

Документ подписан простой электронной подписью
Информация о владельце:
ФИО: Порохня Андрей Алексеевич
Должность: И.о. директора института перспективной инженерии
Дата подписания: 22.10.2026 13:25:38
Уникальный программный ключ:
990bea3aecc48c23bd8699e48288f8d1960c600

MINISTRY OF SCIENCE AND HIGHER EDUCATION OF THE RUSSIAN FEDERATION
Federal State Autonomous Educational Institution
Higher Education
"NORTH CAUCASUS FEDERAL UNIVERSITY"

APPROVED BY
Acting Director of the Institute
Advanced Engineering
Cand. Tech. Sci., Associate Professor
A.A. Porokhnya

DISCIPLINE ASSESSMENT TOOLS FUND
"Information Theory and Coding"

Field of study	11.03.02 Infocommunication Technologies and Communication Systems
Profile	Intelligent Data Processing in Infocommunication Systems and Networks
Year of start of training	2026
Form of study	Full-time
Implemented in a semester	5

Introduction

1. Purpose

The Fund of Assessment Tools for the discipline "Information Theory and Coding" is designed for an objective assessment of the level of competence formation.

2. FOS is an appendix to the program of the discipline "Information Theory and Coding".

3. The developer is V.P. Mochalov, Associate Professor of the Department of Digital, Robotic Systems and Electronics of the Institute of Advanced Engineering.

4. An examination of the FOC was carried out.

Members of the expert group:

Chairman: V.P. Mochalov, Professor of the Department of Digital, Robotic Systems and Electronics of the Institute of Advanced Engineering.

Members of the Commission:

S.V. Yakovlev, Associate Professor of the Department of Digital, Robotic Systems and Electronics of the Institute of Advanced Engineering.

S.V. Melnikov, Senior Researcher of the Interdisciplinary Training and Research Center for Agricultural Technologies, Associate Professor of the Department of Digital, Robotic Systems and Electronics of the Institute of Advanced Engineering.

Representative of the employer's organization:

Mironov V.A., General Director of Orintex LLC.

Expert opinion: The FAT for the discipline allows you to assess the level of competence formation. Start approbation.

5. The validity period of the FAT is determined by the period of implementation of the educational program.

Description of indicators and assessment criteria at various stages of their formation, description of assessment scales

Competency(s), indicator(s)	Levels of competence formation			
	The minimum level has not been reached (Unsatisfactory) 2 points	Minimum level (satisfactory) 3 points	Intermediate level (good) 4 points	High level (excellent) 5 points
Competency: OPK-4				
Learning outcomes in the discipline (module): <i>Indicator:</i> ID-1 OPK-4 uses information and communication technologies to search for the necessary information	Unable to complete tasks related to this competency achievement indicator	Performs tasks at the reproductive level related to this indicator of competence achievement	Performs tasks related to this indicator of competence achievement in standard situations, making minor mistakes	Fully performs tasks related to this indicator of competence achievement, including in non-standard situations
Learning outcomes in the discipline (module): <i>Indicator:</i> 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.	Unable to complete tasks related to this competency achievement indicator	Performs tasks at the reproductive level related to this indicator of competence achievement	Performs tasks related to this indicator of competence achievement in standard situations, making minor mistakes	Fully performs tasks related to this indicator of competence achievement, including in non-standard situations
Learning outcomes in the discipline (module): <i>Indicator:</i> ID-4 OPK-4 uses the capabilities of computer technology and	Unable to complete tasks related to this competency achievement indicator	Performs tasks at the reproductive level related to this indicator of competence achievement	Performs tasks related to this indicator of competence achievement in standard situations, making minor mistakes	Fully performs tasks related to this indicator of competence achievement, including in non-standard situations

software to solve problems of control and algorithmization of information processing processes.				
---	--	--	--	--

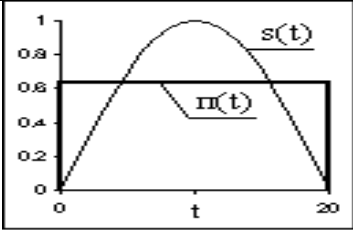
Assessment of the level of competence in the discipline is carried out on the basis of the "Regulation on the current monitoring of progress and intermediate certification of students in educational programs of higher education - bachelor's programs, specialist programs, master's programs - in the Federal State Autonomous Educational Institution of Higher Education "North Caucasus Federal University" in the current edition.

