14. The binary number 10110011100101010000l can be written in octal as
(a) 5471230_8 (b) 5471241_8 (c) 2634521_8 (d) 23162501_8
15. The binary number 1000110101000l101111 can be written in hexadecimal as
(a) $AD467_{16}$ (b) $8C46F_{16}$ (c) $8D46F_{16}$ (d) $AE46F_{16}$
16. The binary number for $F7A9_{16}$ is
(a) 1111011110101001 (b) 1110111110101001
(c) 1111111010110001 (d) 1111011010101001
17. The BCD number for decimal 473 is
(a) 111011010 (b) 110001110011 (c) 010001110011 (d) 010011110011
18. Refer to Table 2–7. The command STOP in ASCII is
(a) 10100111010100100111111010000 (b) 10100101001100100111010100000
(c) 10010101110110110011101010001 (d) 10100111010100100111011100100
19. The code that has an even-parity error is
(a) 1010011 (b) 1101000 (c) 1001000 (d) 1110111

PROBLEMS

Answers to odd-numbered problems are at the end of the book.

SECTION 2–1 Decimal Numbers

1. What is the weight of the digit 6 in each of the following decimal numbers?
(a) 1386 (b) 54,692 (c) 671,920
2. Express each of the following decimal numbers as a power of ten:
(a) 10 (b) 100 (c) 10,000 (d) 1,000,000
3. Give the value of each digit in the following decimal numbers:
(a) 471 (b) 9356 (c) 125,000
4. How high can you count with four decimal digits?

SECTION 2–2 Binary Numbers

5. Convert the following binary numbers to decimal:
(a) 11 (b) 100 (c) 111 (d) 1000
(e) 1001 (f) 1100 (g) 1011 (h) 1111
6. Convert the following binary numbers to decimal:
(a) 1110 (b) 1010 (c) 11100 (d) 10000
(e) 10101 (f) 11101 (g) 10111 (h) 11111
7. Convert each binary number to decimal:
(a) 110011.11 (b) 101010.01 (c) 1000001.111
(d) 1111000.101 (e) 1011100.10101 (f) 1110001.0001
(g) 1011010.1010 (h) 1111111.11111
8. What is the highest decimal number that can be represented by each of the following numbers of binary digits (bits)?
(a) two (b) three (c) four (d) five (e) six
(f) seven (g) eight (h) nine (i) ten (j) eleven
9. How many bits are required to represent the following decimal numbers?
(a) 17 (b) 35 (c) 49 (d) 68
(e) 81 (f) 114 (g) 132 (h) 205

10. Generate the binary sequence for each decimal sequence:
(a) 0 through 7 **(b)** 8 through 15 **(c)** 16 through 31
(d) 32 through 63 **(e)** 64 through 75

SECTION 2–3 Decimal-to-Binary Conversion

11. Convert each decimal number to binary by using the sum-of-weights method:
(a) 10 **(b)** 17 **(c)** 24 **(d)** 48
(e) 61 **(f)** 93 **(g)** 125 **(h)** 186

12. Convert each decimal fraction to binary using the sum-of-weights method:
(a) 0.32 **(b)** 0.246 **(c)** 0.0981

13. Convert each decimal number to binary using repeated division by 2:
(a) 15 **(b)** 21 **(c)** 28 **(d)** 34
(e) 40 **(f)** 59 **(g)** 65 **(h)** 73

14. Convert each decimal fraction to binary using repeated multiplication by 2:
(a) 0.98 **(b)** 0.347 **(c)** 0.9028

SECTION 2–4 Binary Arithmetic

15. Add the binary numbers:
(a) $11 + 01$ **(b)** $10 + 10$ **(c)** $101 + 11$
(d) $111 + 110$ **(e)** $1001 + 101$ **(f)** $1101 + 1011$

16. Use direct subtraction on the following binary numbers:
(a) $11 - 1$ **(b)** $101 - 100$ **(c)** $110 - 101$
(d) $1110 - 11$ **(e)** $1100 - 1001$ **(f)** $11010 - 10111$

17. Perform the following binary multiplications:
(a) 11×11 **(b)** 100×10 **(c)** 111×101
(d) 1001×110 **(e)** 1101×1101 **(f)** 1110×1101

18. Divide the binary numbers as indicated:
(a) $100 \div 10$ **(b)** $1001 \div 11$ **(c)** $1100 \div 100$

SECTION 2–5 1's and 2's Complements of Binary Numbers

19. Determine the 1's complement of each binary number:
(a) 101 **(b)** 110 **(c)** 1010
(d) 11010111 **(e)** 1110101 **(f)** 00001

