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.
3. Analog-to-digital conversion is the transformation an analog signal into a digital signal using sampling.
5. Amplitude modulation is more susceptible to noise.
7. 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.
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.
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.
15. AMI, B8ZS, HDB3
17.
    a. PAM
    b. Quantization
    c. Binary encoding
    d. Digital-to-digital encoding
19. The higher the number of bits allotted for each sample the more precise the digital representation of the signal will be.
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.

23. The carrier signal is a high-frequency signal that is modulated by the information signal.
25. FSK: the bandwidth is almost equal to the baud rate plus the frequency shift.
27. Amplitude and phase of each signal unit; number of bits per baud.
29. QAM is a combination of PSK and ASK.
31. AM is used for analog-to-analog conversion, ASK 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.

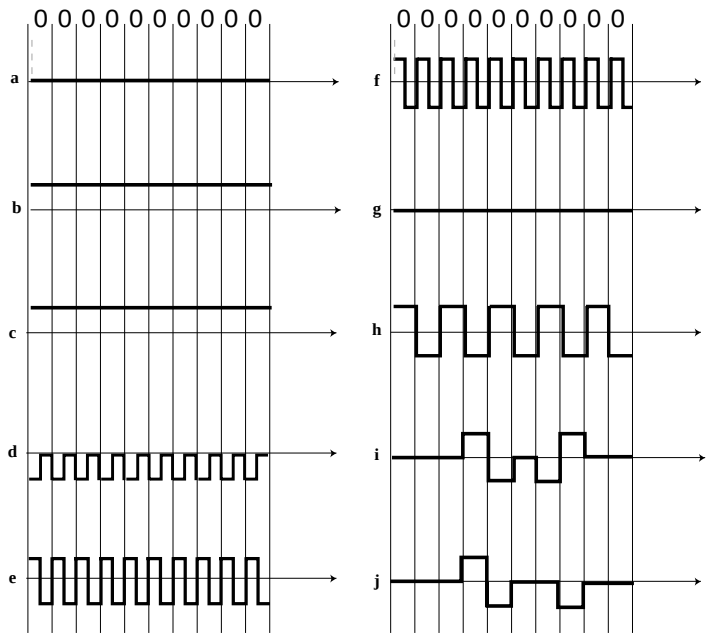
5.2 MULTIPLE CHOICE QUESTIONS

35. a 37. c 39. b 41. c 43. d 45. d 47. a 49. d 51. c 53. a
55. b 57. b 59. b 61. c 63. d 65. c 67. b 69. d

5.3 EXERCISES

71. See Figure 5.1
73. See Figure 5.2
75. 00100100
77. 00101101
79. 00011100
81. 10001001
83. 10100000000010
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
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.

Figure 5.1 *Exercise 71*



d. The frequency is infinity; the sampling rate is infinite (you cannot sample this type of signal).

89. 8000 samples/sec

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
i.

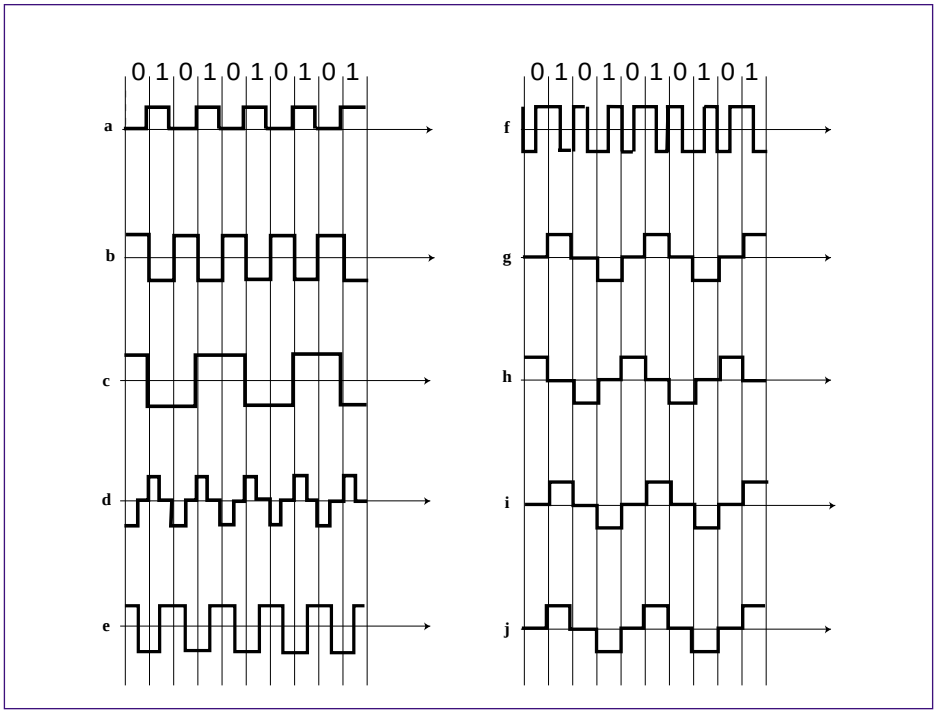
93.

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

95.

a. $0.91 \times 127 = 116 \quad \Rightarrow 01110100$

Figure 5.2 *Exercise 73*

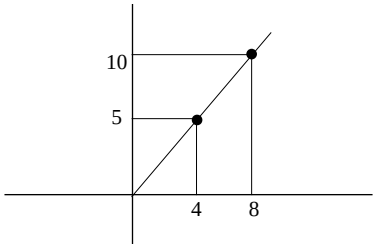


b. $-0.25 \times 127 = -32 \Rightarrow 10100000$

c. $0.56 \times 127 = 71 \Rightarrow 01000111$

97. It is ASK (2 amplitudes, 1 phase) with 1 bit per baud. See Figure 5.3

Figure 5.3 *Exercise 97*



99. It is PSK (1 amplitude, 2 phases) with 1 bit per baud. See Figure 5.4

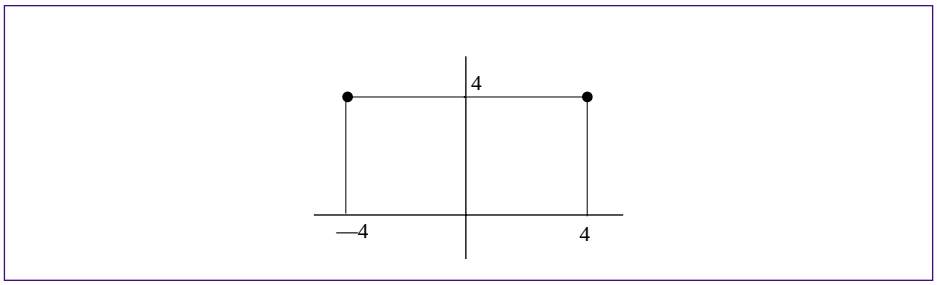
101. ASK

103. QAM

105. No, 12 is not a power of 2.

107. The number of points in a constellation is a power of 2.

Figure 5.4 *Exercise 99*



109.

a. BW = $4 \times 2 = 8$ KHz

b. BW = $8 \times 2 = 16$ KHz

c. BW = $(3{,}000 - 2{,}000) \times 2 = 2{,}000$ Hz = 2 KHz