Tutorial - 3 (Solutions)

Q1 (a) $68.75 - 27.50$

$$\begin{array}{l} 01000100.1100 \\ +\ 11100100.0111 \quad \text{(In 1's complement form)} \\ \hline 1001\ 01001.0011 \\ \hookrightarrow \quad +\ 1 \quad \text{(End around carry)} \\ \hline 00101001.0100 \end{array}$$

The MSB is a 0. So, the result is positive and is in its normal binary form. Therefore, the result is +41.25.

(b) $43.25 - 89.75$

$$\begin{array}{l} 00101011.0100 \\ +\ 10100110.0011 \quad \text{(In 1's complement form)} \\ \hline 11010001.0111 \end{array}$$

There is no carry. The MSB is a 1. So, the result is negative and is in its 1's complement form. The 1's complement of 11010001.0111 is 00101110.1000. Therefore, the result is -46.50.

Q2 (a) $87.5 - 45.75$

$$\begin{array}{l} 01010111.1000 \\ +\ 11010010.0100 \quad \text{(-45.75 in 2's complement form)} \\ \hline 100101001.1100 \quad \text{(ignore the carry)} \end{array}$$

There is a carry, ignore it. The MSB is 0. So, the result is positive and is in normal binary form. Therefore, the result is +41.75.

(b) $27.125 - 79.625$

$$\begin{array}{l} 00011011.0010 \\ +\ 10110000.0110 \quad \text{(In 2's complement form)} \\ \hline 11001011.1000 \quad \text{(No carry)} \end{array}$$

There is no carry. The MSB is a 1 indicating that the

result is negative and is in its 2's complement form. The 2's complement of 11001011.1000 is 00110100.1000. Therefore, the result is −52.5.

Q3 (i)

(a)

$$\begin{array}{r} 212 \\ -\ 121 \\ \hline \end{array} \qquad \begin{aligned} 2\times3^2+1\times3+2 &= (23)_{10} \\ 1\times3^2+2\times3+1 &= (16)_{10} \end{aligned}$$

2's complement of 121 in base-3 is

$$\begin{array}{r} 222 \\ -\ 121 \\ \hline 101 \end{array}$$

$$\begin{array}{r} 212 \\ +\ 101 \\ \hline (1)020 \\ \hline 021 \end{array} \qquad (10)_3 = (3)_{10}$$

$(021)_3 = (2\times3+1)_{10} = (7)_{10}$

(b) $121 \longrightarrow (16)_{10}$

$-\ 212 \longrightarrow (23)_{10}$

2's complement of 212 in base-3 is

$$\begin{array}{r} 222 \\ -\ 212 \\ \hline 010 \end{array}$$

$$\begin{array}{r} 121 \\ +\ 010 \\ \hline 201 \end{array}$$

Now 2's complement of 201 is $\begin{array}{r} 222 \\ -\ 201 \\ \hline 021 \end{array}$

021 ⟶ 7

Ans = −7.

(ii) (a)
$$\begin{array}{r} 212 \\ -\ 121 \\ \hline \end{array}$$

3's complement of 121

$$\begin{array}{r} 222 \\ -121 \\ \hline 101 \\ +\ 1 \\ \hline 102 \end{array}$$

$$\begin{array}{r} 212 \\ +102 \\ \hline \not{X}021 \\ \text{(Ans)} \end{array} \quad = \quad 2\times3+1 = (7)_{10}$$

(b)
$$\begin{array}{r} 121 \\ -\ 212 \\ \hline \end{array}$$

3's complement of 212

$$\begin{array}{r} 222 \\ -\ 212 \\ \hline 010 \\ +\ \ 1 \\ \hline 011 \end{array}$$

$$\begin{array}{r} 121 \\ +011 \\ \hline 202 \end{array}$$

3's complement

$$\begin{array}{r} 222 \\ -202 \\ \hline 020 \\ +1 \\ \hline \end{array}$$

021 ⟶ 7, Ans = −7.

Q4 (a) 2928.54
−0416.73

2928.54
⇒ +9583.27 (10's Comp. of 416.73)
12511.81 (Ignore the carry)

There is a carry indicating that the answer is positive. Ignore the carry. Ans = 2511.81.

(b) 0416.73
− 2928.54

0416.73
⇒ +7071.46 (10's comp. of 2928.54)
7488.19 (No carry)

There is no carry indicating that the answer is negative. So, take the 10's complement of the intermediate result and put a minus sign. The 10's complement of 7488.19 is 2511.81.

∴ Ans = −2511.81.

Q5 (a) 745.81
− 436.62

745.81
+ 563.37 (9's complement of 436.62)
1309.18
→ +1
309.19

The carry indicates that the answer is positive. So the answer is +309.19.

(b)

$$\begin{array}{r} 436.62 \\ -745.81 \\ \hline \end{array} \Rightarrow \begin{array}{r} 436.62 \\ +254.18 \\ \hline 690.80 \end{array}$$

(9's complement of 745.81)

There is no carry indicating that the answer is -ve. So, take the 9's complement of the intermediate result and put a minus sign. The 9's complement of 690.80 is 309.19.

∴ Ans = -309.19

Q6 (a)

$$\begin{array}{r} 101 \,)\, 110101.11 \,(\, 1010.11 \\ 101 \\ \hline 0110 \\ 101 \\ \hline 111 \\ 101 \\ \hline 101 \\ 101 \\ \hline 000 \end{array}$$

∴ 110101.11 ÷ 101 = 1010.11

(b)

$$\begin{array}{r} 1011.101 \\ 101.01 \\ \hline 1011101 \\ 0000000 \\ 1011101 \\ 0000000 \\ 1011101 \\ \hline 111101.00001 \end{array}$$

(c)
$$\begin{array}{r} 1010.010 \\ 111.111 \\ \hline 0010.011 \end{array}$$

(d)
$$\begin{array}{r} 1101.101 \\ +\ 111.011 \\ \hline 10101.000 \end{array}$$

Q7 (a) 16-bit sign magnitude → 0000000001001010
16-bit sign 1's complement → 0000000001001010
16-bit sign 2's complement → 0000000001001010

(b) 16-bit sign magnitude → 1000000011100000
16-bit sign 1's complement → ~~+00001~~ ~~++++++++++++0000~~
1111111100001111
16-bit sign 2's complement → 1111111100010000

Q8 $-(2^{n-1}-1)$ to $(2^{n-1}-1)$

Q9 -2^{n-1} to $(2^{n-1}-1)$