CHAPTER 5

Encoding and Modulating

5.1 REVIEW QUESTIONS

1. In this text, modulation is transformation of a digital or analog signal into another analog signal; encoding is the conversion of streams of bits into a digital signal.
2. Digital-to-digital encoding is the conversion of digital information into a digital signal.
3. Analog-to-digital conversion is the transformation an analog signal into a digital signal using sampling.
4. Digital-to-analog conversion is the modulation of a digital signal into an analog signal.
5. Analog-to-analog conversion is the modulation of an analog signal into another analog signal.
6. Amplitude modulation is more susceptible to noise.
7. QAM combines both ASK and FSK and provides many combinations of amplitude and phase. Each combination can represent more than one bit.
8. Unipolar encoding uses only one voltage level. Polar encoding uses two levels, positive for 1, negative for 0 (or vice versa), and bipolar encoding uses two alternating levels for bit 1 and zero voltage for bit 0 (or vice versa).
9. The DC component is the constant portion of a signal.
10. A synchronization problem can occur when a data stream includes a long series of 1s and 0s. A timer may have trouble determining the beginning and end of each bit.
11. In NRZ-L the signal depends on the state of the bit: a positive voltage is usually a 0, and the negative a 1. In NRZ-I the signal is inverted when a 1 is encountered.
12. Manchester encoding uses the inversion at the middle of a bit interval for both synchronization and bit representation. In differential Manchester encoding the transition at the middle of a bit is used only for synchronization, while the inversion or its absence at the beginning of the bit shows the bit representation.

13. The major disadvantage of NRZ encoding is the lack of a synchronization method for long streams of 0s or 1s. Both RZ and biphase encoding feature a signal change at the middle of each bit that is used for synchronization.
14. Both methods convert digital data into digital signals. In RZ, a 1 bit is represented by positive-to-zero, and 0 by negative-to-zero, whereas in bipolar AMI a 0 is represented by a zero voltage, while 1 is represented by alternating positive and negative values.
15. AMI, B8ZS, HDB3
16. B8ZS and HDB3 are conventions adopted to provide synchronization in a long string of 0s. B8ZS is a North American convention and HDB3 is used in Europe and Japan. Both apply to bipolar AMI and are based on violations of the standard pattern. In B8ZS violations are introduced for 8 or more consecutive 0s in the data stream. In HDB3 violations are introduced for 4 or more consecutive 0s.
17.
    a. PAM
    b. Quantization
    c. Binary encoding
    d. Digital-to-digital encoding
18. The higher the number of samples taken the more accurate the digital reproduction of an analog signal.
19. The higher the number of bits allotted for each sample the more precise the digital representation of the signal will be.
20. ASK, FSK, PSK, and QAM.
21. Bit rate is the number of bits transmitted during one second, whereas baud rate is the number of signal units, which can represent more than one bit, transmitted per second. In ASK both the bit and baud rates are the same. In PSK and QAM the baud rate is less than or equal to the bit rate of the signal.
22. Modulation is the process of modification of one or more characteristics of a carrier signal by an analog signal that needs to be transmitted.
23. The carrier signal is a high-frequency signal that is modulated by the information signal.
24. ASK: the bandwidth is almost equal to the baud rate.
25. FSK: the bandwidth is almost equal to the baud rate plus the frequency shift.
26. PSK: the bandwidth is almost equal to the baud rate.
27. Amplitude and phase of each signal unit; number of bits per baud.
28. QAM: the bandwidth is almost equal to the baud rate.
29. QAM is a combination of PSK and ASK.
30. PSK is based on phase shift and therefore is less susceptible to noise.
31. AM is used for analog-to-analog conversion, ASK for digital-to-analog.
32. FM is used for analog-to-analog conversion, FSK for digital-to-analog.

33. The bandwidth of an AM carrier signal is twice the bandwidth of the modulating signal, whereas the bandwidth of an FM signal is 10 times the bandwidth of the modulating signal.

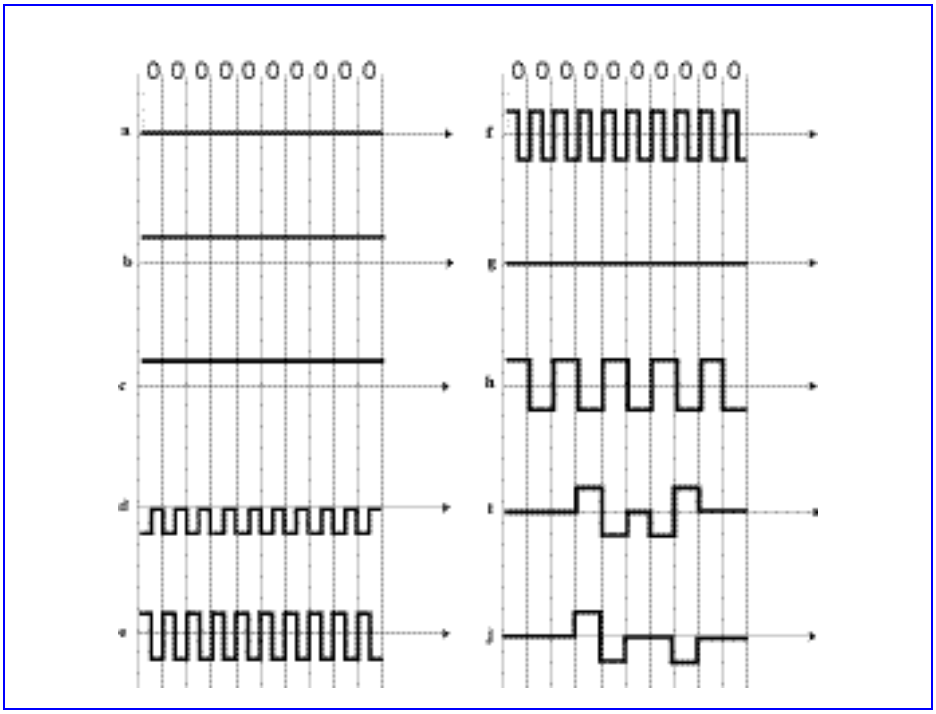
5.2 MULTIPLE CHOICE QUESTIONS

34. b 35. a 36. d 37. c 38. a 39. b 40. d 41. c 42. d 43. d
44. c 45. d 46. c 47. a 48. b 49. d 50. a 51. c 52. a 53. a
54. d 55. b 56. b 57. b 58. a 59. b 60. c 61. c 62. b 63. d
64. d 65. c 66. b 67. b 68. d 69. d

5.3 EXERCISES

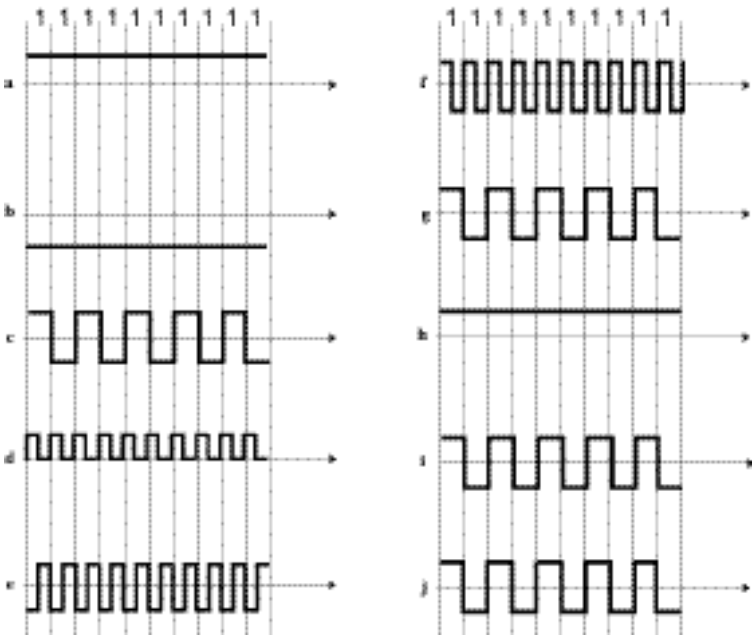
70.
    a. 5 s: 5000 bits
    b. 1/5 s: 200bits
    c. 100 ms: 100 bits
71. See Figure 5.1
72. See Figure 5.2
73. See Figure 5.3
74. See Figure 5.4
75. 00100100
76. 11001001
77. 00101101
78. 01110011
79. 00011100
80. 10010010
81. 10001001
82. 01110110
83. 10100000000010
84. 00100000100100
85.
    a. 1 level (plus one zero voltage)
    b. 2 levels
    c. 2 levels
    d. 2 levels (plus zero voltage for half of each bit interval)
    e. 2 levels
    f. 2 levels

Figur e 5.1 *Exercise 71*



86. 8,000 samples per second
87.
    a. Not enough information is given (highest frequency is unknown)
    b. 12,000 samples per second
    c. Theoretically, the sampling rate is 0. However, this is a special case where one sample will do the job.
    d. The frequency is infinity; the sampling rate is infinite (you cannot sample this type of signal).
88. 1/8000 = 0.125 ms
89. 8000 samples/sec
90. Two bits per sample: bit rate = 8,000 × 2 = 16,000.
91.
    a. 2000 bps
    b. 4000 bps
    c. 6000 bps
    d. 3000 bps
    e. 2000 bps
    f. 2000 bps
    g. 1500 bps
    h. 6000 bps

Figur e 5.2 *Exercise 72*



92.

a. 1000 baud
b. 2000 baud
c. 1500 baud
d. 6000 baud

93.

a. 1000 bps
b. 1000 bps
c. 3000 bps
d. 4000 bps

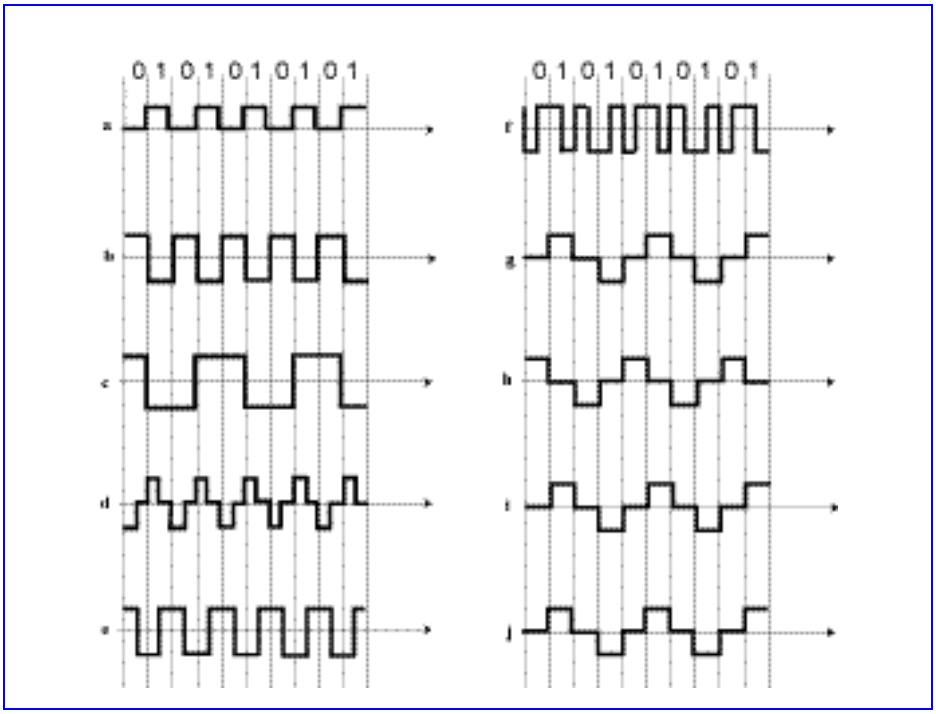
94. See Figure 5.5.

95.

a. 0.91 × 127 = 116 01110100
b. –0.25 × 127 = –32 10100000
c. 0.56 × 127 = 71 01000111

96. It is ASK (2 amplitudes, 1 phase) with 1 bit per baud. See Figure 5.6.
97. It is ASK (2 amplitudes, 1 phase) with 1 bit per baud. See Figure 5.7
98. It is PSK (1 amplitude, 2 phases) with 1 bit per baud. See Figure 5.8
99. It is PSK (1 amplitude, 2 phases) with 1 bit per baud. See Figure 5.9

Figur e 5.3 *Exercise 73*



100. It is 4-QAM (2 amplitudes, 4 phases) with 2 bits per baud. See Figure 5.10
101. ASK
102. PSK
103. QAM
104. QAM
105. No, 12 is not a power of 2.
106. No, 18 is not a power of 2.
107. The number of points in a constellation is a power of 2.
108. Three bits per baud
109.
    a. BW = 4 × 2 = 8 KHz
    b. BW = 8 × 2 = 16 KHz
    c. BW = (3,000 – 2,000) × 2 = 2,000 Hz = 2 KHz
110.
    a. BW = 12 × 10 = 120 KHz
    b. BW = 8 × 10 = 80 KHz
    c. BW = 1,000 × 10 = 10 KHz

Figure 5.4 *Exercise 74*

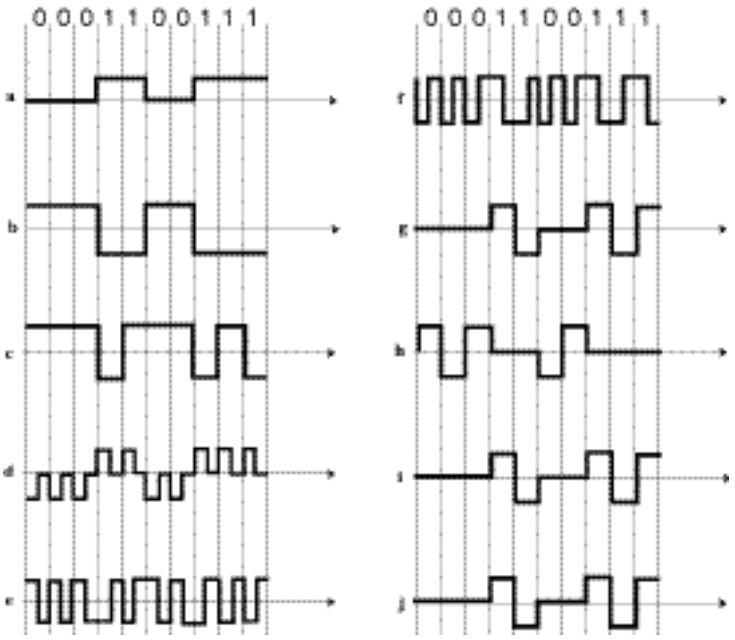


Figure 5.5 *Exercise 94*

Figure 5.6 *Exercise 96*

Figure 5.7 *Exercise 97*

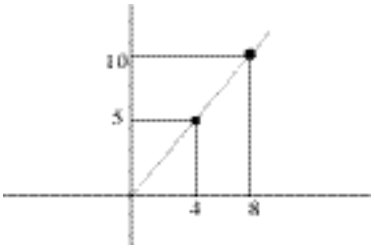


Figure 5.8 *Exercise 98*

Figure 5.9 *Exercise 99*

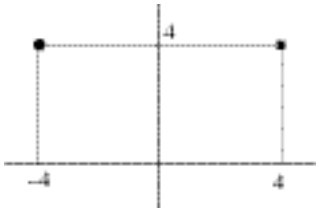


Figure 5.10 *Exercise 100*