SUBJECT : Principles of Data Communications
CODE : XCS244
CLASS : IV Semester
DEPARTMENT : MSc SE/CT

Name of Staff : Anusha Linda Kostka J

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Department : MSc SE/CT/IT

Part A

1. Define frequency multiplexing.
   A method by which multiple transmission occurs in a single communication channel is called multiplexing. Individual messages are transferred to a new position in the frequency spectrum. Such a multiplexing is called frequency multiplexing.

2. What is a modulated carrier?
   The operations performed on the signal to achieve frequency multiplexing result in the generation of a waveform which may be described as the carrier modified in its amplitude, frequency or phase individually or in a combination varies with time. Such a modified carrier is a modulated carrier.

3. Give the general equation for auxillary sinusoidal signal?
   $A_m Coswt$

4. Give the general equation for a frequency translated waveform?
   $Vc(t)Vm(t) = AmAc/4 [e^{j(Wc+Wm)t} + e^{-j(Wc+Wm)t} + e^{j(Wc-Wm)t} + e^{-j(Wc+Wm)t}]$

5. What are the four spectral components of amplitude AmAc/4?
   Fc+Fm, Fc-Fm, -Fc+Fm, -Fc-Fm

6. What is a baseband frequency range or baseband?
   The spectral range occupied by the original signal is called baseband or baseband frequency range.

7. Define heterodyning or mixing?
   The operation of multiplying a signal with an auxillary sinusoidal signal is called mixing or heterodyning.

8. What are upper sideband and lower sideband signals?
   The signal which consist of spectral components above the auxillary signal in the range Fc to Fc+ Fm is called upper sideband signal and spectral components below the auxillary signal in the range Fc-Fm to Fc is called the lower sideband signal.

9. How will you recover a baseband signal?
   The recovery may be achieved by a reverse translation which is accomplished by multiplying the translated signal with CosWct.

10. How is a double frequency signal removed?
    The spectral range of the double frequency signal and the baseband signal are widely separated. Therefore the double frequency signal is easily removed by a low pass filter.

11. What is amplitude modulation?

The process of recovering the baseband signal is called amplitude modulation. The general equation is,

$$V(t) = Ac[1+m(t)]\text{Cos } Wct$$

12. Define demodulation or detection?
    The recovery of the baseband signal is referred to as amplitude modulation.

13. What are the methods of demodulation in Am?
    a. Diode circuit
    b. Non linear device or Square law demodulator

14. Define percentage modulation?
    The extent to which a carrier is amplitude modulated is expressed is percentage modulation.

15. What happens when modulation is symmetrical?
    If the modulation is symmetrical, the percentage modulation is defined as P is given by,

$$\frac{P}{100\%} = \frac{Ac(max) - Ac}{Ac} = \frac{Ac - Ac(min)}{Ac} = \frac{Ac(max) - Ac(min)}{2Ac}$$

16. What are the methods of generating single sideband signal?
    a. Filter method
    b. Phasing method

17. Give the relationship between phase and frequency modulation?
    a. Modulating signal →Integrator →Phase modulator = Frequency modulated signal
    b. Modulating signal →Differentiator →Frequency modulator = Phase modulated signal

18. Define frequency deviation.
    The maximum departure of the instantaneous frequency from the carrier frequency is the frequency deviation.

19. State Carson's rule.
    Carson's rule states the bandwidth is twice the sum of the frequency deviation.

20. How is the FM signal generated?
    a. Parameter Variation method
    b. Indirect method or Armstrong method

21. State Sampling theorm.
    Let m(t) be a signal which is bandlimited such that its highest frequency spectral component is Fm. Let the values of m(t) be determined at regular intervals separated by $Ts <= 1/ 2F_m$. Then these samples m(nTs) determine

the signal and the signal is reconstructed from these samples with no distortion.

