CHAPTER 4

Signals

4.1 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. Information can be in the form of data, voice, pictures, etc. To transmit information a transformation into electromagnetic signals is necessary.
4. Analog information: singing a song, flow of time
5. Digital information: number of pages in a book, time measurement with a digital watch
6. Analog signals have an infinite range of values, while digital signals have a limited number of values.
7. Periodic signals consist of a continuously repeated pattern, whereas aperiodic signals have no repetition pattern.
8. Analog data is a set of specific points of data and all possible points in between. Digital data is a set of specific points of data with no points in between.
9. Digital signal.
10. Frequency and period are the inverse of each other. T = 1/ f and f = 1/T.
11. Seconds, milliseconds, microseconds, nanoseconds, and picoseconds.
12. Hertz, kilohertz, megahertz, gigahertz, and terahertz.
13. A high frequency signal changes value in a short period of time; there are many changes in a short time. A low frequency signal has less changes within a certain time; the signal changes slowly.
14. The amplitude of a signal measures the value of the signal at any point.

15. The frequency of a signal refers to the number of periods in one second.
16. The phase describes the position of the waveform relative to time zero.
17. The vertical axis of both plots represents the amplitude. In the time-domain plot the horizontal axis represents the time and in the frequency-domain plot, the frequency.
18. A simple periodic signal is a sine wave. A composite signal is a collection of sine waves.
19. Frequency-domain.
20. Time-domain.
21. Time-domain.
22. The bandwidth of a signal is the highest frequency minus the lowest frequency.
23. Fourier analysis (Appendix D).
24. The bit interval is the time needed to send one bit; its counterpart in analog signals is the period.
25. Bit rate refers to the number of bit intervals per second. It is equivalent to the frequency in analog signals.

4.2 MULTIPLE CHOICE QUESTIONS

26. b 27. c 28. a 29. a 30. a 31. b 32. a 33. d 34. d 35. c
36. d 37. b 38. a 39. b 40. d 41. b 42. a 43. c 44. a 45. b

4.3 EXERCISES

46.

a. 1 Hz = 10^{-3} KHz
b. 1 MHz = 10^{3} KHz
c. 1 GHz = 10^{6} KHz
d. 1 THz = 10^{9} KHz

47.

a. 10 KHz
b. 25.34 MHz
c. 108 x 10^{6} KHz
d. 2.456764 MHz

48.

a. 5 ms
b. 123.1 μs
c. 2.34 x 10^{7} ps
d. 3.451 x 10^{6} ns

49.

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

50.

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

51.

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

52.

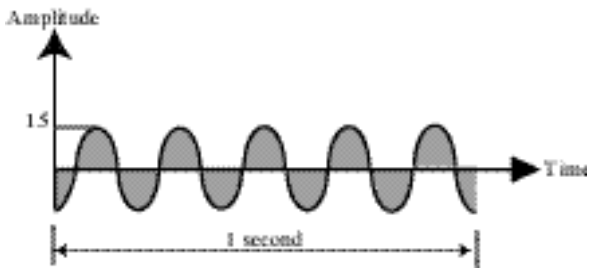
a. 360 or 0 degrees
b. 180 degrees
c. 270 degrees
d. 120 degrees

53.

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

54. See Figure 4.1

Figur e 4.1 *Exercise 54*



55. See Figure 4.2.
56. See Figure 4.3.

Figure 4.2 *Exercise 55*

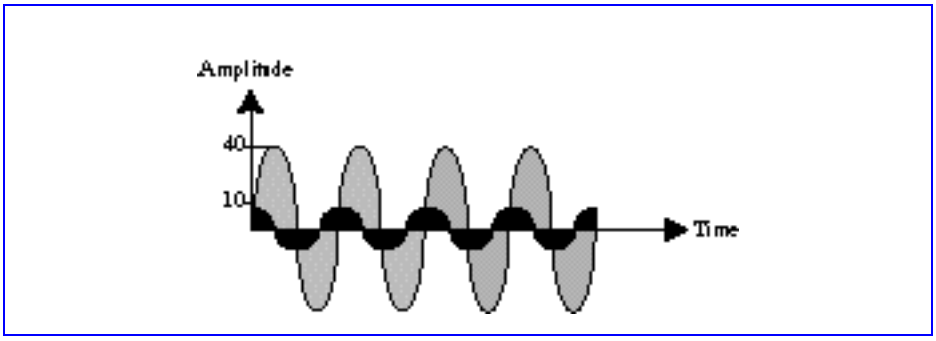
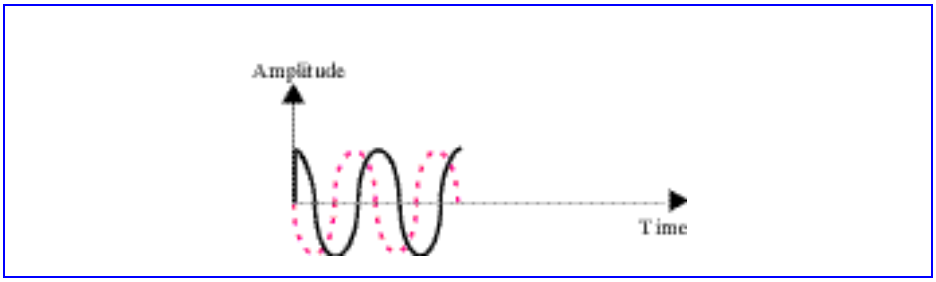
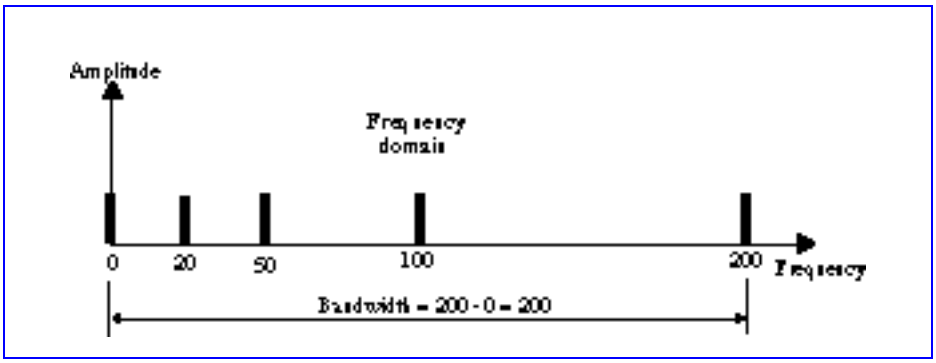


Figure 4.3 *Exercise 56*



57. See Figure 4.4

Figure 4.4 *Exercise 57*



58. See Figure 4.5
59. See Figure 4.6
60. See Figure 4.7
61. The bandwidth of a signal is the width of its frequency spectrum. In both cases, the frequency spectrum is not applicable, therefore the question can not be answered on this basis.
62.

Figure 4.5 *Exercise 58*

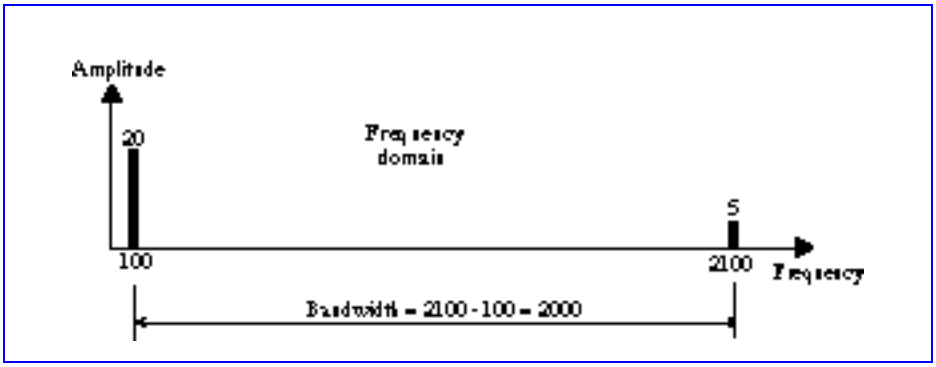


Figure 4.6 *Exercise 59*

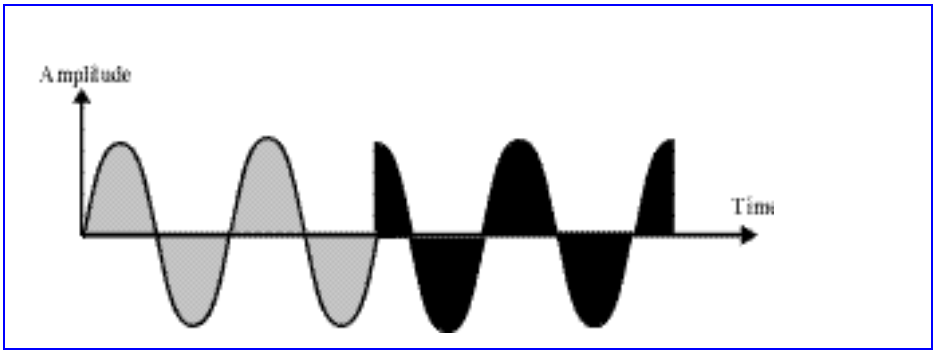
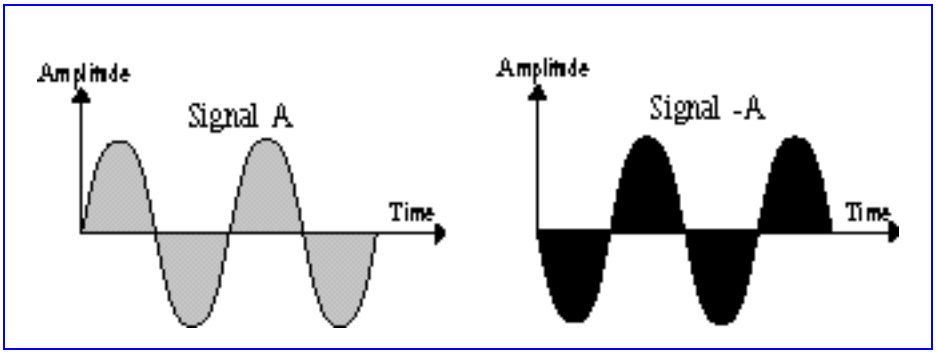


Figure 4.7 *Exercise 60*



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

63.

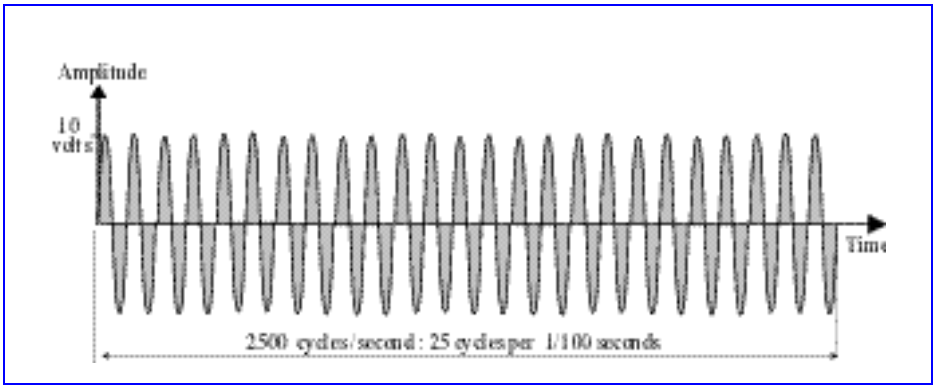
a. 0.01 s

b. 5 μs
c. 0.2 μs
d. 1 ns

64.
a. 0.01 s
b. 8 ms
c. 800 s

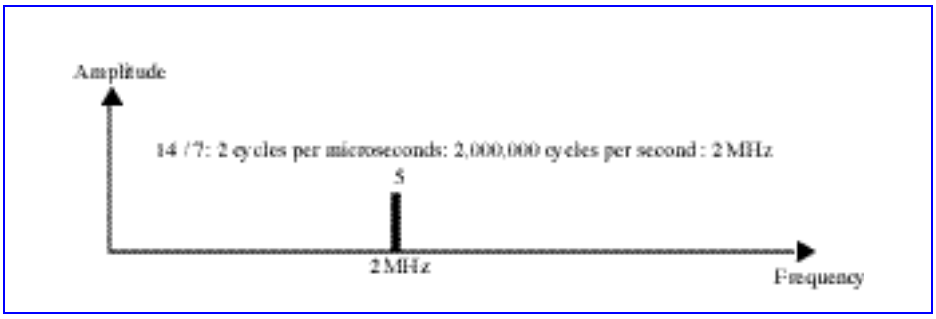
65. 500 Mbps
66. 2 MHz
67. See Figure 4.8

Figure 4.8 *Exercise 67*



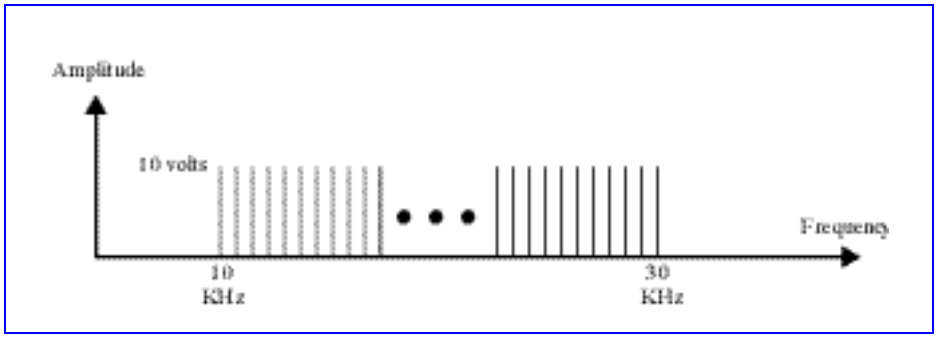
68. 2 MHz. See Figure 4.9.

Figure 4.9 *Exercise 68*



69. 25 Hz
70. 0 Hz
71. See Figure 4.10
72. See Figure 4.11
73. 90 degrees

Figur e 4.10 *Exercise 71*



Figur e 4.11 *Exercise 72*