $_{OPK-4}$		2.00		12.00	Interview
5	**Digital modulation (manipulation) and pulse modulation methods.** Digital modulation (manipulation). Pulse modulation methods. Study of signals with digital modulation (manipulation). Practical work 5. Study of spectral analysis and signal synthesis based on the Fourier transform	OPK-4 ID-1 $_{OPK-4}$ ID-3 $_{OPK-4}$ ID-4 $_{OPK-4}$		2.00		12.00	Interview
6	**Signal conversion in communication channels. Mathematical models of communication channels.** Transmission of signals through communication channels. Mathematical models of communication channels. Study of communication channel models. Study of the probabilistic characteristics of a discrete communication channel in the presence of additive fluctuation interference. Practical work 6. Investigation of the properties of the Fourier transform	OPK-4 ID-1 $_{OPK-4}$ ID-3 $_{OPK-4}$ ID-4 $_{OPK-4}$		2.00		12.00	Interview
7	**Fundamentals of the theory of noise immunity of message transmission systems.** Immunity of the discrete message transmission system: signal reception as a statistical problem, criteria for optimal signal reception, optimal reception of discrete signals, immunity for coherent reception of binary signals, incoherent reception of discrete signals. Immunity of the continuous message transmission system: optimal reception of continuous signals, optimal linear filtering of signals, potential immunity of continuous message transmission. Study of optimal signal reception. Study of potential noise immunity in coherent and incoherent reception. Practical Work 7. Study of Correlation Characteristics of Signals	OPK-4 ID-1 $_{OPK-4}$ ID-3 $_{OPK-4}$ ID-4 $_{OPK-4}$		2.00		12.00	Interview

8	**Fundamentals of the theory of information transfer.** Information characteristics of the message source. Discrete channel bandwidth. Discrete message compression methods. Continuous channel bandwidth. Study of the bandwidth of communication channels. Practical work 8. Study of amplitude modulation and detection of AM signals	OPK-4 ID-1 OPK-4 ID-3 OPK-4 ID-4 OPK-4		2.00		12.00	Interview
9	**Fundamentals of noise-resistant coding.** Introduction to Corrective Codes. Linear Block Codes. Hamming Codes. Cyclic Codes. Study of noise-resistant codes. Practical work 9. Study of frequency-modulated radio signals	OPK-4 ID-1 OPK-4 ID-3 OPK-4 ID-4 OPK-4		4.00		12.00	Interview
10	**Adaptive interference suppression devices.** Fundamentals of Adaptive Interference Suppression. Adaptive notch and high-pass filters. Adaptive prediction devices, tracking filters, and storage devices. Filter research. Practical work 10. Study of discrete signals and their characteristics	OPK-4 ID-1 OPK-4 ID-3 OPK-4 ID-4 OPK-4		4.00		12.00	Interview
11	**Methods of receiving signals in difficult conditions.** Reception of signals in channels with fading. Methods of combating signal fading. Methods of combating intersymbol interference. Reception of discrete messages in channels with spectrum-concentrated and impulse interference. Compensation of interference and distortion in the channel. Investigation of methods for receiving signals that increase the signal-to-noise ratio. Practical work 11. Research on broadband noise-like signals	OPK-4 ID-1 OPK-4 ID-3 OPK-4 ID-4 OPK-4		4.00		14.00	Interview
12	**Principles of multichannel communication and information distribution.** Methods of Common Channel Resource Allocation. Frequency Channel Separation. Time Channel Separation. Code Channel Separation. Study of the principles of multichannel communication. Practical work 12. Study of numerical characteristics and laws of probability distribution of stochastic processes	OPK-4 ID-1 OPK-4 ID-3 OPK-4 ID-4 OPK-4		4.00		14.00	Interview
	TOTAL for the 5th semester			32.00		148.00	6

	TOTAL			32.00		148.00	

1. GENERAL CHARACTERISTICS OF INDEPENDENT WORK

All types of independent work in the discipline "Information Theory and Coding" are given in the table "Technological map of independent work". The basis of students' independent work in the discipline is taking notes of lectures and recommended sources, preparing for computer testing of knowledge, drawing up and preparing for the defense of reports on laboratory work, performing multi-level individual tasks in the course of laboratory work. For each type of independent work, certain forms of reporting are provided, which students present to the teacher during practical classes or during individual consultation hours.

Table 1 - Technological map of independent work

Code of the assessed competency, indicators	The stage of competence formation (No topics) *(in accordance with the work program of the discipline)*	Assessment Tools and Technologies	Type of control, certification *(current/intermediate)*	Type of control *(oral, written or with the use of technical means)*	Name of the Valuation Tool
Semester 5					
OPK-4 ID-1 $_{OPK-4}$ ID-3 $_{OPK-4}$ ID-4 $_{OPK-4}$	Topics No 1–12	Interview, evaluation of answers to questions on these topics	Current	Oral	Interview Questions
OPK-4 ID-1 $_{OPK-4}$ ID-3 $_{OPK-4}$ ID-4 $_{OPK-4}$	Topics No 1–12	Testing with the help of computer-based test tasks	Current	with the use of technical means	computer-based test tasks

OPK-4 ID-1 OPK-4 ID-3 OPK-4 ID-4 OPK-4	Topics No 1–12	Interview, evaluation of answers to questions for the defense of laboratory works	Current	Written	Practical Paper Defense Interview Questions
OPK-4 ID-1 OPK-4 ID-3 OPK-4 ID-4 OPK-4	Topics No 1–12	Assessment of knowledge of exam questions	Intermediate	Oral	Questions for the exam

For the successful development of the discipline, it is necessary to perform the types of independent work indicated in Table 1, using the recommended sources of information.

List of basic literature:

1 Akulinichev Yu.P. Theory of Electrical Communication: Electronic Resource: Textbook / A.S. Berngardt / Yu.P. Akulinichev. - Tomsk: Tomsk State University of Control Systems and Radioelectronics, 2015. - 193 p. - The book is in the basic version of the EBS IPRbooks.

2 Akulinichev Yu.P. Theory of Electrical Communication. Laboratory Practicum Electronic Resource / Akulinichev Yu.P. - Moscow: TUSUR, 2012. - 123 p.

3 Akulinichev Yu.P. Teoriya elektricheskogo svyazi Elektronnyi resurs [Theory of Electrical Communication: Elektronnyi resurs] / Akulinichev Yu.P.: a manual for conducting practical classes and independent work of students. - Moscow: TUSUR, 2012. - 202 p.

4 Akulinichev Yu.P. Theory of Electrical Communication Elektronnyi resurs: uchebno-metodicheskoe posobie [Theory of Electrical Communication: Educational and Methodological Manual]. - Tomsk: Tomsk State University of Control Systems and Radioelectronics, 2015. - 124 p. - The book is in the basic version of the EBS IPRbooks.

5 Grigoriev V.A. Theory of Electrical Communication Elektronnyi resurs: Sbornik zadach [Theory of Electrical Communication: Elektronnyi resurs: Sbornik zadach [Theory of Electrical Communication]. St. Petersburg: ITMO University, 2012. - 78 p. - The book is in the premium version of EBS IPR BOOKS. - ISBN 2227-8397

6 Pashintsev V. P., Lyakhov A. V. General Theory of Communication: Textbook (Laboratory Practice) / Pashintsev V. P., Lyakhov A. V. – Stavropol: NCFU Publishing House, 2015. – 629 p.

List of additional literature:

1 Akulinichev Yu.P., Berngardt A.S. - Tomsk: Tomsk State University of Control Systems

and Radioelectronics, 2012. - 209 p.: ill., tabl., schemes. - http://biblioclub.ru/. - ISBN 978-5-4332-0035-7

2 Akulinichev Yu.P., Bernagrdt A.S. Theory and Technique of Information Transmission Elektronnyi resurs: Uchebnoe posobie [Theory and Technique of Information Transmission]. - Tomsk: Tomsk State University of Control Systems and Radioelectronics, El Content, 2012. - 210 p. - The book is in the premium version of EBS IPR BOOKS. - ISBN 978-5-4332-0035-7

3 Akulinichev Yu.P. General Theory of Communication Elektronnyi resurs: uchebnoe posobie [General Theory of Communication: Electronic Resource: Textbook]. - Tomsk: Tomsk State University of Management Systems and Radioelectronics, 2015. - 193 p. - The book is in the basic version of the EBS IPRbooks.