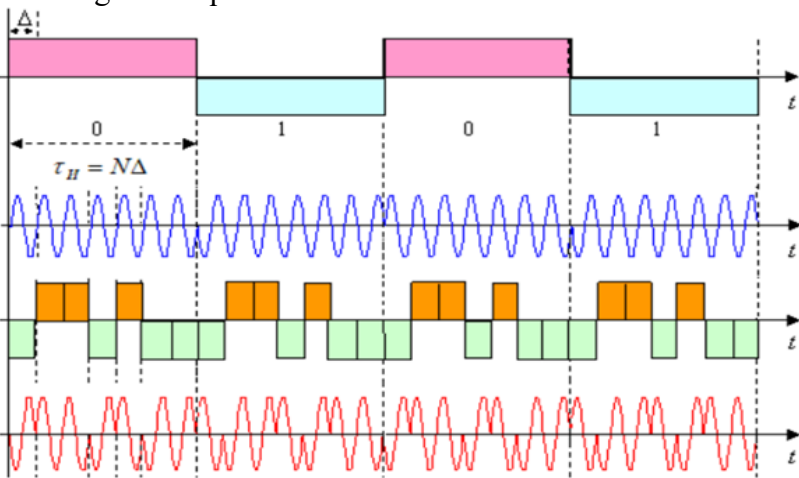
ASSESSMENT TOOLS FOR CHECKING THE LEVEL OF COMPETENCE FORMATION

Job Number	Correct answer	Content of the question	Competence
Semester 5			
1.	a)	The probability of error in binary binary signal detection is correctly described by the expression a) $P_{ош} = P(0)P_{ш} + P(U_c)P_{ш}$ b) $P_{ош} = P(0)P_{ш} + P(U_c)P_{ш}$ c) $P_{ош} = P(U_{ш})P_{ш} + P(U_c)P_{ш}$ d) $P_{ош} = P(U_{ш})P_{ш} + P(U_c)P_{ш}$	OPK-4
2.	a)	The figure shows ... a) orthonormal basis of harmonic functions b) Orthonormal basis of Walsh functions c) Orthonormal basis of Bessel functions d) Orthonormal basis of Laguer functions e) Orthonormal basis of Haar functions	OPK-4
3.	a)	A random signal is stationary if its statistical characteristics do not depend on ... a) from the initial moment of time b) Its background c) its current values	OPK-4

		(d) Its future significance	
4.	a)	An ergodic random signal is... a random process (a) Stationary (b) Non-stationary (c) deterministic (d) Discrete	OPK-4
5.	a)	A metric signal space is a set of signals for which _ is appropriately defined. (a) Distance (b) Splitting (c) Attitude (d) Compliance (e) Rule	OPK-4
6.	1 – 2 – 3 – 4	The correct sequence of representation of the signal in the Fourier trigonometric series is: 1) $\frac{a_0}{2} = \frac{1}{T} \int_{t_1}^{t_2} s(t) dt,$ 2) $a_n = \frac{2}{T} \int_{t_1}^{t_2} s(t) \cos n\omega_1 t dt, \quad b_n = \frac{2}{T} \int_{t_1}^{t_2} s(t) \sin n\omega_1 t dt.$ 3) $A_n = \sqrt{a_n^2 + b_n^2}, \quad \psi_n = \arctg \frac{b_n}{a_n}.$ 4) $s(t) = \frac{a_0}{2} + \sum_{n=1}^{\infty} A_n \cos(n\omega_1 t - \psi_n),$	OPK-4
7.	a)	Mathematical expression of the inverse Fourier transform if $S(\omega)$ is the spectral density of the signal $s(t)$. a) $s(t) = \frac{1}{2\pi} \int_{-\infty}^{\infty} S(\omega) e^{j\omega t} dt$ b) $s(t) = \frac{1}{2\pi} \int_{-\infty}^{\infty} S(\omega) e^{-j\omega t} dt$ c) $s(t) = \int_{-\infty}^{\infty} S(\omega) e^{-j\omega t} dt$ d) $s(t) = \int_{-\infty}^{\infty} S(\omega) e^{j\omega t} dt$	OPK-4