22. Define guard band.
    The range from F_m to F_s-F_m Where F_s is the sampling rate is called the guard band.

23. What is quantization noise.
    The difference $m(t)$-$m_q(t)$ is noise and is called Quantization noise where $m_q(t)$ is the quantized noise.

24. What is Quantization error.
    The difference or error due to the quantization process is called quantization error.

25. What is entropy?
    The average information is referred to as entropy.

26. Define information rate.
    If the source of the messages generates messages at the rate r messages per second then the information rate is defined to be,
    R=rH = average number of bits of information/second.

27. State Shannon's theorm.
    Given a source of M equally likely messages with M>1, which is generating information at the rate R. Given a channel with the channel capacity C then if,
    R<=C There exists a coding technique such that the output of the source maybe transmitted over the channel with a probability of error in he received message which may be small.

28. What is the channel capacity of bandlimited guassian channel?
    $$C = B \log (1 + S/N) \text{ bits/s}$$

29. Give examples of algebraic codes.
    Single parity-check Bit code, Repeated codes, Hadamard code, Hamming code, Extended code,Cyclic code, Golay Code, BCH codes.

30. Differentite guided media and unguided media?
    In guide media the waves are guided along a physical path.
    Eg, Twisted pair, coaxial cable, optical fiber.
    Unguided media provide a means of transmitting electromagnetic waves but do not guide them.
    Eg, Propagation through air, vaccum and sea water.
31. Define direct link?
    It is the transmission path between two devices in which signals propagate directly from the transmitter to receiver with no intermediate devices.

32. Define simplex transmission.

The signals are transmitted in only one direction one is the transmitter and the other is the receiver.

33. Define half duplex transmission.
    Both the stations transmit, but only one at a time.

34. Define full duplex transmission.
    Both stations may transmit simultaneously.

35. What is a continuous signal?
    A continuous signal is one in which the signal intensity varies in a smooth fashion over time.

36. What is a discrete signal?
    A discrete signal is one in which the signal intensity maintains a constant level for some period of time and the changes to another constant level.

37. How is a sine wave represented?
    A sine wave is represented by three parameters:
    a. peak amplitude(A)
    b. Frequency (f)
    c. Phase

38. Define peak amplitude.
    The peak amplitude is the maximum value or strength of the signal over time. It is measured in volts.

39. What are signals?
    Signals are electric or electromagnetic representation of data.

40. Define signaling.
    Signaling is the physical propagation of the signal along the suitable medium.

41. Define transmission.
    Transmission is the communication of data by the propagation and processing of signals.

42. What are the most significant transmission impairments?
    a. Attenuation and attenuation distortion
    b. Delay distortion
    c. Noise.
43. What are the categories of noise?
    a. Thermal noise
    b. Intermodulation noise
    c. Crosstalk
    d. Impulse noise.

44. What is thermal noise?
    Thermal noise is due to thermal agitation of electrons.

45. Define intermodulation noise.
    When signals at different frequencies share the transmission medium, an intermodulation noise occurs.

46. Define channel capacity.
    The maximum rate at which data can be transmitted over a given communication path or channel is referred to as channel capacity.

47. What is an error rate.
    The rate at which the error occurs, where an error is the reception of a 1 when a 0 was transmitted or the reception of a 0 when a 1 was transmitted.

48. What is signal to noise ratio (SNR)?
    It is the ratio of power in a signal to the power contained in the noise that is present at a particular point in the transmission.

49. What is synchronous transmission?
    Data are transmitted one character at a time, where each character is 5 to 8 bits in length.

50. What is Synchronous transmission?
    A block of bits is transmitted in a steady stream without start and stop codes.

51. What are the errors that occur in asynchronous transmission?
    a. Last sampled bit is incorrectly received.
    b. Bit count may be out of alignment.

52. What is framing error in asynchronous transmission?
    If bit 7 is 1 and bit 8 is 0, bit 8 could be mistaken for a start bit. This condition is termed as framing error.