4 Bikkenin R.R. Theory of Electrical Communication: Textbook. Manual for Higher Educational Institutions / R. R. Bikkenin,

M. N. Chesnokov. - Moscow: Academy, 2010. - Grief: Rek. UMO. - Refs.: p. 323-324. - ISBN 978-5-7695-6510-6

5 Vasyukov V.N. General Theory of Communication Elektronnyi resurs [General Theory of Communication: Elektronnyi resurs] / Vasyukov V.N.: textbook. - Novosibirsk: NSTU, 2017. - 580 p. - ISBN 978-5-7782-3010-1

6 Veligosha A.V. General Theory of Communication: Textbook / A.V. Veligosha; Ministry of Education and Science of the Russian Federation; Federal State Autonomous Educational Institution of Higher Professional Education "North Caucasian Federal University". - Stavropol: NCFU, 2014. - 240 p.: ill. - http://biblioclub.ru/. - Bibliogr.: p. 231

The system of assessment of knowledge, skills, and abilities that characterize the stages of competence formation

Within the framework of the rating system established at the university, the performance of students in the discipline is assessed during current control and intermediate certification.

Current control is carried out at each training session, as well as during the established control points (CT), the time of which and the types of reporting on them are given in Table 2.

The test of readiness for practical work is carried out in the form of an interview at the beginning of each practical work.

Table 2.

No CT	**Type of reporting activity of students**	**Deadlines**	**Number of points**
1.	Defense of reports on practice. works No 1–4, in the course of the implementation of multi-level individual tasks is checked.	Practical work 9 Semester week 6	10
2.	Defense of reports on practice. works No 5–7, during which the implementation of multi-level individual tasks is checked. Completion of the 1st computer test.	Practical work 15 Semester Week 10	15
3.	Defense of reports on practice. works No 8–12, during which the implementation of multi-level individual tasks is checked. Interview and checking lecture notes based on the results of independent study of literature.	Practical work 21 Semester Week 15	15
4.	Defense of reports on practice. works No 13–16, during which the implementation of multi-level individual tasks is checked. Completion of the 2nd computer test.	Practical work 26 Semester Week 17	15
	Total		**55**

The maximum possible score for the entire current control is set at **55.** The current control measure is considered passed if the student received at least 60% of the maximum score established for this control. The rating score given to the student for the current control measure passed by the student within the time limits established by the schedule of control measures is determined as follows:

Level of execution of the control task	***Rating score (in % of the maximum score for the control task)***
Excellent	***100***
Good	***80***

Satisfactory	***60***
Unsatisfactory	***0***

Intermediate certification in the form of an exam provides for a mandatory examination procedure and is evaluated with 40 points out of 100. If the student's rating score in the discipline at the end of the semester is 60, then the program automatically adds 32 bonus points and gives an "excellent" grade.

A student's positive answer in the exam is evaluated by rating points in the range from **20** to **40** (**20** ≤ Sekz ≤ **40**), a score **less than 20** points is considered unsatisfactory.

The scale of correspondence of the rating score of the exam according to the 5-point system:

Rating score in the discipline	**Score on a 5-point system**
35 – 40	Excellent
28 – 34	Good
20 – 27	Satisfactory

The final grade in the discipline studied in one semester is determined by the sum of the points scored for the work during the semester and the points received when passing the exam:

Scale for converting the rating score for the discipline into a 5-point system:

Rating score in the discipline	***Score on a 5-point system***
88-100	*Excellent*
72-87	*Good*
53-71	*Satisfactory*
<53	*Unsatisfactory*

2. METHODICAL RECOMMENDATIONS FOR THE STUDY OF THEORETICAL MATERIAL

When studying the topics of lectures and the given literature on their own, students are recommended:

— on the day of the lesson, work out the educational material studied in the lesson according to the notes. At the same time, it is necessary to highlight the questions that should be paid more attention to in the further study of the current topic. After working through the educational material, it is necessary to answer the recommended control questions;

— In order to qualitatively consolidate the studied material in the future, it is necessary to work out the educational material in more detail using the recommended literature. Students are recommended to identify issues that require more detailed study with the help of the teacher;

— On the eve of the lecture, the student is recommended to consolidate the previously studied theoretical material, prepare questions that require clarification from the teacher.

Recommendations for the organization of work with literature

To master, consolidate and systematize knowledge, students are recommended to work independently with the recommended literature and lecture notes. When working independently with the recommended literature, students are recommended to take notes of the educational material set forth in the recommended sources.

Taking notes of sources is carried out during a detailed study of the topic, while students are recommended:

— supplement the lecture notes by expanding it on the most important issues considered in the lesson. Taking notes of sources consists in supplementing the notes with the following provisions:

— basic definitions and their physical meaning;

— basic mathematical relations with the disclosure of their physical meaning;

— conclusions on educational issues, the topic of the classes studied.

Control of this type of independent work is carried out in training classes by checking lecture notes and interviews by the teacher.

When taking notes of sources, students should proceed from a rational volume, the material being summarized. The synopsis should be brief and understandable when used after studying the current topic.

When taking notes of sources, it is recommended to highlight individual figures, their most important fragments, and the most important formulas in color. When taking notes in class, it is recommended to fill in two-thirds of the page of the notebook sheet vertically, and use the free part when supplementing the notes on the issue under study.

For the successful development of the discipline, it is necessary to independently study the presented topics in detail according to the recommended sources of information.

Synopsis of sources is evaluated as satisfactory and unsatisfactory. Work on summarizing sources is evaluated satisfactorily if:

— the synopsis has a sufficient amount of detail on the topic being studied, providing a given level of mastering the theoretical material of the discipline;

— The synopsis is neatly drawn up, the studied material is presented sequentially in accordance with the order of studying the discipline, contains generalizing conclusions on each topic.

Work on taking notes of sources is assessed unsatisfactorily if the requirements for a satisfactory assessment are not met.

3. GUIDELINES FOR LABORATORY WORK

When performing a workshop on the discipline (practical work) to achieve a basic level of competence formation, the student must be able to apply basic knowledge in the sections of the discipline, have the skills to independently solve educational problems of the basic level.

When performing a workshop on the discipline (practical work), in order to achieve an increased level of competence formation, the student must be able to apply higher knowledge in the sections of the discipline, possess the skills of independent solution of educational tasks of an advanced level.

Methodical instructions for preparing for practical work

Preparation for practical work is recommended to be carried out in the following sequence:

— to understand the topic and purpose of the upcoming practical work;

— study theoretical material in accordance with the topic of practical work (it is recommended to use recommended literature, lecture notes, textbook (workshop on laboratory work);

— get acquainted with the equipment and materials used in practical work (when using specialized equipment or software, it is necessary to study the procedure and rules for its use).

Methodical instructions for practical work

When performing practical work, students must strictly comply with the established safety requirements.

When performing practical work, students are recommended:

— to understand the purpose of the tasks performed and ways to solve them;

— to perform the tasks specified in the practical work in the sequence in which they are indicated in the laboratory workshop;

— use the help of a teacher when performing a practical task and studying theoretical material;

— draw up a report on practical work;

— answer control questions.

Methodical instructions for preparing for the defense of practical work

When preparing for the defense of practical work, students are recommended:

— prepare a report on practical work;

— prepare a justification for the conclusions made;

— consolidate knowledge of theoretical material on the topic of practical work (it is recommended to use control questions);

— know the procedure for making calculations (conducting research);

— be able to show and explain the order of research when using specialized equipment or software.

The defense of practical work is carried out by interviewing the student with the teacher. During the interview, the student submits a report on practical work for verification. An interview with a student applying for an "excellent" grade is conducted on questions and practical tasks of an advanced level of study. An interview with a student who does not apply for an "excellent" grade is conducted on questions and practical tasks of the basic level of study.

4. INTERVIEW QUESTIONS FOR INDEPENDENT STUDY OF LITERATURE

Basic level:

Topic 1. General information on telecommunication facilities.

1) Information, messages, signals and interference.
2) General principles of building communication systems.
3) Characteristics of information transmission

systems. Topic 2. Mathematical models of signals and interference.

4) Mathematical description of signals and interference.
5) Frequency form of signal representation.

Topic 3. Analytical and discrete representation of signals.

6) Analytical representation of the signal.

Topic 4. Fundamentals of the theory of modulation and detection.

7) Amplitude modulation.
8) Amplitude detection.

Topic 5. Digital modulation (manipulation) and pulse modulation methods.

9) Pulse modulation methods.

conne ctions . Topic 6. Signal conversion in communication channels. Mathematical models of channels

10) The passage of signals through communication channels.

Topic 7. Fundamentals of the theory of noise immunity of message transmission systems.

11) Noise immunity of the discrete message transmission system: signal reception as a statistical problem, criteria for optimal reception of signals, optimal reception of discrete signals, noise immunity in coherent reception of binary signals, incoherent reception of discrete signals.

Topic 8. Fundamentals of the theory of information transfer.

12) Information characteristics of the message source.
13) Bandwidth of a discrete channel. Topic 9.

Fundamentals of noise-resistant coding.

14) Introduction to Corrective Codes.
15) Linear block codes.