20. Determine the 2's complement of each binary number using either method:
(a) 10 **(b)** 111 **(c)** 1001 **(d)** 1101
(e) 11100 **(f)** 10011 **(g)** 10110000 **(h)** 00111101

SECTION 2–6 Signed Numbers

21. Express each decimal number in binary as an 8-bit sign-magnitude number:
(a) +29 **(b)** −85 **(c)** +100 **(d)** −123

22. Express each decimal number as an 8-bit number in the 1's complement form:
(a) −34 **(b)** +57 **(c)** −99 **(d)** +115

23. Express each decimal number as an 8-bit number in the 2's complement form:
(a) +12 **(b)** −68 **(c)** +101 **(d)** −125

24. Determine the decimal value of each signed binary number in the sign-magnitude form:
(a) 10011001 **(b)** 01110100 **(c)** 10111111

25. Determine the decimal value of each signed binary number in the 1's complement form:
(a) 10011001 **(b)** 01110100 **(c)** 10111111

26. Determine the decimal value of each signed binary number in the 2's complement form:
(a) 10011001 **(b)** 01110100 **(c)** 10111111

27. Express each of the following sign-magnitude binary numbers in single-precision floating-point format:
(a) 0111110000101011 **(b)** 100110000011000

28. Determine the values of the following single-precision floating-point numbers:
(a) 1 10000001 01001001110001000000000
(b) 0 11001100 10000111110100100000000

SECTION 2–7 Arithmetic Operations with Signed Numbers

29. Convert each pair of decimal numbers to binary and add using the 2's complement form:
(a) 33 and 15 **(b)** 56 and −27 **(c)** −46 and 25 **(d)** −110 and −84

30. Perform each addition in the 2's complement form:
(a) 00010110 + 00110011 **(b)** 01110000 + 10101111

31. Perform each addition in the 2's complement form:
(a) 10001100 + 00111001 **(b)** 11011001 + 11100111

32. Perform each subtraction in the 2's complement form:
(a) 00110011 − 00010000 **(b)** 01100101 − 11101000

33. Multiply 01101010 by 11110001 in the 2's complement form.

34. Divide 01000100 by 00011001 in the 2's complement form.

SECTION 2–8 Hexadecimal Numbers

35. Convert each hexadecimal number to binary:
(a) 38_{16} **(b)** 59_{16} **(c)** $A14_{16}$ **(d)** $5C8_{16}$
(e) 4100_{16} **(f)** $FB17_{16}$ **(g)** $8A9D_{16}$

36. Convert each binary number to hexadecimal:
(a) 1110 **(b)** 10 **(c)** 10111
(d) 10100110 **(e)** 1111110000 **(f)** 100110000010

37. Convert each hexadecimal number to decimal:
(a) 23_{16} **(b)** 92_{16} **(c)** $1A_{16}$ **(d)** $8D_{16}$
(e) $F3_{16}$ **(f)** EB_{16} **(g)** $5C2_{16}$ **(h)** 700_{16}

38. Convert each decimal number to hexadecimal:
(a) 8 **(b)** 14 **(c)** 33 **(d)** 52
(e) 284 **(f)** 2890 **(g)** 4019 **(h)** 6500

39. Perform the following additions:
(a) $37_{16} + 29_{16}$ **(b)** $A0_{16} + 6B_{16}$ **(c)** $FF_{16} + BB_{16}$

40. Perform the following subtractions:
(a) $51_{16} - 40_{16}$ **(b)** $C8_{16} - 3A_{16}$ **(c)** $FD_{16} - 88_{16}$

SECTION 2–9 Octal Numbers

41. Convert each octal number to decimal:
(a) 12_8 **(b)** 27_8 **(c)** 56_8 **(d)** 64_8 **(e)** 103_8
(f) 557_8 **(g)** 163_8 **(h)** 1024_8 **(i)** 7765_8

42. Convert each decimal number to octal by repeated division by 8:
(a) 15 **(b)** 27 **(c)** 46 **(d)** 70
(e) 100 **(f)** 142 **(g)** 219 **(h)** 435

43. Convert each octal number to binary:

(a) 13_8 **(b)** 57_8 **(c)** 101_8 **(d)** 321_8 **(e)** 540_8

(f) 4653_8 **(g)** 13271_8 **(h)** 45600_8 **(i)** 100213_8

44. Convert each binary number to octal:

(a) 111 **(b)** 10 **(c)** 110111

(d) 101010 **(e)** 1100 **(f)** 1011110

(g) 101100011001 **(h)** 10110000011 **(i)** 111111101111000

SECTION 2–10 Binary Coded Decimal (BCD)

45. Convert each of the following decimal numbers to 8421 BCD:

(a) 10 **(b)** 13 **(c)** 18 **(d)** 21 **(e)** 25 **(f)** 36

(g) 44 **(h)** 57 **(i)** 69 **(j)** 98 **(k)** 125 **(l)** 156

46. Convert each of the decimal numbers in Problem 45 to straight binary, and compare the number of bits required with that required for BCD.