53. Define a frame in synchronous transmission.
    The data plus preamble, post-amble, and control information are called a frame.
54. What are the characteristics that distinguish various data link configurations?
    a. Topology
    b. Whether the link is half duplex or full duplex.
55. Define a topology.
    Topology of a data link refers to the physical arrangement of stations ona transmission medium.

56. How are the data exchanges over a transmission line classified?
    a. Full duplex
    b. Half duplex
    c.
57. What are DTE and DCE?

The devices which include terminals and computers are referred to as data terminal equipment and the DTE makes use of transmission system through the mediation of DCE.

58. Give an example of DCE.
    Modem

59. What are interchange circuits?
    Both data and control information are exchanged which is done over a set of wires referred to as interchange circuits.

60. What are the characteristics of an interface?
    a. Mechanical
    b. Electrical
    c. Functional
    d. Procedural

61. Briefly define the characteristics of an interface?
    a. Mechanical – actual physical connection of the DTE to the DCE.
    b. Electrical – voltage levels and timing of voltage changes.
    c. Functional – specify functions that are performed by assigning meanings to each of the interchange circuits.
    d. Procedural – sequence of events for transmitting data based on functional characteristics of the interface.

62. State one of the widely used interface?
    V.24

63. What are the various encoding techniques?
    a. Digital data,digital signal
    b. Digital data, analog signal
    c. Analog data, digital signal
    d. Analog data, analog signal

64. Give an example for digital encoding of digital data?
    NRZI, Bipolar AMI, Pseudo-ternary

65. Give an example for digital data, analog signal?
    Modem

66. What are the basic techniques of digital data, analog signal?
    a. ASK
    b. FSK
    c. PSK

67. Give an example for digitization of analog signals?
    Pulse Code Modulation.

68. What are the techniques used for analog data, digital signal?
    a. Pulse code Modulation

b. Delta Modulation

69. What are the techniques used for analog data,analog signal?
    a. Amplitude modulation
    b. Frequency modulation
    c. Phase modulation

70. What is digital signaling?
    A data source g(t), which may be either digital or analog is encoded into a digital signal x(t). The actual form of x(t) depends on the encoding technique and is called digital signaling.

71. What is analog signaling?
    The transmission of carrier is done by modulation is called analog signaling.

72. Define unipolar and polar signaling?
    If the signal elements all have the same algebraic sign ie positive or negative then the signal is unipolar. In polar signalingone is represented as positive and other negative.

73. Define data rate.
    The rate at which data elements are transmitted.

74. What is a signal element?
    The part of the signal that occupies the shortest interval of a signaling code.

75. Define modulation rate?
    The rate at which signal elements are transmitted are modulation rate. It is measured in baud.

76. Give an example of differential encoding?
    NRZI

77. What are the common techniques of biphase?
    a. Manchester
    b. Differential Manchester

78. What are the advantages of biphase?
    a. Synchronization
    b. No dc component
    c. Error detection

79. What is the transmission bandwidth for ASK?
    $B_T = (1+r) R$

80. What is digitization?
    Digitization is the process of converting analog data into digital signal.

81. What is companding?
    Companding is a process that compresses the intensity range of the signal by imparting more gain to weak signals than to strong signals on input.

82. What are the important parameters in a DM scheme?
    a. The size of the step assigned to each binary digit
    b. Sampling rate

83. What are the various forms of data link control?
    a. Flow control.
    b. Error Control
    c. High level data link control.

84. What is a datalink?
    When a data link control protocol is used, the transmission medium between systems is referred to as data link.

85. What is a flow control?
    It is a technique which enables a receiver to regulate the flow of data from a sender so that that the receiver buffer do not overflow.

86. What are the various methods of flow control?
    a. Stop and wait flow control.
    b. Sliding window flow control.

87. What are the reasons for the breakage of large data blocks into smaller blocks?
    a. The buffer size of the receiver may be limited.
    b. The longer the transmission, the more likely there will be error retransmission of the entire frame.