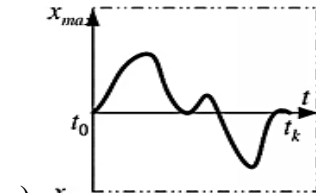
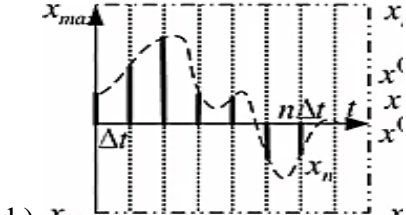
8.	d)	Mathematical expression of the forward Fourier transform if $S(\omega)$ is the spectral density of the signal $s(t)$. a) $s(t) = \frac{1}{2\pi} \int_{-\infty}^{\infty} S(\omega) e^{j\omega t} dt$ b) $s(t) = \frac{1}{2\pi} \int_{-\infty}^{\infty} S(\omega) e^{-j\omega t} dt$ c) $S(\omega) = \int_{-\infty}^{\infty} s(t) e^{j\omega t} dt$ d) $S(\omega) = \int_{-\infty}^{\infty} s(t) e^{-j\omega t} dt$	OPK-4
9.	1 – a 2 – b 3 – c 4 – d	To establish a correspondence between the names of random information processes and their definitions 1) continuous random process 2) Continuous random sequence 3) Discrete Random Process 4) Discrete random sequence a) a random process in which a set of states makes up a continuum, and changes in states are possible at arbitrary moments of time (b) A stochastic process in which a set of states constitutes a continuum, and changes in states are possible at a finite number of moments in time c) a random process in which a set of states is finite, and changes in states are possible at arbitrary moments in time (d) A stochastic process in which a set of states is finite, and changes in states are possible at a finite number of moments in time	OPK-4
10.	4	The signal $s(t)$ has the form of a square pulse with an amplitude of 2 V lasting 8 s. Hilbert's norm for such a signal is ... (indicate the answer with a number).	OPK-4
11.		The signal at the interval (0.T) is half of the period of the sine wave with amplitude A: $s(t) = A \cdot \sin(\pi t/T)$, $0 \leq t \leq T$. It is necessary to approximate (replace) this signal with a square pulse $p(t)$ with amplitude B (see Fig.).	OPK-4

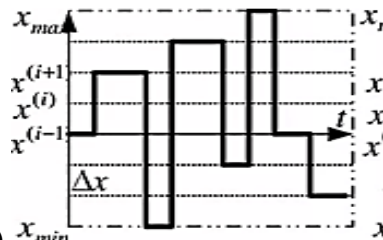
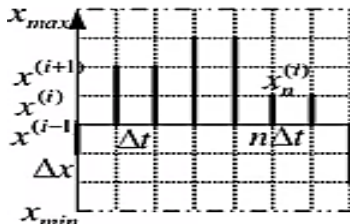
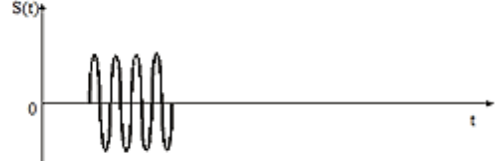
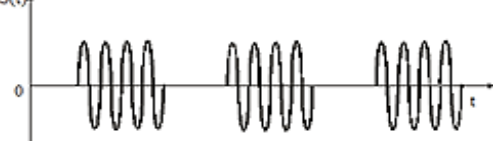
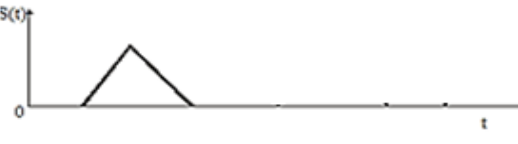
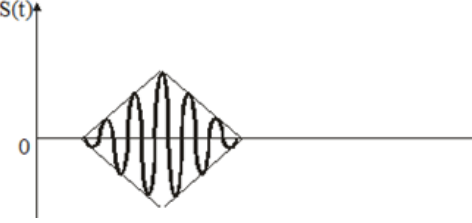
			
12.		Calculate the autocorrelation function of a single square pulse given on a time interval (0.T) with an amplitude value equal to A.	OPK-4
13.		Characteristics of interference as random processes, their mathematical description	OPK-4
14.		Determine the average amount of information transmitted over a communication channel based on one sample, under the following conditions: the transmitted signal $s(t)$ is a normal random process with a zero mean value and a dispersion of $\sigma^{2s} = 15$ mW; the bandwidth of the channel $F_k = 4000$ Hz; the channel has a fluctuation interference independent of the signal $n(t)$ of the "white noise" type with a power spectral density of $N_0 = 2.5 \cdot 10^{-7}$ W/Hz, normal distribution and zero average value.	OPK-4
15.		Find the bandwidth of a Gaussian communication channel with a band of $F=4$ kHz, if the input of the channel receives a signal with a power of $P_c=1.2$ mW, and the channel has noise with a power spectral density of $N_0=10^{-7}$ W/Hz.	OPK-4
16.		To determine and depict the spectral density of a square pulse with a duration T and an amplitude A. $s(t) = \begin{cases} A, & t < \frac{T}{2}, \\ 0, & t > \frac{T}{2}. \end{cases}$	OPK-4
17.		The concept of linear space, norms and metrics of signals.	OPK-4
18.		The concept and mathematical expressions of the power and energy of signals.	OPK-4
19.		Coordinate basis of the signal space.	OPK-4
20.		Orthogonal signals. Orthonormal basis of space. Decomposition of a signal into a series according to an ordered system of orthonormalized basic functions.	OPK-4

21.		Spectral analysis of periodic and non-periodic signals. Amplitude and phase spectra.	OPK-4
22.		Correlation functions of signals, their physical meaning, formulas for calculation.	OPK-4
23.		Formulation of V. A. Kotelnikov's theorem, its physical meaning and practical application.	OPK-4
24.		Physical nature of natural noises, their mathematical description.	OPK-4
25.	7	The figure shows the time diagrams obtained at the stages of FM broadband signal formation. The base of this signal is equal to ... 	OPK-2
26.	50	In a time-division system, the pulse width $\tau_I = 1 \mu s$. At the upper frequency of the message spectrum $F_B = 5 \text{ kHz}$, the system can accommodate ... channels	OPK-2
27.	d)	It has been established that the receiver can reproduce the message absolutely accurately if: a) has a filter with a minimum RMS error (b) Has a filter with the highest signal-to-noise ratio (c) Contains a correlator (d) Only when there is no noise	OPK-2
28.	b)	Studies have shown that the maximum signal-to-noise ratio in a quasi-optimal linear filter is achieved by a) Selection of the frequency response form (frequency response and frequency response) b) by selecting the bandwidth for a given frequency response shape c) selection of the method of noise-resistant coding d) the choice of modulation method	OPK-2

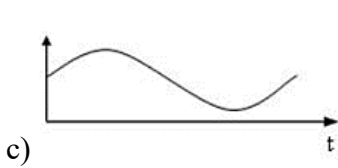
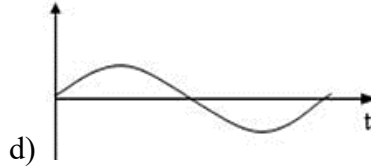
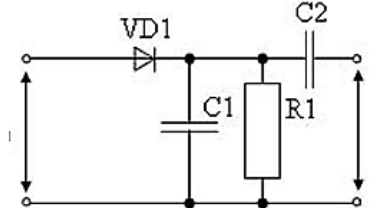
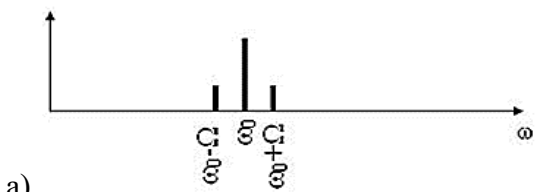
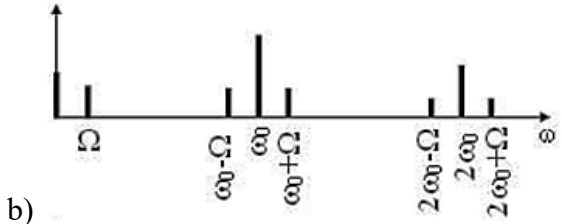
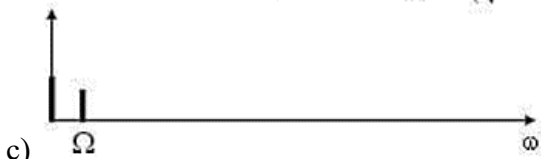
29.	a)	Studies have shown that the optimal linear Wiener filter works according to what criterion a) the minimum of the root mean square error. (b) Maximum signal-to-noise ratio c) the maximum RMS error (d) Minimum signal-to-noise ratio	OPK-2
30.	d)	It has been established that the optimal filter is considered to have a cross-correlation function: (a) Maximum (b) Minimal c) equal to the root mean square error (d) Less than the RMS error	OPK-2
31.	1 MHz (1000 kHz)	The sampling interval is 6 μ s. The number of quantization levels is 64. The quantization step is 12 mV. The width of the PCM signal spectrum is ... (enter the answer as a number, and indicate the units separated by a space)	OPK-2
32.	6,25	The amplitude of sending the DFM signal is 5 V, the sending duration is 1 s, the spectral density of white noise is 2 V ² /Hz. The s/n ratio at the output of the filter coordinated with the signal is ... (answer to enter as a number)	OPK-2
33.	1 – a 2 – b 3 – c	Establish a correspondence between the received signal in the binary optimal receiver and the signals generated by the reference oscillators: 1) DAM 2) DCM 3) DFM a) $u_1(t)=U_m \cdot \cos(\omega_0 t)$, $u_0(t)=0$ b) $u_1(t)= U_m \cdot \cos(\omega_1 t)$, $u_0(t)= U_m \cdot \cos(\omega_0 t)$ c) $u_1(t)= U_m \cdot \cos(\omega t)$, $u_0(t)= -U_m \cdot \cos(\omega t)$	OPK-2
34.	12 kbit/s 12000 bps	The bandwidth of a communication channel with a bandwidth of $F=4$ kHz and a ratio of $R_s/P_{sh} = 7$ is equal to ... (enter the answer as a number, and indicate the units of measurement separated by a space)	OPK-2
35.	1 – a 2 – b 3 – c 4 – d	Establish a correspondence between code combinations and their code distance: 1) 0011 and 0101 2) 100101 and 010100 3) 0011 and 1100 4) 001000 and 001001 a) 2 b) 3 c) 4	OPK-2

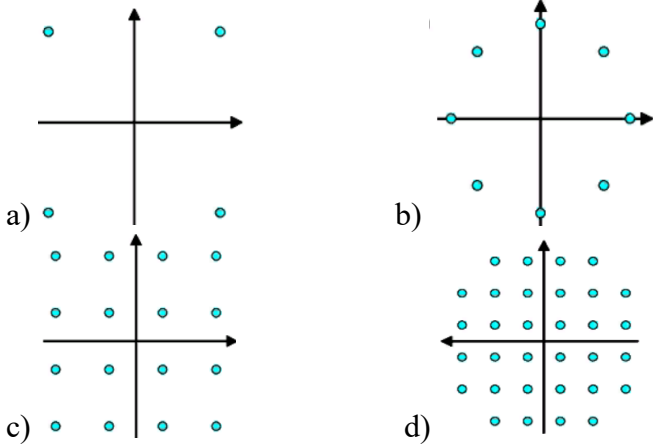
		d) 1																																																												
36.		The message source produces 4 messages with probabilities $P(a1)=0.2$; $P(a2)=0.3$; $P(a3)=0.4$; $P(a4)=0.1$. Estimate the amount of information contained in each of the source messages. Determine the entropy of the source and estimate its redundancy.	OPK-2																																																											
37.		Examine the binary block code, determining whether it is linear, redundant and minimum code distance, provided that the code is intended to encode eight messages and contains the following code combinations: $b1=00000$; $b2=10011$; $b3=01010$; $b4=11001$; $b5=00101$; $b6=10110$; $b7=01111$; $b8=11100$.	OPK-2																																																											
38.		To study the dependence of the amplitude spectrum of the sequence of square pulses (PPI) on duty cycle.	OPK-2																																																											
39.		Analyze the AM signal for the output of the resonant amplifier. Signal parameters: modulating signal frequency – $\Omega = 2\pi \cdot 3 \cdot 10^3$ rad/s, modulation factor – $m = 1/3$, signal amplitude – $U_0 = 10^{-4}$ V. Amplifier parameters: transmission ratio $K(j\omega) = \frac{K_0}{1 + j(\omega - \omega_0)\tau_k}$, $K_0 = 100$, the resonant frequency of the circuit is $\omega_0 = 2\pi \cdot 10^6$ rad/s, the time constant of the circuit τ_k is determined from the ratio $\Omega\tau_k = 1$.	OPK-2																																																											
40.		To construct and analyze the amplitude spectrum of a frequency-modulated signal. Initial data: modulating signal frequency $\Omega = 2\pi \cdot 10^3$ rad/s, modulation index $m = 4$, signal amplitude $U_0 = 1$ V, Carrier frequency $\omega_0 = 2\pi \cdot 10^6$ rad/s. Value of Bessel functions $J_k(m)$: <table><tr><th rowspan="2">k</th><th colspan="5">m</th></tr><tr><th>1</th><th>2</th><th>3</th><th>4</th><th>5</th></tr><tr><td>0</td><td>0.765</td><td>0,224</td><td>-0,260</td><td>-0,397</td><td>-0,178</td></tr><tr><td>1</td><td>0,440</td><td>0,577</td><td>0,339</td><td>-0,066</td><td>-0,328</td></tr><tr><td>2</td><td>0,115</td><td>0,353</td><td>0,486</td><td>0,364</td><td>0,047</td></tr><tr><td>3</td><td>0.020</td><td>0,129</td><td>0,309</td><td>0,430</td><td>0,0365</td></tr><tr><td>4</td><td>0,002</td><td>0,034</td><td>0,132</td><td>0,281</td><td>0,391</td></tr><tr><td>5</td><td>$2 \cdot 10^{-4}$</td><td>0,007</td><td>0,043</td><td>0,132</td><td>0,261</td></tr><tr><td>6</td><td>$2 \cdot 10^{-5}$</td><td>0,001</td><td>1,011</td><td>0,049</td><td>0,131</td></tr><tr><td>7</td><td>10^{-6}</td><td>$2 \cdot 10^{-4}$</td><td>0,003</td><td>0,015</td><td>0,053</td></tr></table>	k	m					1	2	3	4	5	0	0.765	0,224	-0,260	-0,397	-0,178	1	0,440	0,577	0,339	-0,066	-0,328	2	0,115	0,353	0,486	0,364	0,047	3	0.020	0,129	0,309	0,430	0,0365	4	0,002	0,034	0,132	0,281	0,391	5	$2 \cdot 10^{-4}$	0,007	0,043	0,132	0,261	6	$2 \cdot 10^{-5}$	0,001	1,011	0,049	0,131	7	10^{-6}	$2 \cdot 10^{-4}$	0,003	0,015	0,053	OPK-2
k	m																																																													
	1	2	3	4	5																																																									
0	0.765	0,224	-0,260	-0,397	-0,178																																																									
1	0,440	0,577	0,339	-0,066	-0,328																																																									
2	0,115	0,353	0,486	0,364	0,047																																																									
3	0.020	0,129	0,309	0,430	0,0365																																																									
4	0,002	0,034	0,132	0,281	0,391																																																									
5	$2 \cdot 10^{-4}$	0,007	0,043	0,132	0,261																																																									
6	$2 \cdot 10^{-5}$	0,001	1,011	0,049	0,131																																																									
7	10^{-6}	$2 \cdot 10^{-4}$	0,003	0,015	0,053																																																									