Topic 10. Adaptive interference suppression devices.

16) Basics of adaptive interference rejection.
17) Adaptive notch and high-pass filters. Topic 11. Methods of

signal reception in difficult conditions.

18) Receiving signals in fading channels.
19) Methods of combating signal fading.
20) Methods of combating intersymbol interference.

Topic 12. Principles of multi-channel communication and information distribution.

21) Methods for allocating a shared channel resource.
22) Frequency separation of channels.

Advanced Level:

Topic 1. General information on telecommunication facilities.

23) Interference and distortion in the communication channel.

Topic 2. Mathematical models of signals and interference.

24) Mathematical representation of random signals and interference.
25) Graphical and geometric representation of signals. Topic 3.

Analytical and discrete representation of signals.

26) Discretization of signals in time.

Topic 4. Fundamentals of the theory of modulation and detection.

27) Frequency and phase modulation.

28) Phase and frequency detection.

Topic 5. Digital modulation (manipulation) and pulse modulation methods.

29) Pulse modulation methods.

Topic 6. Signal conversion in communication channels. Mathematical models of channels conne
ctions 30) Mathematical models of communication channels.
. Topic 7. Fundamentals of the theory of noise immunity of message transmission systems.

31) Noise immunity of the continuous message transmission system: optimal reception of continuous signals, optimal linear filtering of signals, potential noise immunity of continuous message transmission.

Topic 8. Fundamentals of the theory of information transfer.

32) Discrete message compression methods.

33) Continuous channel capacity. Topic 9.

Fundamentals of noise-resistant coding.

34) Hamming codes.

35) Cyclic codes.

Topic 10. Adaptive interference suppression devices.

36) Adaptive Prediction Devices, Tracking Filters and Storage Devices. Topic

11. Methods of Receiving Signals in Difficult Conditions.

37) Reception of discrete messages in channels with spectrum-concentrated and intrusive interference.

38) Compensates for interference and distortion in the channel.

Topic 12. Principles of multi-channel communication and information distribution.

39) Temporary separation of channels.

40) Code channel separation.

Criteria for assessing competencies:

The grade "excellent" is given to the student if the student gave a complete, detailed answer to the question, while the totality of conscious knowledge on the topic of discipline is shown, the main provisions of the question are demonstratively revealed; the answer traces a clear structure, a logical sequence that reflects the essence of the concepts disclosed. The answer is presented in literary language using technical terminology. There may be shortcomings in the definition of concepts, corrected by the student independently in the process of answering. The situational problem on the topic is solved correctly.

A grade of "good" is given to a student if the student gave a complete, detailed answer to the question, while the ability to distinguish essential and insignificant features, cause-and-effect relationships is shown. The answer is clearly structured, logical, presented in literary language using technical terminology. 2-3 inaccuracies or minor mistakes may be made, corrected by the student with the help of the teacher. The situational task on the topic is solved correctly, but no more than one mistake was made when solving it.

The grade "satisfactory" is given to the student if the student gave an incomplete and insufficiently detailed answer. The logic and sequence of presentation have violations. Mistakes were made in the disclosure of concepts, the use of terms. The student is not able to independently distinguish essential and insignificant features and cause-and-effect relationships. There are no conclusions in the answer. The ability to reveal the meaning of generalized knowledge is not shown. Speech design requires correction. The situational task on the topic is solved correctly, but no more than two mistakes were made when solving it.

The grade "unsatisfactory" is given to the student if the answer is scattered knowledge with significant errors on the question. There are fragments, illogical presentation. The student is not aware of the connection of the discussed issue with others

questions of the topic. There are no conclusions, concretization and evidence of the presentation. Speech is illiterate, terminology is not used. Additional and clarifying questions of the teacher do not lead to correction of the student's answer, or the answer to the question is completely absent or the student refused to answer. The situational task on the topic is solved incorrectly.

Description of the grading scale

The grade for answering questions during the interview is determined in accordance with the table Lyceum.

Evaluation	Grade for a basic theoretical question	Grade for a theoretical question of an advanced level	Note
Excellent	Excellent (good)	Excellent	Assessment is well allowed Basic Level Only
Good	Good (satisfied)	Good	Grade satisfactory allowed only on the basis of basic level questions
satisfactory	Satisfactory	Satisfactory	
Unsatisfactory	One or two questions are rated unsatisfactory		

According to the rating system, the current control activity is considered passed if the student received at least 60% of the maximum score established for this control. The rating score given to the student for the current control measure passed by the student within the deadlines established by the schedule of control activities is determined as follows:

Level of completion of the control task	Rating score (in % of the maximum score for the control task)
Excellent	**100**
Good	**80**
Satisfactory	**60**
Unsatisfactory	**0**

Methodological materials that determine the procedures for assessing knowledge, skills, and (or) experience of activity, characterizing the stages of competence formation

The procedure for conducting this assessment includes an interview on two theoretical questions from among the listed. One question belongs to the basic level, and the second to the advanced level. During the interview, the student has the right to use his own notes.

The questions offered to the student allow you to check the general professional competencies of OPK-4. The fundamental differences between the tasks of the basic level and the advanced level lie in the complexity of the questions on the level of learning "understanding".

To prepare for this assessment event, 18 hours of the semester are required *(approximately 1.5 hours for each topic*). The student must prepare written answers to the listed theoretical questions in the form of a summary of the educational material and, on their basis, prepare for the questions indicated in the methodological materials for discussion.

When checking the task, active participation in the work is assessed; confident command of the material; ability to clearly and logically express one's thoughts; ability to creatively approach the solution of the main issues of the topic; independence of thinking, full compliance of the synopsis with the established requirements; independent oral speech, fully revealing the essence of the problem of the meeting.

Scorecard

No p/n	Surname, first name of the student.	Type of work						Conclusion
		Work with additional sources KAMI information	Answers to intermediate questions	Logic and scientific presentation	Formulation of conclusions and evidence	Presentation of the results of the work	Participation in discussion, ability to conduct a dialogue	
1								
2								
…								

5. COMPUTER-BASED TESTS FOR SELF-TESTING, PREPARATION FOR TESTING

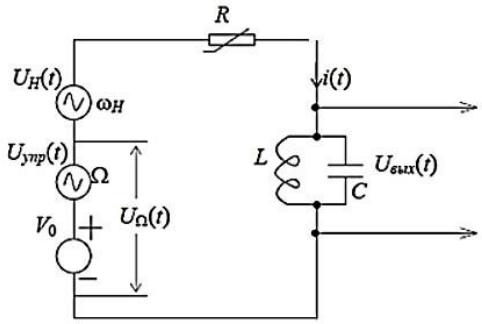
Test tasks are formed in the form of two tests in the Iren program of 100 tasks each. A total of 200 test tasks of different levels: for choosing an answer; for entering an answer; for compliance; for classification.

Examples of basic level test tasks: a) a test task for a choice of answers:

Первичные электрические сигналы это ...

- сигналы, возникающие в результате непосредственного преобразования сообщения в электромагнитное колебание с меняющейся скоростью их изменения
- сигналы, возникающие в результате непосредственного преобразования сообщения в электромагнитное колебание с относительно малой скоростью их изменения
- сигналы, возникающие в результате непосредственного преобразования сообщения в электромагнитное колебание с относительно высокой скоростью их изменения
- сигналы, возникающие в результате непосредственного преобразования сообщения в электромагнитное колебание со средней скоростью их изменения

На рисунке представлена схема



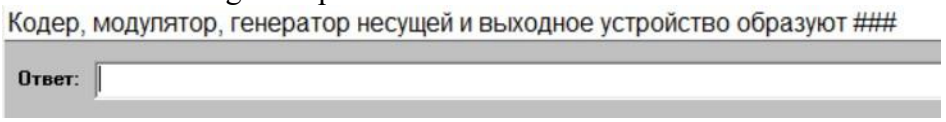
- амплитудного детектора на нелинейном элементе
- амплитудного модулятора на линейном элементе с переменными параметрами
- амплитудного модулятора на нелинейном элементе
- амплитудного детектора на линейном элементе с переменными параметрами

b) a test task for a simple match:

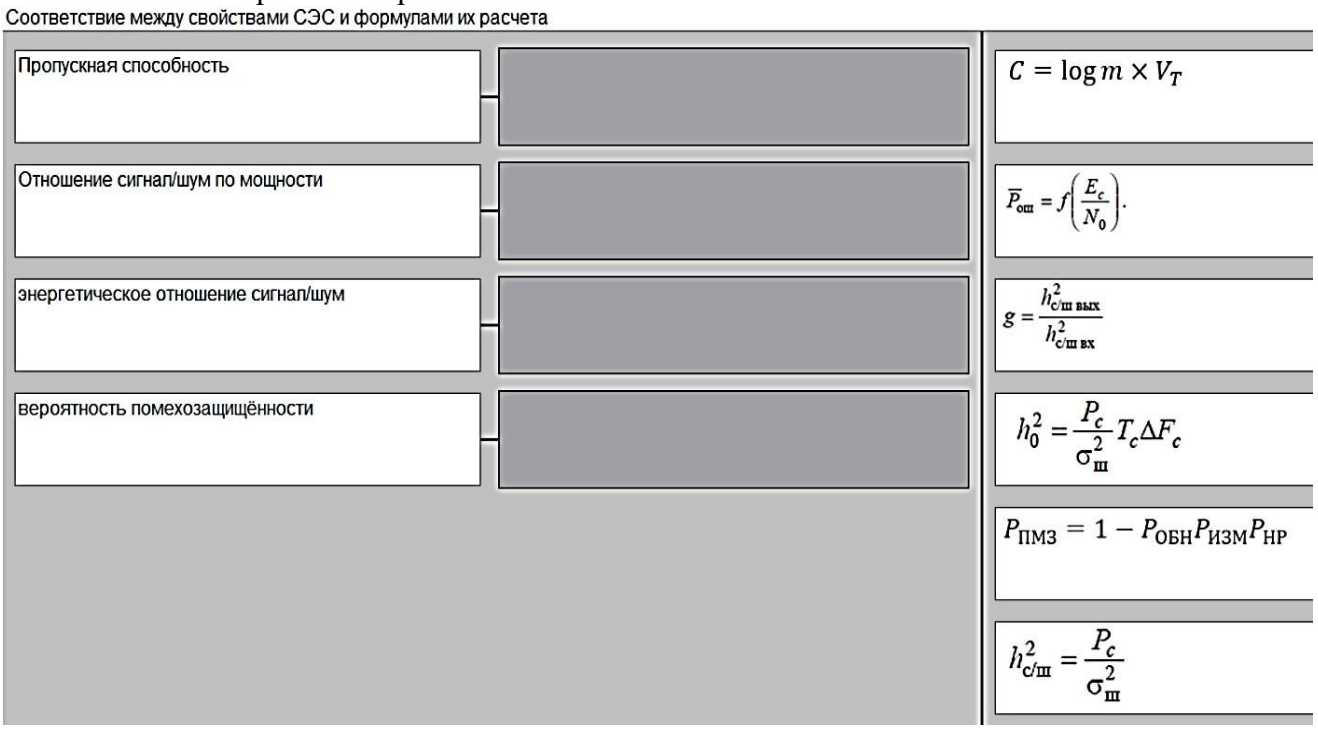
Соответсвие между элементами системы связи и их функциями

Источник информации		изменяет один из параметров переносчика в соответствие с информационным сигналом
Кодер		преобразует высокочастотный сигнал в низкочастотный сигнал, расширяя его спектр
Генератор несущий		кодирует первичный сигнал в сигнал-переносчик
Модулятор		формирует первичный электрический сигнал, преобразует аналоговый сигнал в дискретный
Выходное устройство		формирует электрический сигнал-переносчик
		усиливает сигнал, ограничивая спектр сигнала до полосы частот системы связи
		формирует вторичный сигнал из передаваемого сообщения

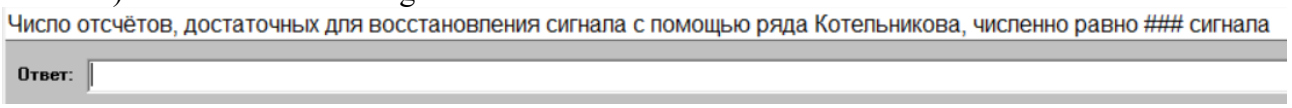
c) a test task for entering a simple answer:



Examples of test tasks of an advanced level: a) test task for complex correspondence:



b) a test task for entering an answer with the calculation of the answer:



c) test task for classification (compliance):

Description of the Computer-Based Testing Assessment Scale

One test task of the basic level is evaluated as 1 point, and one test task of the advanced level is evaluated as 2 points. The "Iren" program randomly selects the number of test tasks specified by the teacher (as a rule, 15-20 tasks).

The total number of points for the test is determined by the formula:

$$K = \frac{mb + 2 \cdot mp}{n_b + 2 \cdot n_P} \cdot 100\% \text{ with } n + n_b = \nu_P = n$$

where MB is the number of correct answers to the test tasks of the basic level, MP is the number of correct answers to the test tasks of the advanced level, NB is the number of given test tasks of the basic level, n is the number of given test tasks of the advanced level, N is the total number of test tasks.

The current control activity is considered passed if the student received at least 53% of the maximum score established for this control. The rating score given to the student for the current control measure passed by the student within the time limits established by the schedule of control measures is determined as follows:

Level of execution of the control task	**Rating score (in % of the maximum score for the control task)**
Excellent	**not less than 88**
Good	**from 72 to 87**
Satisfactory	**from 53 to 71**
Unsatisfactory	**less than 53**

Methodical materials that determine the procedures for assessing knowledge, skills, and (or) work experience that characterize the stages of competence formation The procedure for conducting this assessment activity includes computer testing using the test program "Iren". This program randomly selects from the general list of tasks the number of tasks specified by the teacher on each topic of disciplina. As a rule, one test contains 15-20 test tasks. 1-2 minutes are provided.

Basic level test questions include questions with a choice of answers, questions with

the house of answer and simple questions for establishing compliance. Advanced test questions include complex questions for establishing compliance, tasks with calculation and input of answer, questions for classification and ordering of actions (operations).

The questions offered to the student allow you to check the general professional competencies of OPK-1, OPK-2, OPK-3.

To prepare for this assessment activity, 18 hours per semester are required *(9 hours for each test*).

The student must prepare for computer testing by mastering the tests and conducting self-testing. Self-testing is carried out using exe files with training test tasks given to students at the beginning of the semester of study.

Scorecard

No p/n	Surname, first name of the student.	Number of test tasks	Number of correct answers	Scored points	Total score
1					
2					
…					

6. LAB INTERVIEW QUESTIONS

Basic level

Practical work 1. Study of the characteristics of signals essential for their transmission through communication channels

1) What characteristics of signals are essential for their transmission over communication cables?
2) What energy characteristics of signals are studied in the course of practical work?
3) How to determine the signal strength?
4) How to determine the signal energy?
5) How do you determine instantaneous signal strength?
6) How do you determine the average signal strength if the signal energy is infinite?
7) How do you determine the RMS (effective) value of a signal?
8) What is Effective Signal Duration?
9) How do I determine the effective signal duration?
10) How to determine the amplitude spectrum of a signal?
11) What is the methodology for performing an individual task?
12) What conclusions can be drawn from the results of the implementation of an individual task? ?

Practical Work 2. Study of the characteristics of signals in their vector pre-Establishment

13) How to determine the norm of a real signal?
14) How to determine the norm of a complex signal?
15) What does the square of the signal norm coincide with?
16) How to determine the distance between signals?
17) How to determine the energy of the sum of two signals?
18) How to determine the mutual energy of two signals?
19) What is the methodology for performing an individual task?
20) What conclusions can be drawn from the results of the implementation of an individual task? ?

Practical Work 3. Study of Discretization of Continuous Signals

21) What signal is called analog?
22) What is the purpose of sampling analog signals?
23) What signal is called discrete?
24) How is V. A. Kotelnikov's theorem formulated?
25) How to restore the original analog signal from a set of its discrete tov?
26) How is the Kotelnikov basis formed?
27) Write down the expression for the kth basis function of Kotelnikov.
28) What is the Applied Significance of V. A. Kotelnikov's Theorem for Electrical conne ctions ?
29) What is the Kotelnikov Analog Sample Rate?
30) How to determine the upper limit frequency of the signal spectrum?
31) What is the methodology for performing an individual task?
32) What conclusions can be drawn from the results of the implementation of an individual task?

Practical work 4. Study of spectral analysis and synthesis of periodic ?

signals

33) What signal is called a periodic signal?
34) What is the main idea of spectral analysis of periodic signals?
35) What is the Periodic Signal Spectrum?

36) What requirements must a periodic time function s(t) meet in order to be subjected to a Fourier spectral analysis?

37) What is the Periodic Signal Period?

38) What is the fundamental frequency of a periodic signal?

39) What does the Fourier series notation for periodic signals s(t) look like in the time interval $-\infty \le t \le \infty$ (sinus-cosine, real and complex form)?

40) What is the amplitude spectrum of a periodic signal?

41) What is the amplitude spectral diagram of a periodic signal?

42) What is the phase spectrum of a periodic signal?

43) What is a phase spectral diagram of a periodic signal?

44) What is harmonica?

45) What are the main properties of periodic signal spectral diagrams?

46) What is called the power spectrum of a periodic signal?

