

## Solutions to Problem Set #2

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6. (a)  $1110 = 1 \times 2^3 + 1 \times 2^2 + 1 \times 2^1 = 8 + 4 + 2 = 14$   
 (b)  $1010 = 1 \times 2^3 + 1 \times 2^1 = 8 + 2 = 10$   
 (c)  $11100 = 1 \times 2^4 + 1 \times 2^3 + 1 \times 2^2 = 16 + 8 + 4 = 28$   
 (d)  $10000 = 1 \times 2^4 = 16$   
 (e)  $10101 = 1 \times 2^4 + 1 \times 2^2 + 1 \times 2^0 = 16 + 4 + 1 = 21$   
 (f)  $11101 = 1 \times 2^4 + 1 \times 2^3 + 1 \times 2^2 + 1 \times 2^0 = 16 + 8 + 4 + 1 = 29$   
 (g)  $10111 = 1 \times 2^4 + 1 \times 2^2 + 1 \times 2^1 + 1 \times 2^0 = 16 + 4 + 2 + 1 = 23$   
 (h)  $11111 = 1 \times 2^4 + 1 \times 2^3 + 1 \times 2^2 + 1 \times 2^1 + 1 \times 2^0 = 16 + 8 + 4 + 2 + 1 = 31$
12. (a)  $0.32 \cong 0.00 + 0.25 + 0.0625 + 0.0 + 0.0 + 0.0078125 = 0.0101001$   
 (b)  $0.246 \cong 0.0 + 0.0 + 0.125 + 0.0625 + 0.03125 + 0.015625 = 0.001111$   
 (c)  $0.0981 \cong 0.0 + 0.0 + 0.0 + 0.0625 + 0.03125 + 0.0 + 0.0 + 0.00390625 = 0.0001101$
14. (a)  $0.98 \times 2 = 1.96$  1 (MSB)  
 $0.96 \times 2 = 1.92$  1  
 $0.92 \times 2 = 1.84$  1  
 $0.84 \times 2 = 1.68$  1  
 $0.68 \times 2 = 1.36$  1  
 $0.36 \times 2 = 0.72$  0  
 continue if more accuracy is desired  
 0.111110
- (b)  $0.347 \times 2 = 0.694$  0 (MSB)  
 $0.694 \times 2 = 1.388$  1  
 $0.388 \times 2 = 0.776$  0  
 $0.776 \times 2 = 1.552$  1  
 $0.552 \times 2 = 1.104$  1  
 $0.104 \times 2 = 0.208$  0  
 $0.208 \times 2 = 0.416$  0  
 continue if more accuracy is desired  
 0.0101100
- (c)  $0.9028 \times 2 = 1.8056$  1 (MSB)  
 $0.8056 \times 2 = 1.6112$  1  
 $0.6112 \times 2 = 1.2224$  1  
 $0.2224 \times 2 = 0.4448$  0  
 $0.4448 \times 2 = 0.8896$  0  
 $0.8896 \times 2 = 1.7792$  1  
 $0.7792 \times 2 = 1.5584$  1  
 continue if more accuracy is desired  
 0.1110011
16. (a) 
$$\begin{array}{r} 11 \\ -01 \\ \hline 10 \end{array}$$
 (b) 
$$\begin{array}{r} 101 \\ -100 \\ \hline 001 \end{array}$$
 (c) 
$$\begin{array}{r} 110 \\ -101 \\ \hline 001 \end{array}$$
- (d) 
$$\begin{array}{r} 1110 \\ -0011 \\ \hline 1011 \end{array}$$
 (e) 
$$\begin{array}{r} 1100 \\ -1001 \\ \hline 0011 \end{array}$$
 (f) 
$$\begin{array}{r} 11010 \\ -10111 \\ \hline 00011 \end{array}$$

18. (a)  $\frac{100}{10} = 010$  (b)  $\frac{1001}{0011} = 0011$  (c)  $\frac{1100}{0100} = 0011$

21. (a) The 1's complement of 101 is 010.  
 (b) The 1's complement of 110 is 001.  
 (c) The 1's complement of 1010 is 0101.  
 (d) The 1's complement of 11010111 is 00101000.  
 (e) The 1's complement of 1110101 is 0001010.  
 (f) The 1's complement of 00001 is 11110.