41.		Determine the maximum number of channels located in the frequency range from $f_{\min} = 88$ MHz to $f_{\max} = 108$ MHz when using frequency modulated signals having the following parameters: frequency deviation $\Delta f_M = 50$ kHz, upper frequency of the message spectrum $F_b = 12$ kHz.	OPK-2
42.		To conduct a study of additive white Gaussian noise at the output of a bandpass filter.	OPK-2
43.		Simulate a discrete communication channel with additive Gaussian noise.	OPK-2
44.		Simulate a discrete communication channel to transmit a signal with an undefined phase and in the presence of additive noise.	OPK-2
45.		To develop a circuit model for the formation of a broadband signal FM SHPS.	OPK-2
46.		To conduct a study of a discrete communication channel in the presence of additive fluctuation interference in the Mathcad program, to obtain the dependence of the probability of erroneous reception <i>of Rosh on the average</i> signal-to-noise ratio.	OPK-2
47.		A method of experimental study of a method of integral signal reception that increases the signal-to-noise ratio in the presence of additive fluctuation interference.	OPK-2
48.		To conduct a study of the potential noise immunity of the receiver at coherent reception in the Mathcad program.	OPK-2
49.		To conduct a study of the potential noise immunity of the receiver in case of incoherent reception in the Mathcad program.	OPK-2
50.		To conduct a study of noise immunity in the fading communication channel in the Mathcad program.	OPK-2
51.	1 – a 2 – b 3 – c 4 – d	Match the signal representation to its image: 1) Analog Signal 2) Discrete Signal 3) quantized signal 4) Digital Signal  a)  b)	OPK-3

		 	
52.	1 – a 2 – b 3 – c 4 – d	Match the input and output of the optimal filter:      	OPK-3

53.	0,6	Modulation coefficient AM of the signal shown in the figure, provided that $U_{\max} = 8 \text{ V}$, $U_{\min} = 2 \text{ V}$, is equal to (answer should be entered as a number)	OPK-3
54.	1 – a 2 – b 3 – c 4 – d	To establish a correspondence between the types of signal and the specified places in the schematic diagram of a non-coherent amplitude detector on a diode 1) At the detector input 2) on a diode 3) At the outlet filter 4) at the detector output	OPK-3

		 	
55.	1 – a 2 – b 3 – c 4 – d	To establish a correspondence between the types of spectrum and the specified places in the circuit diagram of a non-coherent amplitude detector on a diode  1) At the detector input 2) on a diode 3) At the outlet filter 4) at the detector output    	OPK-3
56.	10	The maximum and minimum frequencies in frequency modulation are 100 kHz and 120 kHz. The modulating frequency is 6280 rad/s. FM index is ... (enter answer as number)	OPK-3
57.	1 – a 2 – b 3 – c	Establish a correspondence between the signal and its constellation 1) QPSK 2) 8PSK	OPK-3