88. Compare propagation time and a transmission time?
    The transmission time is normalized to 1 and the propagation delay is expressed as the variable a. So when a is less than 1, the propagation time is less than the transmission time, When a is greater than 1 the propagation time is greater than transmission time.

89. What is an error control?
    It refers to the mechanism to detect and correct errors that occur in the transmission of frames.

90. What are the types of errors?
    a. Lost frame.
    b. Damaged frame

91. What are the common techniques of error control?
    a. Error detection
    b. Positive acknowledgement
    c. Retransmission after timeout.
    d. Negative acknowledgement and retransmission

92. What are the versions of ARQ?
    a. Stop and wait ARQ
    b. Go back N ARQ
    c. Selective reject ARQ

93. What are the basic characteristics of HDLC?
    a. Three types of stations
    b. Two link configurations
    c. Three data transfer modes of operation.

94. What are types of stations in HDLC?
    a. Primary station
    b. Secondary station
    c. Combined station

95. What are the types of link configurations?
    a. Unbalanced configuration
    b. Balanced configuration

96. What are the data transfer modes?
    a. Normal Response modes
    b. Asynchronous balanced mode
    c. Asynchronous response mode.

97. What is data transparency?
    With the use of bit stuffing, bit patterns can be inserted into the data field of the frame. This property is known as data transparency.

98. What are the types of frames in HDLC?
    a. Information frames
    b. Supervisory frames
    c. Unnumbered frames

99. What is a frame check sequence field?
    The frame check sequence is an error detecting code calculated from the remaining bits of the frame, exclusive of flags.

100. What are the forms of multiplexing?
    a. Frequency division multiplexing
    b. Time division multiplexing

Part B (16 marks)

1. Explain the method of translation and draw the spectrum of those sinusoidal signals?

   $A_m Coswt$

   The general equation for a frequency translated waveform?

   $Vc(t)Vm(t) = AmAc/4 [e^{j(Wc+Wm)t} + e^{-j(Wc+Wm)t} + e^{j(Wc-Wm)t} + e^{-j(Wc+Wm)t}]$

   The four spectral components of amplitude AmAc/4?

   Fc+Fm, Fc-Fm, -Fc+Fm, -Fc-Fm

   Baseband frequency range or baseband

   The spectral range occupied by the original signal is called baseband or baseband frequency range.

   Heterodyning or mixing

   The operation of multiplying a signal with an auxillary sinusoidal signal is called mixing or heterodyning.

   Upper sideband and lower sideband signals

   The signal which consist of spectral components above the auxillary signal in the range Fc to Fc+ Fm is called upper sideband signal and spectral components below the auxillary signal in the range Fc-Fm to Fc is called the lower sideband signal.

2. Explain the generation of SSB signals?
   a. Filter method
   b. Phasing method
   c. Block diagrams and equations

3. Explain the demodulation of AM signals?

   Square law demodulator

   Recovering baseband signal

   $Y=kx^2$

   Graph for the given equation

4. Explain the method of frequency translation of FM and draw the spectrum.

   $V(t) = Cos (Wct + B Sin Wm t)$

   Sub the values of $Cos (Wct + B Sin Wm t)$

   And derive the equations

   $V(t) = J0(B) Cos Wct – J1(B)[Cos (Wc-Wm)t – Cos (Wc-Wm)t]$

   $+ J2(B)[Cos(Wc-Wm)t + Cos (Wc-Wm)t] -…….$

5. Explain the methods of generation of Fm signals.
   a. Parameter Variation Method
   b. Indirect method or Armstrong method

6. Explain the method of demodulation of FM signal.
   a. FM Demodulation
   b. Frequency Selective network
   c. Block Diagram

7. Explain the use of orthogonal signal to attain Shannon's limit.
    a. Orthogonal signals
    b. Property- Integration of S $i(t)^2$ = Es
    c. Calculation of error probability
        i. Probability e1 and e2 are smaller than e i
        ii. Probability Pl such that ei is greater than other outputs

8. Explain soft decision coding in detail.
    The power signal & waveform combined with noise and subjected to a correlator gives the sample value of time.
    General equations of code word ci.
    Expected value of $E(n_i^2)$, $E(n_j^2)$, $E(n_i n_j)$

9. Give some examples of algebraic codes.
    Single parity-check Bit code, Repeated codes, Hadamard code, Hamming code, Extended code,Cyclic code, Golay Code, BCH codes.