22. Take the 1's complement and add 1:

- (a)  $01 + 1 = 10$  (b)  $000 + 1 = 001$   
 (c)  $0110 + 1 = 0111$  (d)  $0010 + 1 = 0011$   
 (e)  $00011 + 1 = 00100$  (f)  $01100 + 1 = 01101$   
 (g)  $01001111 + 1 = 01010000$  (h)  $11000010 + 1 = 11000011$

25. (a) Magnitude of 12 = 1100  
 $+12 = 00001100$  (b) Magnitude of 68 = 1000100  
 $-68 = 10111100$   
 (c) Magnitude of  $101_{10} = 1100101$   
 $+101_{10} = 01100101$  (d) Magnitude of 125 = 1111101  
 $-125 = 10000011$

28. (a)  $10011001 = -(1100111) = -103$   
 (b)  $01110100 = +(1110100) = +116$   
 (c)  $10111111 = -(1000001) = -65$

30. (a) 11000000101001001110001000000000  
 Sign = 1  
 Exponent =  $10000001 = 129 - 127 = 2$   
 Mantissa =  $1.01001001110001 \times 2^2 = 101.001001110001$   
 $-101.001001110001 = -5.15258789$

32. (a) 
$$\begin{array}{r} 00010110 \\ + 00110011 \\ \hline 01001001 \end{array}$$
 (b) 
$$\begin{array}{r} 01110000 \\ + 10101111 \\ \hline 10001111 \end{array}$$

38. (a)  $1110 = E_{16}$

(d)  $1010\ 0110 = A6_{16}$

41. (a)  $37_{16} + 29_{16} = 60_{16}$   
 (b)  $A0_{16} + 6B_{16} = 10B_{16}$   
 (c)  $FF_{16} + BB_{16} = 1BA_{16}$

42. (a)  $51_{16} - 40_{16} = 11_{16}$   
 (b)  $C8_{16} - 3A_{16} = 8E_{16}$   
 (c)  $FD_{16} - 88_{16} = 75_{16}$

44. (a)  $\frac{15}{8} = 1$ , remainder = 7 (LSD)  
 $\frac{1}{8} = 0$ , remainder = 1  
 octal number =  $17_8$  (b)  $\frac{27}{8} = 3$ , remainder = 3 (LSD)  
 $\frac{3}{8} = 0$ , remainder = 3  
 octal number =  $33_8$

$$(g) \quad \frac{219}{8} = 27, \text{ remainder} = 3 \text{ (LSD)}$$

$$\frac{27}{8} = 3, \text{ remainder} = 3$$

$$\frac{3}{8} = 0, \text{ remainder} = 3$$

$$\text{octal number} = 333_8$$

$$(h) \quad \frac{435}{8} = 54, \text{ remainder} = 3 \text{ (LSD)}$$

$$\frac{54}{8} = 6, \text{ remainder} = 6$$

$$\frac{6}{8} = 0, \text{ remainder} = 6$$

$$\text{octal number} = 663_8$$

$$46. \quad (a) \quad 111 = 7_8$$

$$(e) \quad 001 \ 100 = 14_8$$

$$(h) \quad 010 \ 110 \ 000 \ 011 = 2603_8$$

$$50. \quad (a) \quad 0001 = 1$$

$$(b) \quad 0110 = 6$$

$$(e) \quad 0001 \ 1001 = 19$$

$$(f) \quad 0011 \ 0010 = 32$$

$$(g) \quad 0100 \ 0101 = 45$$

$$(h) \quad 1001 \ 1000 = 98$$

$$52. \quad (a) \quad \begin{array}{r} 0010 \\ + 0001 \\ \hline 0011 \end{array}$$

$$(b) \quad \begin{array}{r} 0101 \\ + 0011 \\ \hline 1000 \end{array}$$

$$(c) \quad \begin{array}{r} 0111 \\ + 0010 \\ \hline 1001 \end{array}$$

$$(d) \quad \begin{array}{r} 1000 \\ + 0001 \\ \hline 1001 \end{array}$$

$$(e) \quad \begin{array}{r} 00011000 \\ + 00010001 \\ \hline 00101001 \end{array}$$

$$(f) \quad \begin{array}{r} 01100100 \\ + 00110011 \\ \hline 10010111 \end{array}$$

$$60. \quad 1001000 \ 1100101 \ 1101100 \ 1101100 \ 1101111 \ 0101110 \ 0100000$$

$$\quad \mathbf{H} \quad \mathbf{e} \quad \mathbf{l} \quad \mathbf{l} \quad \mathbf{o} \quad \mathbf{.} \quad \mathbf{\#}$$

$$1001000 \ 1101111 \ 1110111 \ 0100000 \ 1100001 \ 1110010 \ 1100101$$

$$\quad \mathbf{H} \quad \mathbf{o} \quad \mathbf{w} \quad \mathbf{\#} \quad \mathbf{a} \quad \mathbf{r} \quad \mathbf{e}$$

$$0100000 \ 1111001 \ 1101111 \ 1110101 \ 0111111$$

$$\quad \mathbf{\#} \quad \mathbf{y} \quad \mathbf{o} \quad \mathbf{u} \quad \mathbf{?}$$