	4 – d	3) 16QAM 4) 32QAM  a) b) c) d)	
58.	48 kHz	The width of the analog signal spectrum is 4 kHz. The number of quantization levels is 64. The quantization step is 4 mV. The width of the PCM signal spectrum is ... (enter a number, and after the space of the unit)	OPK-3
59.	1 – a 2 – b 3 – c 4 – d	Establish a correspondence between the signal and the formula for calculating the error probability for optimal reception: 1) DAM 2) DCM 3) DFM 4) ODFM a) $P_{ou} = 0.5 \left[1 - \Phi \left(\frac{h_1}{\sqrt{2}} \right) \right]$ b) $P_{ou} = 0.5 [1 - \Phi(h_1)]$ c) $P_{ou} = 0.5 [1 - \Phi(h_1 \sqrt{2})]$ d) $P_{ou} = [1 - \Phi(h \sqrt{2})]$	OPK-3
60.	1 – a 2 – b	Establish a correspondence between the types of channel separation and implementing devices: 1) Frequency Separation of Channels	OPK-3

	3 – c 4 – d	2) temporary separation of channels 3) Phase separation of channels 4) Code channel separation (a) Bandpass filters (b) Switches (c) Synchronous demodulators (d) Harmonized filters	
61.		Structural diagram of the transmitter of the electrical communication system according to the theory of electrical communication	OPK-3
62.		Structural diagram of the receiver of the electrical communication system according to the theory of electrical communication	OPK-3
63.		The partial representation of the signal by the Fourier trigonometric series has the form $s(t) = A_0 + \sum_{n=1}^{\infty} (a_n \cos(2\pi n f t) + b_n \sin(2\pi n f t)) =$ $= A_0 + \sum_{n=1}^{\infty} A_n \cos\left(\frac{2\pi n}{T} t + \psi_n\right)$ Define the name of the letter parameters in this expression.	OPK-3
64.		Determine the bandwidth of a binary telegraph channel if it has a transmission rate of 1000 bps and an error probability of 10^{-3} and conclude how the bandwidth of this channel differs from the ideal one.	OPK-3
65.		Structural diagram and brief description of the optimal Kotelnikov receiver	OPK-3
66.		Structural diagram and brief description of a non-coherent receiver of discrete amplitude-modulated signals.	OPK-3
67.		Mathematical models of discrete communication channels.	OPK-3
68.		Analysis of discrete message compression methods.	OPK-3
69.		Basic parameters of correction codes.	OPK-3
70.		Principles of building correction codes, decoding without correction and with error correction.	OPK-3
71.		Features of encoding and decoding cyclic codes.	OPK-3

72.		Basics of adaptive interference rejection.	OPK-3
73.		Methods of combating signal fading.	OPK-3
74.		Methods of Combating Intersymbol Interference..	OPK-3
75.		Methods for allocating a shared channel resource.	OPK-3

Description of the grading scale

Within the framework of the rating system, students' progress in each discipline is assessed during current control and intermediate certification.

Criteria for assessing competencies

An "excellent" grade is given to a student if he/she completes the tasks of the assessment tools in the discipline related to this competence (indicators of competence achievement) in full and without errors, while demonstrating at a high level the ability to solve standard and non-standard applied practical problems of the theory of electrical communications.

A "good" grade is given to a student if he/she, making minor mistakes, performs the tasks of assessment tools in the discipline related to this competence (indicators of competence achievement), while demonstrating at an average level the ability to solve only standard applied practical problems of the theory of electrical communications.

A "satisfactory" grade is given to a student if he/she performs the tasks of assessment tools in the discipline related to this competence (indicators of competence achievement), while demonstrating at a minimum level the ability to solve standard applied practical problems of the theory of electrical communications.

An "unsatisfactory" grade is given to a student if he/she, performing the tasks of the assessment tools in the discipline, does not reach the minimum level of competence formation ((indicators of competence achievement), while not demonstrating the ability to solve standard applied practical problems of the theory of electrical communication, makes gross mistakes that he cannot correct even with the help of leading questions from the teacher.