47) What parameters of the Gibbs effect of the signal have been studied in practice?

bote?

48) What is the methodology for performing an individual task?

49) What conclusions can be drawn from the results of the implementation of an individual task?

In

Practical Work 5. Study of Correlation Characteristics of Signals

50) What is the correlation function of a signal?

this 51) What is the physical meaning of the correlation function of a signal?

52) What are the properties of the correlation function of the signal?

53) How is the correlation function of a periodic signal calculated?

case, 54) What are the properties of the correlation function of a periodic signal?

55) How to determine the mutual correlation function of two signals?

56) What are the properties of the mutual correlation function of two signals?

the 57) What does a correlator circuit look like? How does it work?

58) Why is it impossible to reconstruct the original signal using the correlation function?

Practical work 6. Study of amplitude modulation and detection of AM-

Moth

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God

will

be

able

to use

the T

signals

59) What modulation is called amplitude?

60) What does the form of recording an amplitude-modulated signal look like?

61) In what ratio are the frequencies of carrier and modulating oscillations usually located between each other?

62) What does the form of writing an amplitude-modulated sig-
nala?

63) What parameters are used to characterize the depth of amplitude modulation? When is the modulating signal a harmonic oscillation?

64) What is the cause of the message distortions observed in remodulation?

65) What is the spectral composition of an AM signal when the modulating signal is a harmonic oscillation?

66) In what range does the average power of an AM signal change during a period of high frequency?

67) How do I determine the peak power value for an AM signal in tone modulation?

68) What are the components of the instantaneous power of an AM signal in a tone module-
?

69) How to determine the average power of an AM signal in tone modulation?

70) How to calculate the power fraction of lateral frequencies in units of power of the carrier part
AM signal in tone modulation?

71) What determines the power distribution in the AM signal spectrum during tone modeling?

72) How to determine the efficiency of amplitude modulation?
73) What does the amplitude (phase) spectrum of an AM signal look like in tone modulation?
74) What is the spectrum width of an AM signal in tone modulation?
75) How is the correlation function of an AM signal calculated in tone modulation?
76) What is the total energy of an AM signal in multitone modulation?
77) What is the idea behind AM signal detection?
78) How is the AM signal spectrum transformed when it is demodulated?
79) What are the ways to demodulate AM signals?
80) What conclusions can be drawn from the results of the implementation of an individual task?
?

Practical work 7. Study of frequency-modulated radio signals

81) What modulation is called frequency modulation?
82) How many kHz (MHz) is 9 · 108 Hz?
83) What does the FM recording form look like?
84) How to determine the frequency deviation of an FM signal?
85) How do I determine the angular modulation index of an FM signal?
86) What parameters are used to characterize FM when the modulating signal
is a harmonic oscillation?
87) What is the spectral composition of an FM signal when the modulating signal is a
harmonic oscillation?
88) How to determine the average power of an FM signal in tone modulation?
89) What determines the power distribution in the FM signal spectrum during tone
modeling?
90) What does the amplitude spectrum of an FM signal look like in tone modulation?
91) What is the width of the FM signal spectrum in tone modulation?
92) What conclusions can be drawn from the results of the implementation of an individual task?
?

Practical work 8. Study of discrete signals and their characteristics

93) What is the purpose of practical work?
94) What is the content of the practical work program?
95) What is the scope of application of discrete signals in modern electrical systems?
connection?
96) What signal is called a meander? What are the features of its amplitude speck?
tra?
97) What are the parameters of the meander as a modulating signal?
98) What is telegraph speed? In what units is it measured?
99) What is the frequency of manipulation? In what units is it measured?
100) What is the scope of AT signals?
101) What does the amplitude spectrum of an AT signal look like?
102) What is the scope of PT signals?
103) What does the amplitude spectrum of a PT signal look like?
104) What is the scope of PT signals?
105) What does the amplitude spectrum of an FT signal look like?
106) What are the advantages and disadvantages of TF signals?
107) What Mathcad functions are used in practical work?
108) What conclusions can be drawn from the results of the individual
Denma
rk? Practical work 9. Study of the relationship between correlation characteristics and

Random Signal Energy Spectrum

109) What is the purpose of practical work?
110) What is the content of the practical work program?
111) What is a random process?

112) What stochastic processes are called stationary processes with continuous (discrete) time?

113) How is the Wiener-Khinchin theorem mathematically written and formulated for a stationary continuous-time random process?

114) How is the Wiener-Khinchin theorem mathematically written and formulated for a stationary random process with discrete time?

115) What is the dimension of the correlation function and the energy spectrum of the incident process?

116) How is the Wiener-Khinchin theorem mathematically written in trigonometric form?

117) How to determine the normalized energy spectrum (correlation function) of a random process?

118) What Mathcad functions are used in practical work?

119) What conclusions can be drawn from the results of the individual Denmark?

Practical work 10. Study of the statistical characteristics of narrowband of random processes

120) What is the purpose of practical work?

121) What is the content of the practical work program?

122) What random process is called narrowband?

123) What law describes the one-dimensional density of the probability distribution of the envelope of a narrow-band random process?

124) How is the law that describes the one-dimensional probability distribution density of the envelope of a narrow-band random process?

125) What law describes the one-dimensional density of the probability distribution of the initial phase of a narrow-band random process?

126) How is the law that describes the one-dimensional probability distribution density of the initial phase of a narrowband random process?

127) What is the dimensionality of the correlation function and the energy spectrum of a narrow-band random process?

128) How does the graph of the one-dimensional density of the envelope probability distribution depend on the standard deviation of a narrow-band process?

129) How is the average value of the envelope of a narrow-band random process expressed in terms of the standard deviation of this process?

130) How is the dispersion of the envelope of a narrow-band random process expressed through the standard deviation of this process?

131) How to determine the width of the energy spectrum of a narrowband random process?

132) How to determine the correlation interval of a narrowband random process?

133) What Mathcad functions are used in practical work?

134) What conclusions can be drawn from the results of the individual Denmark?

Practical Work 11. Study of the Probabilistic Characteristics of Discrete Quality in the presence of additive fluctuation interference

135) What is the purpose of practical work?

136) What is the content of the practical work program?

137) What does a generalized structural diagram of an electrical communication system look like?

138) What is the place of the discrete communication channel in the generalized structural diagram of the electrical communication system?

139) What transformations do information signals undergo in the generalized structural diagram of an electrical communication system?

140) According to what law is the one-dimensional probability density of additive fluctuation interference ξ(t) distributed in a discrete communication channel? How is this law mathematically written?

141) What is the mathematical model of the signal coming to the input of the demodulator of a discrete communication channel?

142) What is the purpose and algorithm of the "First Decisive Circuit" element in a discrete communication channel?

143) What Mathcad functions are used in practical work?

144) What conclusions can be drawn from the results of the individual Denmark?

Practical work 12. Study of signal reception that increases the ratio of Signal/Noise

145) What is the purpose of practical work?

146) What is the content of the practical work program?

147) What is the signal-to-noise ratio?

148) What does a single-count scheme look like and work?

149) What is the principle of the accumulation method?

150) What is the principle of the method of integral reception?

Practical work 13. Study of correlation reception of signals

151) What is the purpose of practical work?

152) What is the content of the practical work program?

153) What does the structural diagram of a correlation receiver look like?

154) What is the place of the discrete communication channel in the generalized structural diagram of the electrical communication system?

155) What are the transformations of the signals and interference in the correlation receiver?

156) What Mathcad functions are used in practice?

157) What conclusions can be drawn from the results of the individual Denma rk? Practical work 14. Study of optimal signal reception

158) What is the purpose of practical work?

159) What is the content of the practical work program?

160) What does the generalized structural diagram of the optimal receiver look like? Lyzed on correlators?

161) How is the one-dimensional probability density of the interference probability ξ(t) written in the synthesis of an optimal receiver?

162) What is the rule of operation of the optimal receiver studied in practical work?

163) What does a generalized structural diagram of an optimal receiver look like, based on matched filters?

164) Which filter is called consistent?

165) What Mathcad functions are used in practical work?

166) What conclusions can be drawn from the results of the individual Denmark?

Practical Work 15. Study of the potential noise immunity at co-rental reception

167) What is the purpose of practical work?

168) What is the content of the practical work program?

169) How is the formula to calculate the lowest possible probability of optimal receiver error under white noise conditions?

170) What is the probability function (Laplace function) or the so-called probability integral?

171) What Mathcad functions are used in practical work?

Practical Work 16. Investigation of Potential Noise Immunity in Incoherent Reception

172) What is the purpose of practical work?

173) What is the content of the practical work program?

174) What Mathcad functions are used in practical work?

175) What conclusions can be drawn from the results of the individual Denma
rk? Practical work 17. Study of noise immunity in a fading channel

176) What is the purpose of practical work?