47. Convert the following decimal numbers to BCD:

(a) 104 **(b)** 128 **(c)** 132 **(d)** 150 **(e)** 186

(f) 210 **(g)** 359 **(h)** 547 **(i)** 1051

48. Convert each of the BCD numbers to decimal:

(a) 0001 **(b)** 0110 **(c)** 1001

(d) 00011000 **(e)** 00011001 **(f)** 00110010

(g) 01000101 **(h)** 10011000 **(i)** 100001110000

49. Convert each of the BCD numbers to decimal:

(a) 10000000 **(b)** 001000110111

(c) 001101000110 **(d)** 010000100001

(e) 011101010100 **(f)** 100000000000

(g) 100101111000 **(h)** 00010110100000011

(i) 10010000000011000 **(j)** 01100110011001111

50. Add the following BCD numbers:

(a) 0010 + 0001 **(b)** 0101 + 0011

(c) 0111 + 0010 **(d)** 1000 + 0001

(e) 00011000 + 00010001 **(f)** 01100100 + 00110011

(g) 01000000 + 01000111 **(h)** 10000101 + 00010011

51. Add the following BCD numbers:

(a) 1000 + 0110 **(b)** 0111 + 0101

(c) 1001 + 1000 **(d)** 1001 + 0111

(e) 00100101 + 00100111 **(f)** 01010001 + 01011000

(g) 10011000 + 10010111 **(h)** 010101100001 + 011100001000

52. Convert each pair of decimal numbers to BCD, and add as indicated:

(a) 4 + 3 **(b)** 5 + 2 **(c)** 6 + 4 **(d)** 17 + 12

(e) 28 + 23 **(f)** 65 + 58 **(g)** 113 + 101 **(h)** 295 + 157

SECTION 2–11 Digital Codes

53. In a certain application a 4-bit binary sequence cycles from 1111 to 0000 periodically. There are four bit changes, and because of circuit delays, these changes may not occur at the same instant. For example, if the LSB changes first, the number will appear as 1110 during the transition from 1111 to 0000 and may be misinterpreted by the system. Illustrate how the Gray code avoids this problem.

54. Convert each binary number to Gray code:

(a) 11011 **(b)** 1001010 **(c)** 1111011101110

55. Convert each Gray code to binary:

(a) 1010 **(b)** 00010 **(c)** 11000010001

56. Convert each of the following decimal numbers to ASCII. Refer to Table 2–7.

(a) 1 **(b)** 3 **(c)** 6 **(d)** 10 **(e)** 18

(f) 29 **(g)** 56 **(h)** 75 **(i)** 107

57. Determine each ASCII character. Refer to Table 2–7.

(a) 0011000 **(b)** 1001010 **(c)** 0111101

(d) 0100011 **(e)** 0111110 **(f)** 1000010

58. Decode the following ASCII coded message:

1001000 1100101 1101100 1101100 1101111 0101110
0100000 1001000 1101111 1110111 0100000 1100001
1110010 1100101 0100000 1111001 1101111 1110101
0111111

59. Write the message in Problem 58 in hexadecimal.

60. Convert the following computer program statement to ASCII:

30 INPUT A. B

SECTION 2–12 Error Detection and Correction Codes

61. Determine which of the following even parity codes are in error:

(a) 100110010 **(b)** 011101010 **(c)** 10111111010001010

62. Determine which of the following odd parity codes are in error:

(a) 11110110 **(b)** 00110001 **(c)** 01010101010101010

63. Attach the proper even parity bit to each of the following bytes of data:

(a) 10100100 **(b)** 00001001 **(c)** 11111110

64. Determine the even-parity Hamming code for the data bits 1100.

65. Determine the odd-parity Hamming code for the data bits 11001.

66. Correct any error in each of the following Hamming codes with even parity.

(a) 1110100 **(b)** 1000111

67. Correct any error in each of the following Hamming codes with odd parity.

(a) 110100011 **(b)** 100001101