10. Explain synchronous and asynchronous transmission.
    synchronous transmission
    Data are transmitted one character at a time, where each character is 5 to 8 bits in length.
    Synchronous transmission
    A block of bits is transmitted in a steady stream without start and stop codes.
    the errors that occur in asynchronous transmission
    a. Last sampled bit is incorrectly received.
    b. Bit count may be out of alignment.
    framing error in asynchronous transmission
    If bit 7 is 1 and bit 8 is 0, bit 8 could be mistaken for a start bit. This condition is termed as framing error.
    frame in synchronous transmission.
    The data plus preamble, post-amble, and control information are called a frame.
    Block diagrams

11. Explain the various transmission media.
    a. Twisted pair
    b. Optic fiber
    c. Coaxial cable

12. Explain the various transmission impairments?
    Transmission is the communication of data by the propagation and processing of signals.
    the most significant transmission impairments?
    a. Attenuation and attenuation distortion
    b. Delay distortion
    c. Noise.

the categories of noise

a. Thermal noise
b. Intermodulation noise
c. Crosstalk
d. Impulse noise.

thermal noise

Thermal noise is due to thermal agitation of electrons.

Intermodulation noise.

When signals at different frequencies share the transmission medium, an intermodulation noise occurs.

13. Explain the concept of interfacing with example.

The devices which include terminals and computers are referred to as data terminal equipment and the DTE makes use of transmission system through the mediation of DCE.

an example of DCE - Modem

interchange circuits - Both data and control information are exchanged which is done over a set of wires referred to as interchange circuits.

The characteristics of an interface

a. Mechanical
b. Electrical
c. Functional
d. Procedural

The characteristics of an interface

a. Mechanical – actual physical connection of the DTE to the DCE.
b. Electrical – voltage levels and timing of voltage changes.
c. Functional – specify functions that are performed by assigning meanings to each of the interchange circuits.
d. Procedural – sequence of events for transmitting data based on functional characteristics of the interface.

One of the widely used interface

V.24

14. Explain the various signal encoding techniques?

a. Digital data Digital signal – binary 0 and binary 1
b. Digital data Analog signal – ASK, FSK, PSK
c. Digital data Analog signal – PCM, DM
d. Analog data, Analog signal – AM, FM, PM

15. Explain the Pulse code modulation.

Sampling theorm
PCM block Diagram
Companding
Effect of nonlinear coding

16. Explain Delta modulation.
    Popular alternative to PCM – DM
    A 1 is generated if the staircase function is to go up during the next interval; a 0 is generated otherwise
    The important parameters in a DM scheme?
        e. The size of the step assigned to each binary digit
        f. Sampling rate
    Diagrams

17. Explain the definitions for digital signal encoding formats?
    a. Non Return to Zero (NRZ)
    b. Non return Zero Inverted
    c. Bipolar AMI
    d. Pseudoternary
    e. Manchester
    f. Differential Manchester
    g. B8ZS
    h. HDB3
    Diagrams

18. Explain the flow controls with diagrams?
    a. Stop and Wait Flow control
    b. Sliding Window Flow Control

19. Explain error control with diagrams.
    a. Stop and wait ARQ
    b. Go back N ARQ
    c. Selective Reject ARQ

20. Explain HDLC of data link control.
    a. Basic characteristics
    b. Frame Structure-Flag, Address, Control, Information, Frame check sequence
    c. Operation