177) What is the content of the practical work program?

178) For what reasons most of the real communication channels are channels? with signal fading?

179) Which communication channel is called the fading communication channel?

180) What is the general mechanism of multipath in the propagation of radio waves?

181) What is diffuse multipath propagation?

182) What is discrete multipath propagation?

183) Continue the phrase "Fading of received signals can be considered like...".

184) How are fades classified?

185) What is the meaning of the term "general fading"?

186) Which expression describes the complete probability of an error in a communication channel with general fading?

187) What conditions must a communication channel meet in order to be called a communication channel with Rayleigh fading?

188) How is the formula for calculating the probability of error in coherent reception in a communication channel with fast relay-type interference fading recorded?

189) How is the formula for calculating the potential noise immunity of coherent reception of AT signals in the communication channel with Relay fading recorded?

190) How is the formula for calculating the potential noise immunity of coherent reception of PT signals in the communication channel with Rayleigh fading recorded?

191) How is the formula for calculating the potential noise immunity of coherent reception of FT signals in the communication channel with Rayleigh fading recorded?

192) How is the formula for calculating the potential noise immunity of coherent reception of oft signals in the communication channel with Relay fading recorded?

193) How is the formula for calculating the potential noise immunity of incoherent reception of AT signals in the communication channel with Relay fades recorded?

194) How is the formula for calculating the potential noise immunity of incoherent reception of CT signals in the communication channel with Relay fading recorded?

195) How is the formula that allows calculating the potential noise immunity of incoherent reception of UFT signals in the communication channel with Relay fades recorded?

196) What Mathcad functions are used in practical work?

197) What conclusions can be drawn from the results of the individual Denmark?

Increased level

Practical work 1. Study of the characteristics of signals essential for their transmission through communication channels

1) Write down the forward integral Fourier transform for the s(t) signal.
2) What is Effective Spectrum Width?
3) How do you determine the upper effective cut-off frequency of a signal spectrum?
4) How do you determine the effective spectrum width of a signal?
5) How does changing the duration of the signal (effective duration of the sign) affect the effective width of its spectrum?

Practical work 2. Study of the characteristics of signals in their vector representation

6) How to check the correctness of the determination of the energy of the sum of two signals in the figure

1.7?

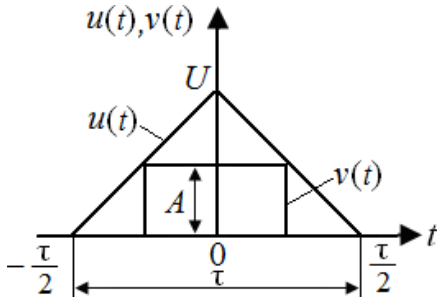
7) How do you determine the dot product of two signals?
8) How to determine the cosine of the angle between signals?
9) What is the energy and pulse rate of a cosine shape:

$$s(t) = \begin{cases} 0, & \omega 0t < -\pi/2 ; \\ \text{Um} \cos \omega_{0t}, & -\pi/2 ; < \omega_{0t} < \pi/2 \\ 0, & \omega 0t > \pi/2 . \end{cases}$$

10) How should the height of a square pulse A and the amplitude correlate?

U sine wave segment (example 2) so that a minimum distance is reached between the signals s1(t) and s2(t)?

11) The u(t) signal is a symmetrical triangular pulse with a height of U and a duration of τ. The signal v(t) is a rectangular pulse of a high A shape inscribed in the u(t) signal (see figure). What should be the amplitude of the square pulse in order for the distance between these two signals to be minimal?



Time diagrams of u(t) and v(t) signals

Practical Work 3. Study of Discretization of Continuous Signals

12) How is the Kotelnikov series written if the function with a limited spectrum x(t) to be sampled is given on a finite time interval t?
13) How to determine the finite number of discrete samples if the function with a limited spectrum x(t) to be sampled is given on a finite time interval t?
14) What is called a signal baseline? What was the base of the signal examined during the individual task?
15) What is the reason for the error of signal recovery based on the set of its discrete samples?
16) How to reduce the error of signal recovery based on a set of its discrete OT accounts?
17) How to determine the relative root mean square error σ2 of the restorative $_s$ From the set of its discrete samples?
18) Calculate the sample period of the signals:

$$s_1(t) = \frac{\sin \omega_{0t}}{\omega 0t}, \qquad s_2(t) = \cos \omega_0 t.$$

How many samples are needed to discretize these signals?

19) What can the hardware implementation of the synthesis of the signal presented by Kotelnikov's row look like?

Practical Work 4. Study of Spectral Analysis and Synthesis of Periodic Signals

20) What are the basic functions of the sinus-cosine form of the Fourier series?

21) How do you determine the constant component of the Fourier spectrum of a periodic sign? What is the meaning of this parameter?

22) How to determine the kth coefficient of the "cosine" ("sinus") component of the Fourier spectrum of a periodic signal?

23) What conclusions can be drawn from the comparison of the real to the sinus-cosine form of the Fourier series?

24) Continue the phrase: "If the signal s(t) being analyzed is real, then..."

25) Continue the phrase: "When there is a need to approximate periodi- function by a trigonometric polynomial, then the smallest square deviation is obtained if...".

26) How is Parseval's equality formulated?

27) What is the reason for the Gibbs effect in the spectral synthesis of periodic signs? How does this effect manifest itself?

Practical Work 5. Study of Correlation Characteristics of Signals

28) What are the applied aspects of applying the mutual correlation function of two signals?

29) Under what conditions can the mutual correlation function of two periodic signals be determined?

30) How to determine the $S12(f)$ mutual spectrum for $s1(t)$ and $s2(t)$ signals?

31) In what cases will the signals $s1(t)$ and $s2(t)$ be uncorrelated?

32) What is the relationship between correlation functions and signal spectra? Practical work 6. Study of amplitude modulation and detection of AM- signals

33) How is two-half-cycle AM signal detection implemented?

34) How is the spectrum of an AM signal transformed during its two-half-cycle detection?

35) What does the diagram of the simplest AM signal receiver with a two-half-period detector look like?

36) How is synchronous AM signal detection implemented?

37) How is the AM signal spectrum transformed during its synchronous detection?

38) How do the results of synchronous detection depend on the modulation depth of the AM signal?

39) What is the main disadvantage of synchronous detection of AM signals?

40) How does the signal at the output of a synchronous AM detector depend on the phase shift of the reference oscillation relative to the phase of the carrier frequency signal?

41) How does the signal at the output of a synchronous AM detector depend on the frequency shift between the carrier and reference oscillations?

Practical work 7. Study of frequency-modulated radio signals

42) What properties of the Bessel functions were used in the study of FM signal spectra?

43) The FM signal in tone modulation has a modulation frequency of F = 10 kHz. At what frequency deviation in the spectrum of this signal will there be no components at the frequencies $f0 \pm F$?

44) An FM signal with an amplitude of 5 V has an instantaneous circular frequency that varies in time according to the law

$\omega(t) = 109[1 + 10{-}4\cos(2 \cdot 103t)]$

What is the angular modulation index of an FM signal and how to record a mathematical model of this signal?

45) The amplitude of the FM signal of the transmitter in the absence of modulating oscillation is 250 V. Measurements have shown that when a tonal modulating oscillation is applied, the amplitude of the component at the carrier frequency becomes equal to 244 V. What is the frequency modulation index and can we assume that an FM signal with a low frequency modulation index is implemented under the conditions described?

46) A FM broadcasting station has a modulation index limit value (at the loudest transmitted signal) of 30. Assuming that the spectrum of a low-frequency modulating signal is limited to the upper frequency of 16 kHz, determine the number of radio channels that can be placed in the VHF range (at frequencies from 30 to 300 MHz) without crosstalk (without spectrum overlap).

47) A single-harmonic FM signal is specified:

$\mathrm{FM(t)} = 7\cos[600\pi\mathrm{t} + 3\sin(2\pi103\mathrm{t}) + \pi/6]$

What are equal to: frequency *F*, Hz, modulating signal; f_{max} is the maximum instantaneous frequency and f_{min} is the minimum instantaneous frequency, Hz; ΔfM is frequency deviation, Hz?

Practical work 8. Study of discrete signals and their characteristics

48) What is the bandwidth for an AT signal?

49) What is "bandwidth occupied" in accordance with the regulations of radio connec

50) What is the bandwidth for a PT signal?

51) How to Determine the Average Frequency, Frequency Diversity, and Frequency Deviation for a Signal tions?

52) What is the bandwidth for an FT signal?

53) What is the essence of relative phase telegraphy (OFT)? Who and who CHT?

When did he offer it?

54) What is the difference between the signal spectra of TF and TF?

Practical work 9. Study of the relationship between correlation characteristics and the energy spectrum of random signals

55) How to determine the width of the energy spectrum of a random process?

