

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) 5 | (b) 10 | (c) 15 | (d) 20 |
| (e) 100 | (f) 120 | (g) 140 | (h) 160 |

10. Generate the binary sequence for each decimal sequence:

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|-------------------|-------------------|-------------------|
| (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:

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|--------|--------|---------|---------|
| (a) 12 | (b) 15 | (c) 25 | (d) 50 |
| (e) 65 | (f) 97 | (g) 127 | (h) 198 |

12. Convert each decimal fraction to binary using the sum-of-weights method:

- | | | |
|----------|-----------|------------|
| (a) 0.26 | (b) 0.762 | (c) 0.0975 |
|----------|-----------|------------|

13. Convert each decimal number to binary using repeated division by 2:

- | | | | |
|--------|--------|--------|--------|
| (a) 13 | (b) 17 | (c) 23 | (d) 30 |
| (e) 35 | (f) 40 | (g) 49 | (h) 60 |

14. Convert each decimal fraction to binary using repeated multiplication by 2:

- | | | |
|----------|-----------|------------|
| (a) 0.76 | (b) 0.456 | (c) 0.8732 |
|----------|-----------|------------|

Section 2-4 Binary Arithmetic

15. Add the binary numbers:

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|---------------|----------------|-----------------|
| (a) 10 + 10 | (b) 10 + 11 | (c) 100 + 11 |
| (d) 111 + 101 | (e) 1111 + 111 | (f) 1111 + 1111 |

16. Use direct subtraction on the following binary numbers:

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|---------------|----------------|-------------------|
| (a) 10 - 1 | (b) 100 - 11 | (c) 110 - 100 |
| (d) 1111 - 11 | (e) 1101 - 101 | (f) 110000 - 1111 |

17. Perform the following binary multiplications:

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|----------------|-----------------|-----------------|
| (a) 11 × 10 | (b) 101 × 11 | (c) 111 × 110 |
| (d) 1100 × 101 | (e) 1110 × 1110 | (f) 1111 × 1100 |

18. Divide the binary numbers as indicated:

- | | | |
|--------------|---------------|----------------|
| (a) 110 ÷ 11 | (b) 1010 ÷ 10 | (c) 1111 ÷ 101 |
|--------------|---------------|----------------|

Section 2-5 Complements of Binary Numbers

19. What are two ways of representing zero in 1's complement form?

20. How is zero represented in 2's complement form?

21. Determine the 1's complement of each binary number:

- | | | |
|--------------|-------------|--------------|
| (a) 100 | (b) 111 | (c) 1100 |
| (d) 10111011 | (e) 1001010 | (f) 10101010 |

22. Determine the 2's complement of each binary number using either method:

- | | | | |
|------------|-----------|--------------|--------------|
| (a) 11 | (b) 110 | (c) 1010 | (d) 1001 |
| (e) 101010 | (f) 11001 | (g) 11001100 | (h) 11000111 |

Section 2-6 Signed Numbers

23. Express each decimal number in binary as an 8-bit sign-magnitude number:
(a) +29 (b) -85 (c) +100 (d) -123
24. Express each decimal number as an 8-bit number in the 1's complement form:
(a) -34 (b) +57 (c) -99 (d) +115
25. Express each decimal number as an 8-bit number in the 2's complement form:
(a) +12 (b) -68 (c) +101 (d) -125
26. Determine the decimal value of each signed binary number in the sign-magnitude form:
(a) 10011001 (b) 01110100 (c) 10111111
27. Determine the decimal value of each signed binary number in the 1's complement form:
(a) 10011001 (b) 01110100 (c) 10111111
28. Determine the decimal value of each signed binary number in the 2's complement form:
(a) 10011001 (b) 01110100 (c) 10111111
29. Express each of the following sign-magnitude binary numbers in single-precision floating-point format:
(a) 0111110000101011 (b) 100110000011000
30. Determine the values of the following single-precision floating-point numbers:
(a) 1 10000001 010010011100010000000000
(b) 0 11001100 100001111101001000000000

Section 2-7 Arithmetic Operations with Signed Numbers

31. 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
32. Perform each addition in the 2's complement form:
(a) 00010110 + 00110011 (b) 01110000 + 10101111
33. Perform each addition in the 2's complement form:
(a) 10001100 + 00111001 (b) 11011001 + 11100111
34. Perform each subtraction in the 2's complement form:
(a) 00110011 - 00010000 (b) 01100101 - 11101000
35. Multiply 01101010 by 11110001 in the 2's complement form.
36. Divide 10001000 by 00100010 in the 2's complement form.

Section 2-8 Hexadecimal Numbers

37. Convert each hexadecimal number to binary:
(a) 46_{16} (b) 54_{16} (c) $B4_{16}$ (d) $1A3_{16}$
(e) FA_{16} (f) ABC_{16} (g) $ABCD_{16}$
38. Convert each binary number to hexadecimal:
(a) 1111 (b) 1011 (c) 11111
(d) 10101010 (e) 10101100 (f) 10111011
39. Convert each hexadecimal number to decimal:
(a) 42_{16} (b) 64_{16} (c) $2B_{16}$ (d) $4D_{16}$
(e) FF_{16} (f) BC_{16} (g) $6F1_{16}$ (h) ABC_{16}
40. Convert each decimal number to hexadecimal:
(a) 10 (b) 15 (c) 32 (d) 54
(e) 365 (f) 3652 (g) 7825 (h) 8925
41. Perform the following additions:
(a) $25_{16} + 33_{16}$ (b) $43_{16} + 62_{16}$ (c) $A4_{16} + F5_{16}$ (d) $FC_{16} + AE_{16}$
42. Perform the following subtractions:
(a) $60_{16} - 39_{16}$ (b) $A5_{16} - 98_{16}$ (c) $F1_{16} - A6_{16}$ (d) $AC_{16} - 10_{16}$

Section 2-9 Octal Numbers

43. Convert each octal number to decimal:

- (a) 14_8 (b) 53_8 (c) 67_8 (d) 174_8
 (e) 635_8 (f) 254_8 (g) 2673_8 (h) 7777_8

44. Convert each decimal number to octal by repeated division by 8:

- (a) 23 (b) 45 (c) 65 (d) 84
 (e) 124 (f) 156 (g) 654 (h) 9999

45. Convert each octal number into binary:

- (a) 17_8 (b) 26_8 (c) 145_8 (d) 456_8
 (e) 653_8 (f) 777_8

46. Convert each binary number to octal:

- (a) 100 (b) 110 (c) 1100
 (d) 1111 (e) 11001 (f) 11110
 (g) 110011 (h) 101010 (i) 10101111

Section 2-10 Binary Coded Decimal (BCD)

47. 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

48. Convert each of the decimal numbers in Problem 47 to straight binary, and compare the number of bits required with that required for BCD.

49. 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

50. 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

51. Convert each of the BCD numbers to decimal:

- (a) 10000000 (b) 001000110111
 (c) 001101000110 (d) 010000100001
 (e) 011101010100 (f) 100000000000
 (g) 100101111000 (h) 0001011010000011
 (i) 1001000000011000 (j) 0110011001100111

52. 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) $10000101 + 00010011$

53. 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) $010101100001 + 011100001000$

54. 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

55. 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