CHAPTER 3

Signals

Review Questions

1. A sine wave has three characteristics: the amplitude, the period or frequency and the phase. The amplitude is the value of the signal at any point on the wave; it is the distance from a given point on the wave to the horizontal axis. The period is the time a signal needs to complete one cycle and the frequency gives the number of periods in one second. The phase indicates the status of the first cycle and describes the position of the waveform at time zero.
2. The spectrum of a signal is the set of sine waves that constitute the signal.
3. Analog signals have an infinite range of values, while digital signals have a limited number of values.
4. Digital signal.
5. Frequency and period are the inverse of each other. T = 1/ f and f = 1/T.
6. Seconds, milliseconds, microseconds, nanoseconds, and picoseconds are the units of period. Hertz, kilohertz, megahertz, gigahertz, and terahertz are the units of frequency.
7. The amplitude of a signal measures the value of the signal at any point.
8. The frequency of a signal refers to the number of periods in one second.
9. The phase describes the position of the waveform relative to time zero.
10. Time-domain.
11. Fourier analysis.
12. The bit interval is the time needed to send one bit; its counterpart in analog signals is the period.
13. Bit rate refers to the number of bit intervals per second; its counterpart in analog signals is frequency.
14. Attenuation, distortion, and noise
15. Decibel measures the relative strength of two signals or a signal at two different points.
16. Propagation time = distance / propagation speed

17. The wavelength is the distance a simple signal can travel in one period. Wavelength = propagation speed x period
18. The Shannon capacity determines the theoretical highest data rate for a channel.

Multiple-Choice Questions

19. b
20. c
21. a
22. a
23. a
24. b
25. a
26. d
27. d
28. c
29. a
30. b
31. a
32. b
33. a
34. c
35. b
36. a
37. b
38. c
39. b
40. a
41. c
42. d
43. b
44. d
45. d
46. a
47. c

Exercises

48.
   a. 4.17×10^{-2} s, 41.7 ms, 4.17×10^{4} μs, 4.17×10^{7} ns, 4.17×10^{10} ps
   b. 1.25×10^{-7} s, 1.25×10^{-4} ms, 0.125 μs, 1.25×10^{2} ns, 1.25×10^{5} ps

c. 7.14×10^{-6} s, 7.14×10^{-3} ms, 7.14 μs, 7.14×10^{3} ns, 7.14×10^{6} ps
d. 8.33×10^{-14} s, 8.33×10^{-11} ms, 8.33×10^{-8} μs, 8.33×10^{-5} ns, 8.33×10^{-2} ps

49.
a. 0.2 Hz, 2×10^{-4} KHz, 2×10^{-7} MHz, 2×10^{-10} GHz, 2×10^{-13} THz
b. 8.33×10^{4} Hz, 83.3 KHz, 8.33×10^{-2} MHz, 8.33×10^{-5} GHz, 8.33×10^{-8} THz
c. 4.55×10^{6} Hz, 4.55×10^{3} KHz, 4.55 MHz, 4.55×10^{-3} GHz, 4.55×10^{-6} THz
d. 1.23×10^{10} Hz, 1.23×10^{7} KHz, 1.23×10^{4} MHz, 12.3 GHz, 1.23×10^{-2} THz

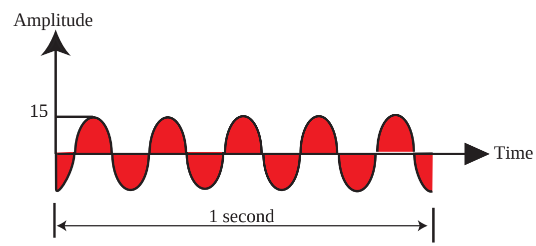
50.
a. 90 degrees
b. 0 degrees
c. 90 degrees
d. 180 degrees

51.
a. 360 or 0 degrees
b. 180 degrees
c. 270 degrees
d. 120 degrees

52.
a. 1/8 cycle
b. 1/4 cycle
c. 1/6 cycle
d. 1 cycle

53. See Figure 3.1

Figure 3.1 *Exercise 53*



54. See Figure 3.2.
55. See Figure 3.3.
56. See Figure 3.4
57. See Figure 3.5
58. See Figure 3.6
59. See Figure 3.7

Figure 3.2 *Exercise 54*

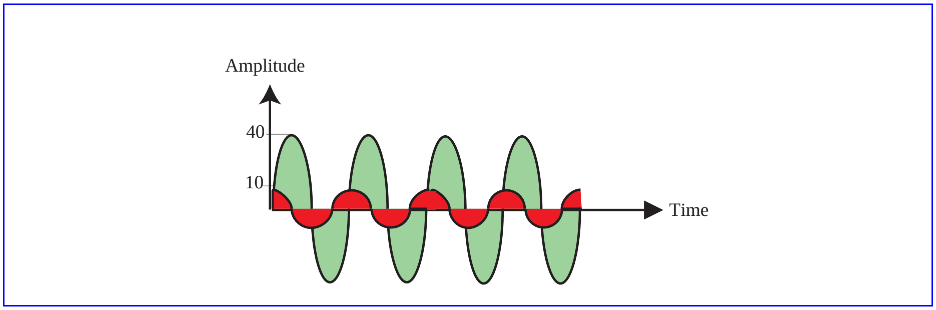


Figure 3.3 *Exercise 55*

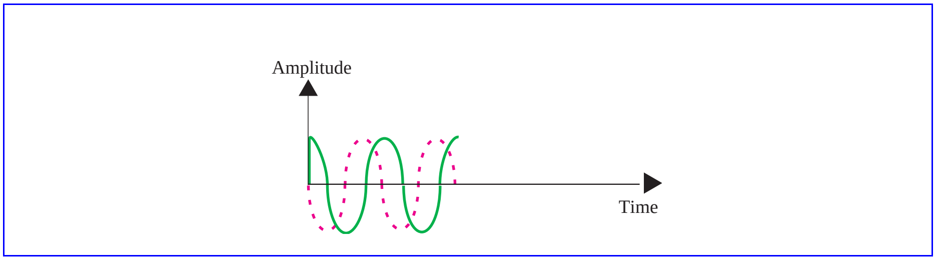


Figure 3.4 *Exercise 56*

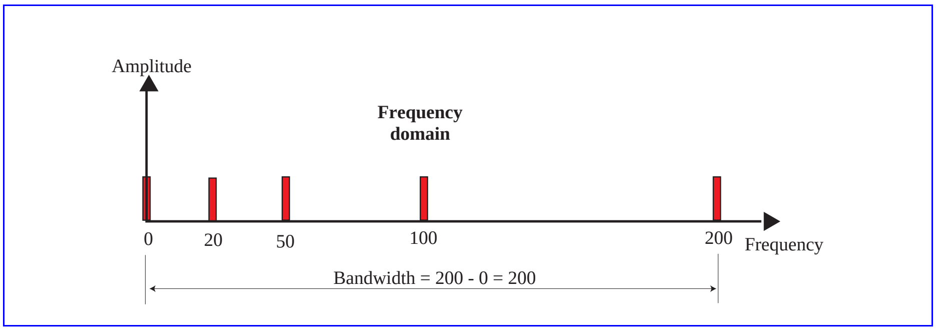


Figure 3.5 *Exercise 57*

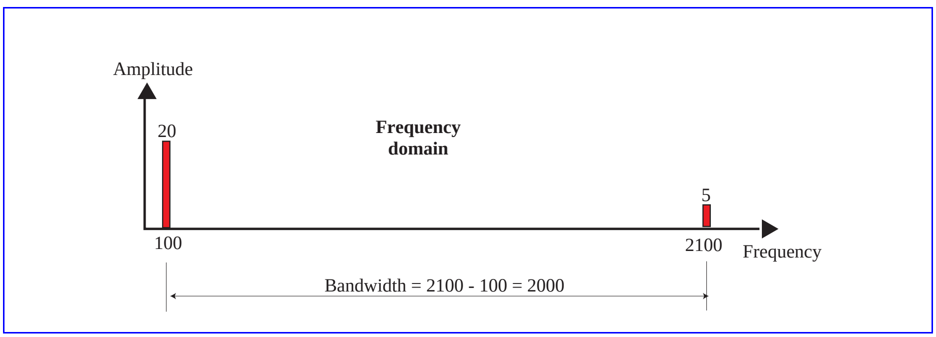


Figure 3.6 *Exercise 58*

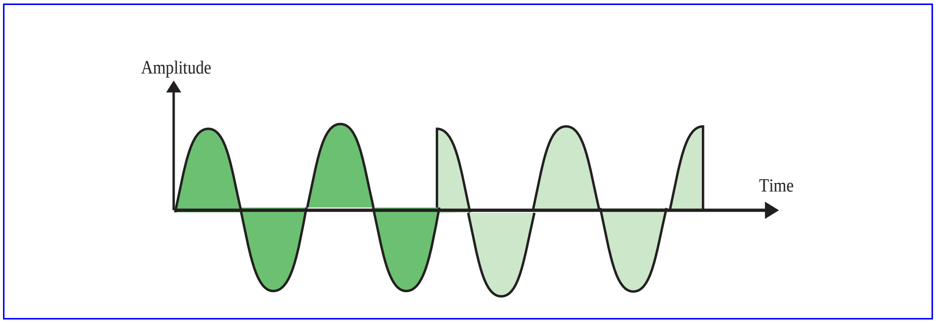
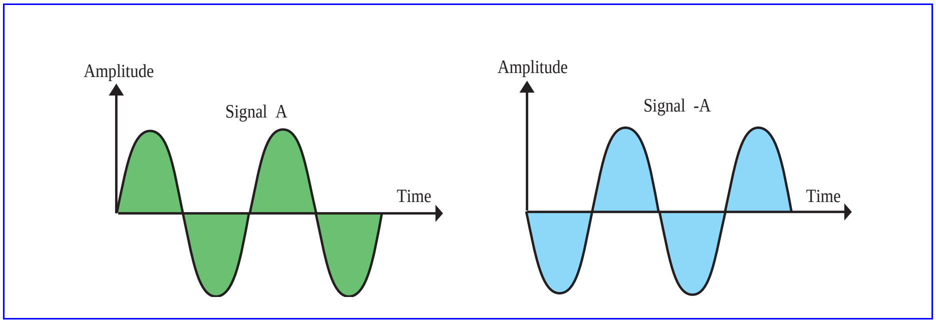


Figure 3.7 *Exercise 59*



60. Each signal is a simple signal in this case. The bandwidth of a simple signal is zero. So the bandwidth of both signals are the same.

61.
   a. 1 Kbps
   b. 500 bps
   c. 500 Kbps
   d. 4 Tbps (4×10^{12} bps)

62.
   a. 0.01 s
   b. 5 μs
   c. 0.2 μs
   d. 1 ns

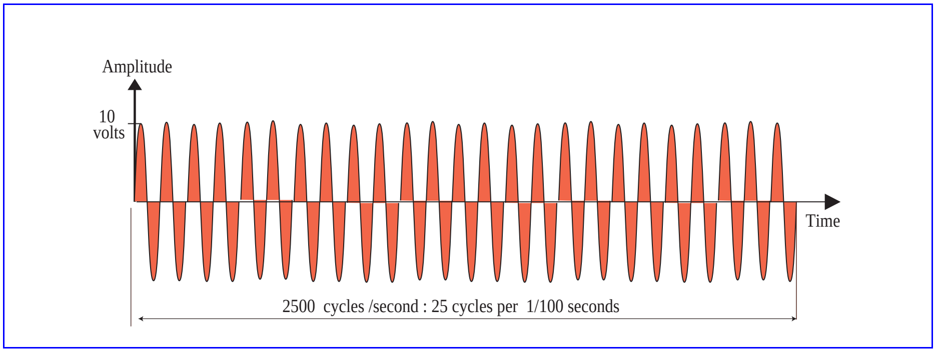
63.
   a. 0.01 s
   b. 8 ms
   c. 800 s

64. 500 Mbps

65. 2 KHz

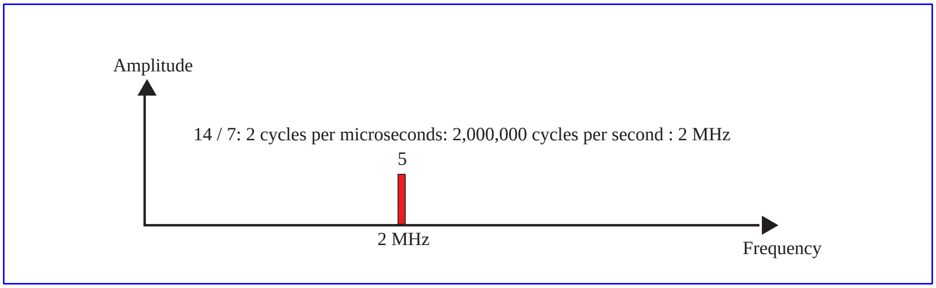
66. See Figure 3.8

Figure 3.8 *Exercise 66*



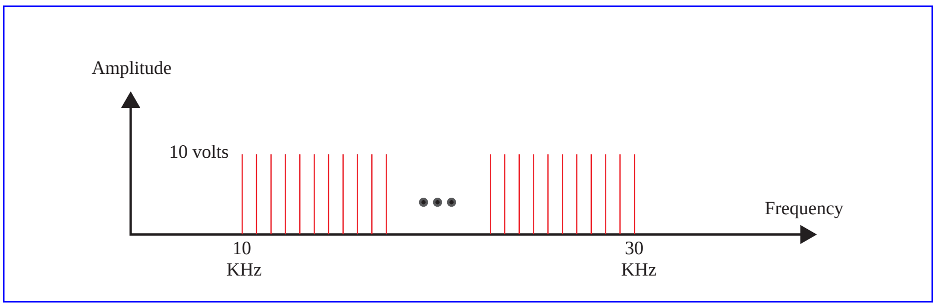
67. 2 MHz. See Figure 3.9.

Figure 3.9 *Exercise 67*



68. 25 Hz
69. 0 Hz
70. See Figure 3.10

Figure 3.10 *Exercise 70*



71. See Figure 3.11
72. 90 degrees
73. $s(t) = 10 \sin(5000\pi t + \pi/6)$
74. See Figure 3.12.

Figure 3.11 *Exercise 71*

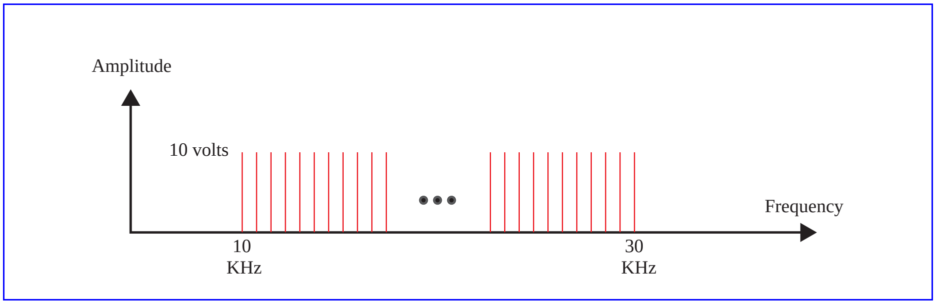
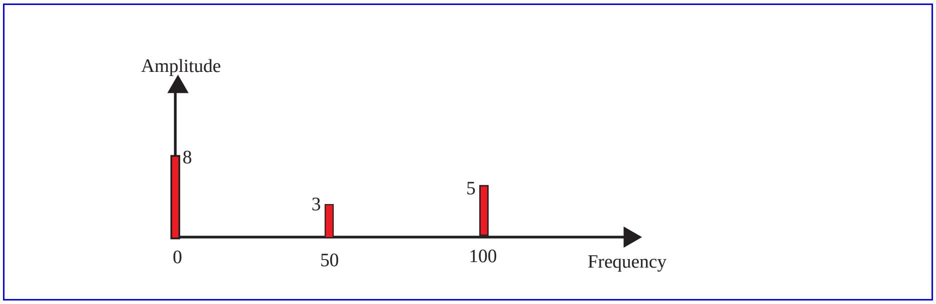


Figure 3.12 *Exercise 74*



75. 200 Hz
76. s(t) = sin (2π f t + π /2)
77. 1 harmonic, 3 Mbps
    3 harmonics, 12 Mbps
    5 harmonics, 27 Mbps
78. dB = 10 $\log_{10}$ (90 / 100) = –0.46 dB
79. –10 = 10 $\log_{10}$ (P_2 / 5) P_2 = 0.5
80. The total gain is 3 × 4 = 12 dB. The signal is amplified by a factor $10^{1.2}$ = 15.85.
81. 100,000 bits / 5 Kbps = 20 s
82. 480 s × 300,000 km/s = 144,000,000 km
83. 1 μm × 5 = 5 μm
84. 4,000 $\log_2$ (1 + 1,000) = 40 Kbps (approximately)
85. 4,000 $\log_2$ (1 + 10 / 0.005) = 43,866 bps