Chapter 1: Binary Systems
Solutions of Problems: [2, 5, 8, 16, 18, 21, 31, 34]

Problem: 1-2
What is the exact number of bytes in a system that contains (a) 32 Kbyte, (b) 64 M bytes, and (c) 6.4 Gbyte?

Solution:
The exact number of bytes in a system that contains
(a) 32K byte = 32 x 2^{10} byte = 32,768 byte
(b) 64M bytes = 64 x 2^{20} bytes = 67,108,864 bytes
(c) 6.4G byte = 6.4 x 2^{30} byte = 6,871,947,674 byte

Problem: 1-5
Determine the base of the numbers in each case for the following operations to be correct:
(a) 14/2 = 5 (b) 54/4 = 13 (c) 24+17=40

Solution:
The base of the numbers in each case for the following operations to be correct:

(a) 14/2 = 5;
Find decimal equivalent
$14=1 \times r^1 + 4 \times r^0 = r + 4$
$2=2 \times r^0=2$
$5=5 \times r^0=5$
$(4+r)/2=5$
Solving this equation, we get r=6, base 6

(b) 54/4 = 13;
Find decimal equivalent
$54=5 \times r^1 + 4 \times r^0 = 5r + 4$
$4=4 \times r^0=4$
$13=1 \times r^1 + 3 \times r^0 = r + 3$
$(5r+4)/4= r + 3$
Solving this equation, we get r=8, base 8

(c) 24+17=40;
Find decimal equivalent
$24=2 \times r^1 + 4 \times r^0 = 2r + 4$
$17=1 \times r^1 + 7 \times r^0 = r + 7$
$40=4 \times r^1 + 0 \times r^0 = 4r + 0$
$(2r + 4) + (r + 7) = 4r$
Solving this equation, we get r=11, base 11

Problem: 1-8
Convert the following binary numbers to hexadecimal and to decimal:

a) 1.11010, b) 1110.10

Explain why the decimal answer in (b) is 8 times that of (a).

Solution:
To convert from binary to hexadecimal:

Each 4 binary digits is equal to 1 hexadecimal digit:

a) $(1.11010)_2 = (1.D0)_{16}$
b) $(1110.10)_2 = (E.8)_{16}$

To convert from binary to decimal:

a) $(1.11010)_2 = (1.8125)_{10}$

$1x2^0 + 1x2^{-1} + 1x2^{-2} + 0x2^{-3} + 1x2^{-4} + 0x2^{-5} = (1).(0.5+0.25+0.0625)$

b) $(1110.10)_2 = (14.5)_{10}$

$1x2^3 + 1x2^2 + 1x2^1 + 0x2^0 + 1x2^{-1} + 0x2^{-2} = (8+4+2).(0.5)$

The decimal answer in (b) is 8 times that of (a) because the binary number in (b) is the same as that in (a) except that the point is shifted to the right 3 digits and this means that it is multiplied by 2^3.

Problem: 1-16
Obtain the 1's and 2's complement of the following binary numbers:
a) 11101010 b) 01111110 c) 00000001 d) 10000000 e) 00000000

Solution:
1's complement : change every 1 to 0 and vice versa.
2's complement : change every 1 to 0 and vice versa ,then add (1) to the least significant bit.

a) 11101010
1's complement : 00010101
2's complement : 00010110

b) 01111110
1's complement : 10000001
2's complement : 10000010

c) 00000001
1's complement : 01111110
2's complement : 11111111

d) 10000000
1's complement : 01111111
2's complement : 10000000

e) 00000000
1's complement : 11111111
2's complement : 100000000

Problem: 1-18

Perform subtraction on the following unsigned binary numbers using the 2's-complement of the subtrahend. Where the result should be negative, 2's-complement it and affix a minus sign.

(a) 11011-11001 (b)110100 -10101 (c)1011-110000 (d)101010-101011

Solution:

a)

$$\begin{aligned} &X = 11011 \quad Y = 11001 \\ &X = 11011 \\ &2\text{'s Complement of } Y = +\ \underline{00111} \\ &Sum = 100010 \\ &Discard\ end\ carry\ 2^5 = -\ \underline{100000} \\ &Answer:\ X - Y = 00010 \end{aligned}$$

b)

$$\begin{aligned} &X = 110100 \quad Y = 10101 \\ &X = 110100 \\ &2\text{'s Complement of } Y = +\ \underline{101011} \\ &Sum = 1011111 \\ &Discard\ end\ carry\ 2^5 = -\ \underline{1000000} \\ &Answer:\ X - Y = 011111 \end{aligned}$$

c)

$$\begin{aligned} &X = 1011 \quad Y = 110000 \\ &X = 1011 \\ &2\text{'s Complement of } Y = +\ \underline{010000} \\ &Sum = 011011 \\ &There\ is\ no\ end\ carry \\ &Answer:\ Y - X = -\ 100101 \end{aligned}$$

d)

$$\begin{aligned} &X = 101010 \quad Y = 101011 \\ &X = 101010 \\ &2\text{'s Complement of } Y = +\ \underline{010101} \\ &Sum = 111111 \\ &There\ is\ no\ end\ carry \\ &Answer:\ Y - X = -\ 000001 \end{aligned}$$

Problem: 1-21

Convert decimal 9126 to both BCD and ASCII codes. For ASCII, an odd parity bit is to be appended at the left.

Solution:

$$(9126)_{10} = (1001\,0001\,0010\,0110)_{BCD}$$

$$(9126)_{10} = (10111001\,00110001\,00110010\;10110110)_{ASCII}$$

Problem: 1-31

What bit must be complemented to change an ASCII letter from capital to lowercase, and vise versa?

Solution:

To do so we complement b_6.

Problem: 1-34

Assume a 3-input AND gate with output F and a 3-input OR gate with G output. Show the signals of the outputs F and G as functions of the three inputs ABC. Use all 8 possible combinations of ABC.

Solution: