


**"I APPROVE"**

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**Control questions of the final control on the discipline "SIGNALS AND SYSTEMS" for students of the 3rd year, on the Direction of education 60611000 - Telecommunication Technology (Telecommunication, Broadcasting, Mobile communication).**

1. What is a signal spectrum? What are signal spectra used for?
2. What characteristics are called spectral? Name the main types of spectral characteristics.
3. What mathematical apparatus is used for spectral representation of a periodic signal?
4. What does spectrum analysis include? Define the amplitude spectrum.
5. Give the formula for decomposing periodic pulses into a Fourier series.
6. Define the concept of a periodic signal.
7. What is meant by a signal spectrum?
8. What is called the amplitude spectrum of a signal?
9. What is called the phase spectrum of a signal?
10. What is called the width of a spectrum?
11. Draw the spectrum of an infinitely long sinusoid.
12. How many forms of Fourier series are there? Provide their analytical notation.
13. What are the amplitude and phase spectra of periodic signals?
14. Write expressions for the direct and inverse Fourier transform.
15. Give the concept of the width of a spectrum; how does it depend on the pulse duration?
16. What formulas are used to calculate the spectral density of a signal?
17. What is the dimension of the spectral density of a signal?
18. What are the amplitude and phase spectra of non-periodic signals?

19. What spectrum does a delta pulse have?
20. What is the difference between the spectra of periodic and non-periodic signals?
21. Write down the direct and inverse Fourier transforms if the frequency is measured in Hz.
22. What are the differences between the spectra of periodic and non-periodic signals?
23. What is called the inverse Fourier transform?
24. Give the concept of a delta function.
25. What is the modulation coefficient? How is it determined.
26. Why does the carrier oscillation have a higher frequency?
27. Under what conditions does overmodulation occur?
28. Draw a timing diagram of a complex Amplitude modulation signal.
29. How is the spectrum width of a single-tone Amplitude modulation signal determined? Draw the appearance of this spectrum.
30. How is the spectrum width of a complex Amplitude modulation signal determined? Draw the appearance of this spectrum.
31. What is modulation? Name its types.
32. What does the frequency spectrum width depend on in amplitude modulation?
33. What are side frequencies and sidebands?
34. What is the spectral composition of an Amplitude modulation signal?
35. How are the spectral components of an Amplitude modulation signal located relative to the carrier frequency.
36. What is amplitude modulation? Write the analytical expression for an Amplitude modulation signal.
37. What is modulation depth?
38. How are the spectrum width of the modulating signal and the spectrum width of the modulated signal related in Amplitude modulation?
39. How is power distributed between the components of an Amplitude modulation signal?
40. Draw the simplest diagram of an amplitude modulator.

41. What is a static modulation characteristic? How can the modulator operating mode be selected based on the static modulation characteristic?
42. Explain the purpose of the transistor and oscillatory circuit in the amplitude modulator.
43. Explain the purpose of the diode and RC circuit in the amplitude detector.
44. How are the parameters of the RC detector circuit selected?
45. What is called Amplitude modulation oscillation detection?
46. Draw the detection characteristic for a linear and quadratic detector.
47. Draw the circuit diagram of a diode detector, explain the operating principle. Draw the time diagrams of currents and voltages.
48. What determines the operating mode of a diode detector?
49. What are the advantages of a linear detector over a quadratic detector?
50. What is called frequency modulation?
51. Draw the circuit diagram of a frequency modulator with a varicap. Explain the principle of its operation.
52. Draw the time and spectral diagrams of a signal with frequency modulation.
53. How is the bandwidth of a frequency modulated signal determined?
54. Define frequency deviation and frequency modulation index.
55. Draw a circuit diagram of a frequency detector with one and two detuned oscillatory circuits.
56. What is called the detection characteristic of a frequency detector?
57. What is called the static modulation characteristic of a frequency modulator?
58. Define an Frequency modulation signal.
59. Write an expression for a tone frequency modulation signal.
60. Define frequency modulation.
61. Define the modulation index and frequency deviation.
62. How is the practical bandwidth of an an Frequency modulation signal determined?
63. Draw a block diagram of a synchronous detector and explain why it includes a multiplier and a low-pass filter.
64. What is the phase sensitivity of a synchronous detector?

65. What is signal sampling in time?
66. Formulate the Kotelnikov theorem and write down the Kotelnikov series
67. Draw a graph and explain the properties of the basis function of the Kotelnikov series.
68. How is a sampled signal restored?
69. What is called an ideal low-pass filter?
70. What is called the impulse response of a radio engineering device?
71. What does the impulse response of an ideal low-pass filter look like?
72. Draw a functional diagram of a digital communication system for transmitting analog signals.
73. Classify discrete types of modulation.
74. What is discrete amplitude modulation? Draw a timing diagram.
75. What is discrete frequency modulation? Draw a timing diagram.
76. What is discrete phase modulation? Draw a timing diagram.
77. What is relative phase modulation? Draw a timing diagram.
78. Write the expression for an amplitude-keyed signal. Explain it.
79. Write the expression for a frequency-keyed signal. Explain it.
80. Write the expression for a phase-keyed signal. Explain it.
81. Draw the block diagram for obtaining an amplitude-keyed signal and its timing diagrams.
82. Draw the block diagram for obtaining a frequency-keyed signal and its timing diagrams.
83. Draw the block diagram for obtaining a phase-keyed signal and its timing diagrams.
84. What is called probability density? What random events are characterized by probability density? What is the unit of measurement of probability density?
85. How is probability density related to the integral distribution function?
86. How can we determine the probability of finding values of a random variable in a given interval if the probability density is known?
87. What is called the mathematical expectation of a random process? Explain its physical meaning?

88. What is called the variance of a random process? Explain its physical meaning?
89. What signals are called random?
90. Which random processes are stationary and ergodic?
91. Write down the Wiener-Khinchine transform and name its main properties.
92. What is "quasi-white noise" and "white noise"?
93. Give an expression for the probability density of the normal distribution law and its graph.
94. Give an expression for the probability density of the uniform distribution law and its graph.
95. Give an expression for the probability density of the Rayleigh law and its graph.
96. Correlation characteristics of random processes.
97. Stationary and ergodic random processes.
98. Which random processes are called stationary?
99. Which random processes are called stationary? Provide definitions of strict stationarity and stationarity in the "broad" sense; give examples.
100. How are the correlation interval and the width of the energy spectrum of a random process related?
101. Write down expressions for the main statistical characteristics (mathematical expectation, variance)
102. How can we determine the probability of finding values of a random variable in a given interval if the probability density is known?
103. What is called the mathematical expectation of a random process? Explain its physical meaning?
104. What is called the variance of a random process? Explain its physical meaning?
105. Which signals are called random?
106. List the main properties of the function and probability density of the distribution of a random variable.
107. What are the main numerical characteristics that describe random processes?
108. Explain the algorithm of the optimal coherent demodulator for the binary AM system

109. Give a geometric interpretation of the optimal reception problem.
110. List the optimality criteria for receiving discrete signals, explain the relationship between them.
111. Write down the algorithm of the optimal coherent demodulator using the maximum likelihood criterion.
112. Write down the algorithm of the optimal coherent demodulator for the binary AM system and draw its functional diagram.
113. What is the "ideal observer criterion"?
114. What is the "maximum likelihood rule"?
115. Give a geometric interpretation of the optimal reception problem.
116. What is meant by the term "Coherent reception"?
117. Give a geometric interpretation of the problem of optimal reception.
118. Write down the algorithm of the optimal coherent demodulator using the maximum likelihood criterion.
119. Write down the algorithm of the optimal coherent demodulator for the binary AM system and draw its functional diagram.
120. What is the "ideal observer criterion"?
121. What is the "maximum likelihood rule"?
122. Draw a structural scheme for obtaining an amplitude-manipulated signal and its time diagrams.
123. Draw a structural scheme for obtaining a frequency-manipulated signal and its time diagrams.
124. Draw a structural scheme for obtaining a space-manipulirovannogo signal and its time diagrams.
125. A periodic signal is given with harmonic component amplitudes  $A_k = \{2, 4, 3, 2, 1, 0.5\}$ . The frequency of the periodic signal is  $f = 2$  kHz. Using this data, plot the amplitude spectrum.
126. A periodic signal is given with the phases of harmonic components  $\phi_k = \{0, 30, 90, -60, 60, 120\}$ . The frequency of the periodic signal is  $f = 2$  kHz. Using this data, plot the phase spectrum.

**Authors**



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