56) How to determine the correlation interval of a random process?

57) How are the width of the energy spectrum and the correlation interval of a random process related?

58) How to determine the spectrum of a discrete random process?

59) How to form an estimate of the correlation function of a stationary random process with discrete time?

60) What is the content of the correloggram method for estimating the energy spectrum of a random process (power spectral density)?

Practical work 10. Investigation of statistical characteristics of narrowband stochastic processes

61) What are the properties of the correlation function of a stationary narrow-band cess?

62) What expression describes the correlation function of a stationary narrow-minded process formed at the output of an idealized narrow-band linear system with a rectangular amplitude-frequency response (AFC), when it is affected by stationary white noise with a one-sided spectral density N0.

63) How are the width of the energy spectrum and the correlation interval of a narrowband random process related?

64) How to determine the Fourier spectrum of a discrete narrowband stochastic process?

65) How to form an estimate of the correlation function of a narrowband random process with discrete time?

66) What is the mean of the envelope of a narrowband random process with the correlation function $R(\tau) = 25\exp(-4 \cdot 106\tau 2)\cos 10^{9\tau}$?

67) What is the variance of the envelope of a narrow-band random process with the correlation function $R(\tau) = 25\exp(-4 \cdot 106\tau 2)\cos 10^{9\tau}$?

68) The narrowband stochastic process ξ(t) has a correlation function $R\xi(\tau) = \sigma_{\xi}^{2}\exp(-\beta\tau 2/2)\cos 2\pi f_{0\tau}$. What relation describes the correlation function of this narrow-band random process?

Practical Work 11. Investigation of Probabilistic Characteristics of Discrete Communication Cable in the Presence of Additive Fluctuation Interference

69) How do you calculate transient probabilities in a discrete communication channel?

70) What parameters determine (set) the model of a discrete communication channel?

71) How to calculate the probabilistic characteristics of a discrete communication channel?

72) Which discrete communication channel is considered symmetrical?

73) What are the probabilistic relations that determine the probabilistic characteristics of a symmetric discrete communication channel?

74) How does the probability of mistaking $P_{osh\ depend}$ on the average signal-to-noise ratio in the discrete communication channel examined?

Practical work 12. Investigation of signal reception that increases the signal-to-noise ratio

75) How are the signal-to-noise ratios at the output and output of the receiver operating according to the accumulation method scheme interrelated, in the absence of correlation between the interference values at the reference moments?

76) How are the signal-to-noise ratios at the output and output of the receiver operating according to the accumulation method scheme interrelated, given that there is a correlation between the interference values at the reference moments?

77) How are the signal-to-noise ratios at the output and output of the receiver operating according to the scheme of the integrated reception method interrelated?

Practical work 13. Study of correlation reception of signals

78) How can the effectiveness of correlation signal reception be assessed?

79) What is the algorithm of the correlation receiver?

80) How are the signal-to-noise power ratios related at the output and input of a correlation receiver?

81) How will the mismatch between the received signal and its copy in the correlation receiver affect the λ parameter? Confirm your conclusion experimentally.

Practical work 14. Study of optimal signal reception

82) What are the requirements for the timing and frequency characteristics of the matched filter?

83) What are the challenges of implementing optimal receivers based on matched filters?

84) What is the impulse response of a filter matched to a sawtooth pulse input signal?

85) What expressions describe and look like the frequency response and frequency response of the filter, agreed upon by the

with a pulse input signal with a spectral function $S(j\omega) = \frac{1}{1+j\omega}$?

Practical work 15. Investigation of potential noise immunity in coherent reception

86) How is the formula for calculating the potential noise immunity of AT signals written?

87) How is the formula for calculating the potential noise immunity of PT signals recorded?

88) How is the formula for calculating the potential noise immunity of FT signal reception recorded?

89) How is the formula for calculating the potential noise immunity of the reception of UFT signals recorded?

90) What assumptions were made in deriving a formula that allows analyzing the potential noise immunity of an optimal binary coherent receiver?

Practical Work 16. Investigation of Potential Noise Immunity in Incoherent Reception

91) How is the formula for calculating the potential noise immunity of AT signals written?

92) How is the formula for calculating the potential noise immunity of incoherent reception of PT signals recorded?

93) How is the formula for calculating the potential noise immunity of incoherent reception of UFT signals recorded?

94) What conclusions can be drawn from the results of comparing the potential noise immunity of incoherent and coherent reception of AT, CT and OFT signals?

Practical work 17. Study of noise immunity in a fading channel

95) What conditions must a communication channel meet in order to be called a communication channel with Rice fading?

96) How does the value of the Rice depth parameter determine the type of total fading that occurs in a communication channel?

97) What is the relationship between Rayleigh and Rice fading in the communication channels of the SV and HF and VHF radio wave bands?

98) How is the formula for calculating the potential noise immunity of incoherent reception of frequency telegraph signals in a communication channel with quasi-Reis (Rice) fading recorded?

99) How is the formula for calculating the potential noise immunity of incoherent reception of relative phase telegraphy signals in a communication channel with quasi-Relei (Rice) fading recorded?

100) What conditions must a communication channel meet in order to be called a communication channel with one-way normal fading?

101) What is the mechanism of discrete-diffuse multipath formation during the propagation of HF radio waves?

102) How is the formula for calculating the potential noise immunity of incoherent reception of frequency telegraphy signals in a communication channel with unilaterally normal fading recorded?

103) What conclusions can be drawn from the results of comparing the potential noise immunity of incoherent and coherent reception of AT, CT, FT and OFT signals in communication channels with common fading?

Evaluation criteria:

Criteria for assessing competencies:

The grade "excellent" is given to the student if the student gave a complete, detailed answer to the question, while the totality of conscious knowledge on the topic of discipline is shown, the main provisions of the question are demonstratively revealed; the answer traces a clear structure, a logical sequence that reflects the essence of the concepts disclosed. The answer is presented in literary language using technical terminology. There may be shortcomings in the definition of concepts, corrected by the student independently in the process of answering. The situational problem on the topic is solved correctly.

A grade of "good" is given to a student if the student gave a complete, detailed answer to the question, while the ability to distinguish essential and insignificant features, cause-and-effect relationships is shown. The answer is clearly structured, logical, presented in literary language using technical terminology. 2-3 inaccuracies or minor mistakes may be made, corrected by the student with the help of the teacher. The situational task on the topic is solved correctly, but no more than one mistake was made when solving it.

The grade "satisfactory" is given to the student if the student gave an incomplete and insufficiently detailed answer. The logic and sequence of presentation have violations. Mistakes were made in the disclosure of concepts, the use of terms. The student is not able to independently distinguish essential and insignificant features and cause-and-effect relationships. There are no conclusions in the answer. The ability to reveal the meaning of generalized knowledge is not shown. Speech design requires correction. The situational task on the topic is solved correctly, but no more than two mistakes were made when solving it.

The grade "unsatisfactory" is given to the student if the answer is scattered knowledge with significant errors on the question. There is fragmentarity, illogic of presentation. The student is not aware of the connection of the discussed issue with other questions of the topic. There are no conclusions, concretization and evidence of the presentation. The speech is illiterate, terminology is not used. Additional and clarifying questions of the teacher do not lead to the correction of the student's answer, or the answer to the question is completely absent or the student refused to answer. The situational task on the topic is solved incorrectly.

Description of the grading scale

The current control measure is considered passed if the student received at least 60% of the maximum score established for this control. The rating score given to the student for the current control measure passed by the student within the deadlines established by the schedule of control measures is determined as follows:

The level of performance of the control Denmark	Rating Score (in % of the maximum score for the control task)
Excellent	100
Good	80
Satisfactory	60
Unsatisfactory	0

Methodological materials that determine the procedures for assessing knowledge, skills, and (or) work experience that characterize the stages of competence formation

The procedure for conducting this assessment includes:

— submission of a completed report on practical work with completed multi-level tasks;

— defense by performing a multi-level task specified by the teacher, and the level of the task is determined by the student independently.

The tasks offered to the student allow you to test the general professional competencies of OPK-4.

To prepare for this assessment event, the student is given 18 hours per semester as part of his independent work.

When preparing for the answer, the student is given the right to use the report on laboratory work.

Scorecard

No p/n	Surname, first name of the student.	Type of work						Conclusion
		Mastery of the method of performing the task	Correctness of the answer	Workability of the model	Accuracy of measurements and correctness of calculations of parameters and characteristics of Therist	The correctness of the design of schemes and graphs is characterized by Stick	Formulation of conclusions, their correspondence to the theory	
1								
2								
…								

8. EXAM QUESTIONS

Questions to check the level of learning

Basic level

1) Basic concepts and definitions of the theory of electrical communication: information, messages, signals and interference.
2) General principles of building communication systems.
3) Interference and distortion in the communication channel.
4) Characteristics of information transmission systems.
5) Mathematical description of signals and interference.
6) Frequency form of signal representation.
7) A stochastic process as a model of a real signal. Stationary and ergodic stochastic processes.
8) Graphical and geometric representation of signals.
9) Analytical representation of signals.
10) Discretization of signals in time.
11) Fundamentals of Amplitude Modulation. Principles of Amplitude Modulation In the 19th century, the Communist Party
12) Technical implementation of amplitude modulation.
13) Amplitude detection by nonlinear circuits. Nonlinear and Frequency Detection detection of the AM signal.
14) Amplitude detection in parametric circuits.
15) Frequency modulation.
16) Phase modulation.
17) Phase detection.
18) Frequency detection.
19) Amplitude types of digital modulation (manipulation): OOK, ASK, M-ASK.
20) Phase types of digital modulation (manipulation): BPSK, QPSK, M-PSK. Combined amplitude-phase types of digital modulation QAM.
21) Frequency types of digital modulation (manipulation): FSK, MSK, M-FSK, GFSK, GMSK.
22) Pulse modulation methods: AIM, PWM, FIM, CHIM, Δ-modulation, RDM, λ-Δ-modulation.
23) The passage of random signals through deterministic linear and non-linear systems. The passage of signals through random communication channels.
24) Mathematical models of continuous communication channels.
25) Mathematical models of discrete communication channels.

Increased level

26) Noise immunity of the discrete message transmission system: signal reception as a statistical problem.
27) Noise immunity of the discrete message transmission system: criteria for optimal signal reception, optimal reception of discrete signals.
28) Noise immunity of the discrete message transmission system: noise immunity at coherent reception of binary signals, incoherent reception of discrete signals.
29) Noise immunity of the continuous message transmission system: optimal reception of continuous signals, optimal linear filtering of signals.
30) Immunity of continuous message transmission system: potential immunity of continuous message transmission.
31) Information characteristics of the message source.
32) Discrete channel bandwidth.
33) Discrete message compression methods.
34) Continuous channel capacity.

35) Introduction to Corrective Codes.
36) Linear block codes.
37) Hamming codes.
38) Cyclic codes.
39) Basics of adaptive interference rejection.
40) Adaptive notch and high-pass filters.
41) Adaptive prediction devices, tracking filters, and storage devices.
42) Receiving signals in fading channels.
43) Methods of combating signal fading.
44) Methods of combating intersymbol interference.
45) Reception of discrete messages in channels with spectrum-concentrated and pulse-based interference.
46) Compensates for interference and distortion in the channel.
47) Methods for allocating a shared channel resource.
48) Frequency separation of channels.
49) Temporary separation of channels.
50) Code channel separation.

Practical tasks to check the level of learning

1) Modeling and study of the characteristics of signals essential for their transmission through communication channels.
2) Modeling and study of signal characteristics in their vector representation.
3) Simulation and study of the procedure for sampling continuous signals.
4) Modeling and research of the procedure for spectral analysis and synthesis of periodic signals.
5) Modeling and study of the procedure for spectral analysis and synthesis of sign-nals based on the Fourier transform.
6) Modeling and investigation of the properties of the Fourier transform.
7) Modeling and Investigation of Correlation Characteristics of Signals.
8) Modeling and study of the process of amplitude modulation and detection of AM signals.
9) Modeling and study of frequency-modulated radio signals.
10) Modeling and study of discrete signals and their characteristics.
11) Modeling and study of broadband noise-like signals.
12) Modeling and Study of Numerical Characteristics and Probability Distribution Laws of Stochastic Processes.
13) Modeling and study of the relationship between correlation characteristics and the energy spectrum of random signals.
14) Modeling and study of statistical characteristics of narrow-band random processes.
15) Modeling and study of probabilistic characteristics of a discrete communication channel in the presence of additive fluctuation interference.
16) Modeling and investigation of the signal reception process that increases the signal-to-noise ratio.
17) Modeling of the correlator and study of correlation reception of signals.
18) Receiver simulation and optimal signal reception research.
19) Receiver simulation and investigation of the process of receiving signals with an unknown initial phase.
20) Receiver simulation and study of potential noise immunity in coherent reception.

21) Receiver simulation and study of potential noise immunity in incoherent reception.

22) Modeling of a communication channel and study of noise immunity in a channel with jams.

23) Receiver simulation and study of interference immunity at diversity reception.

24) Modeling and investigation of discrete Fourier transform and fast Fourier transform procedures.

25) Modeling and research of non-recursive digital filters.

Criteria for assessing competencies

(*in accordance with the results of mastering the discipline***)**

Evaluation criteria for checking the level of theoretical learning*:*

The grade "excellent" is given to the student if he has shown a deep, solid and accurate mastery of the program educational material, while the question posed is revealed consistently, clearly and logically harmoniously, in a full exhaustive volume, the main categories, concepts and terms of the training course were formulated correctly, no mistakes were made when answering

A grade of "good" is given to a student if he has shown a solid knowledge of the program educational material, while the question posed is solved competently and to the point, in a sufficiently complete volume, the main categories, concepts and terms of the training course were formed correctly, some inaccuracies or one mistake were made when answering

A "satisfactory" grade is given to a student if he or she has shown knowledge of only the main part of the educational material without its particular details, while the question posed is disclosed in violation of the logical sequence, not in full; inaccurate formulations of the main categories, concepts and terms of the training course, as well as errors (no more than two) or a number of minor inaccuracies that did not significantly distort the essence of the answer were made.

An "unsatisfactory" grade is given to a student who does not know a significant part of the program material, makes significant mistakes (more than two) that significantly distort its essence. An unsatisfactory grade is also given if there is no answer to the question, or the student refused to take it.

Assessment criteria for testing practical training:

An "excellent" grade is given if he/she has demonstrated a high ability to apply the acquired knowledge in practice through solving a specific problem, freely coped with the task without difficulty, showing the possession of versatile techniques and skills for its implementation, did not make mistakes and inaccuracies;

A "good" grade is given if he/she has demonstrated the ability to apply the acquired knowledge in practice through solving a specific task, coped with the task, showing the possession of the necessary techniques and skills to perform it, while making no more than one mistake;

A "satisfactory" grade is given if he/she has demonstrated a mediocre ability to apply the acquired knowledge in practice through solving a specific problem, coped with the task with difficulty, and made no more than two mistakes;

The grade "unsatisfactory" is given if he did not demonstrate the ability to apply the knowledge gained in practice through solving a specific problem, did not cope with the task or made three or more serious mistakes in solving it.

Description of the grading scale

Intermediate certification in the form of an exam provides for a mandatory examination procedure and is evaluated with 40 points out of 100. If the student's rating score in the discipline at the end of the semester is 60, then the program automatically reaches the

32 bonus points are added and an "excellent" grade is given. A student's positive answer in the exam is evaluated by rating points in the range from **20** to **40** (**20** ≤ S_{copy} ≤ **40**), a score **less than 20** points is considered unsatisfactory.

Scale of correspondence of the rating score of the exam to the 5-point system

Rating score in the discipline	Score on a 5-point system
35 – 40	Excellent
28 – 34	Good
20 – 27	Satisfactory

A student's positive answer at the exam is evaluated by rating points in the range from 5 to 10 for the basic level control question and practical task, from 10 to 20 for the advanced level control question. The scale of correspondence of grades to rating points is presented in the table.

Evaluation	Rating points		
	Security question No1 (basic level)	Security Question No2 (Advanced)	Practical task
Excellent	10	20	10
Good	7	15	7
Satisfactory	5	10	5
Unsatisfactory	0	0	0

If a student has committed a case of violation of the academic discipline during the exam (cheating, using mobile communications, personal or tablet computers, audio or video players, other technical devices), then this student is removed from the exam with an unsatisfactory grade.

Methodological materials that determine the procedures for assessing knowledge, skills, and (or) experience of activity, characterizing the stages of competence formation

The tasks offered to the student allow you to test the general professional competencies of OPK-4. To prepare for the exam, the student is given 40.5 hours as part of his independent work.

The procedure for conducting the exam is carried out in accordance with the Regulation on the current monitoring of progress and intermediate certification of students in educational programs of higher education at NCFU.

The exam in the discipline is provided in oral form on tickets. The exam ticket includes two theoretical questions and one practical task

For preparation on the ticket, 30 minutes are allotted - for theoretical questions, 10 minutes for completing a practical task.

When preparing for the answer, the student is given the right to use the work program of the discipline, his own lecture notes for no more than 10 minutes.

The practical task is performed on a PC. When checking the practical task, the following are evaluated: the correctness of modeling, research methods, the accuracy of measurement results, and the assessment of error.