2.1 # CHAPTER:02

→ Express decimal numbers as a sum of values of each digit

Example 2.1

⇒ $(47) = (4 \times 10^1) + (7 \times 10^0)$

$= 40 + 7$

$= 47$

Related Problems:

⇒ $(939) = (9 \times 10^2) + (3 \times 10^1) + (9 \times 10^0)$

$= 900 + 30 + 9$

$= 939$

Example 2.2

⇒ $(568.23) = (5 \times 10^2) + (6 \times 10^1) + (8 \times 10^0) + (2 \times 10^{-1}) + (3 \times 10^{-2})$

$= (5 \times 100) + (6 \times 10) + (8 \times 1) + (2 \times 0.1) + (3 \times 0.01)$

$= 500 + 60 + 8 + 0.2 + 0.03 = 568.23$

Related Problem

⇒ $(67.924) = (6 \times 10^1) + (7 \times 10^0) + (9 \times 10^{-1}) + (2 \times 10^{-2}) + (4 \times 10^{-3})$

$= (6 \times 10) + (7 \times 1) + (9 \times 0.1) + (2 \times 0.01) + (4 \times 0.001)$

$= 60 + 7 + 0.9 + 0.02 + 0.004$

$= 67.924.$

Section 2.1 DECIMAL NUMBERS.

1. Weight of 7 in each numbers.

(a) 1947

$\Rightarrow (7 \times 10^0) = (7 \times 1) = 7$

(b) 1799

$\Rightarrow (7 \times 10^2) = (7 \times 100) = 700$

(c) 1979

$\Rightarrow (7 \times 10^1) = (7 \times 10) = 70$

2. Express each as power of ten.

(a) 1000

$\Rightarrow 10^3$

(b) 10000000

$\Rightarrow 10^7$

(c) 1000000000

$\Rightarrow 10^9$

3. Give value of each digit:

(a) 263

$\Rightarrow (2 \times 10^2) + (6 \times 10^1) + (3 \times 10^0)$

$\Rightarrow 2 \times 100 + 6 \times 10 + 3 \times 1$

$\Rightarrow 200 + 60 + 3$

(b) 5436

$\Rightarrow (5 \times 10^3) + (4 \times 10^2) + (3 \times 10^1) + (6 \times 10^0)$

$\Rightarrow 5 \times 1000 + (4 \times 100) + (3 \times 10) + (6 \times 1)$

$\Rightarrow 5000 + 400 + 30 + 6$

(c) 234543

$\Rightarrow (2 \times 10^5) + (3 \times 10^4) + (4 \times 10^3) + (5 \times 10^2) + (4 \times 10^1) + (3 \times 10^0)$

$\Rightarrow (2 \times 10000) + (3 \times 10000) + (4 \times 1000) + (5 \times 100) + (4 \times 10) + (3 \times 1)$

$\Rightarrow 200000 + 30000 + 4000 + 500 + 40 + 3.$

4. 999999

BINARY NUMBERS:-

Example 2.3 1101101 to decimal.

$(1101101)^2 = (1\times10^6) + (1\times10^5) + (0\times10^4) + (1\times10^3) + (1\times10^2) + (0\times10^1) + (1\times10^0)$

$= 64 + 32 + 0 + 8 +$

$\Rightarrow (1101101)^2 = (1\times2^6) + (1\times2^5) + (0\times2^4) + (1\times2^3) + (1\times2^2) + (0\times2^1) + (1\times2^0)$

$= 64 + 32 + 0 + 8 + 4 + 1$

$= (109)_{10}$ Ans.

Example 2.4 0.1011 to decimal.

$\Rightarrow (0.1011)_2 = (1\times2^{-1}) + (0\times2^{-2}) + (1\times2^{-3}) + (1\times2^{-4})$

$= 0.5 + 0 + 0.125 + 0.0625$

$= (0.6875)_{10}$ Ans.

Section 2.2

5. Convert following binary numbers

a) 001

$\Rightarrow (001)_2 = (0\times10^2) + (0\times10$

$= (0\times2^2) + (0\times2^1) + (1\times2^0)$

$= 0 + 0 + 1$

$= (1)_{10}$ Ans.

b) 010

$\Rightarrow (010)_2 = (0 \times 2^2) + (1 \times 2^1) + (0 \times 2^0)$

$= 0 + 2 + 0$

$= (2)_{10}$ Ans.

(c) 101

$\Rightarrow (101)_2 = (1 \times 2^2) + (0 \times 2^1) + (1 \times 2^0)$

$= 4 + 0 + 1$

$= (5)_{10}$ Ans.

(d) 110

$\Rightarrow (110)_2 = (1 \times 2^2) + (1 \times 2^1) + (0 \times 2^0)$

$= 4 + 2 + 0$

$= (6)_{10}$ Ans.

(e) 1010

$\Rightarrow (1010)_2 = (1 \times 2^3) + (0 \times 2^2) + (1 \times 2^1) + (0 \times 2^0$

$= 8 + 0 + 2 + 0$

$= (10)_{10}$ Ans.

(f) 1011

$\Rightarrow (1011)_2 = (1 \times 2^3) + (0 \times 2^2) + (1 \times 2^1) + (1 \times 2^0)$

$= 8 + 0 + 2 + 1$

$= (11)_{10}$ Ans.

(g) 1110

$\Rightarrow (1110)_2 = (1 \times 2^3) + (1 \times 2^2) + (1 \times 2^1) + (0 \times 2^0)$

$= 8 + 4 + 2 + 0$

$= (14)_{10}$ Ans.

(h) 1111

$\Rightarrow (1111)_2 = (1\times2^3)+(1\times2^2)+(1\times2^1)+(1\times2^0)$

$= 8+4+2+1$

$= (15)_{10}$ Ans.

6. Convert binary numbers into decimal.

a) 100001

$\Rightarrow (1\times2^5)+(0\times2^4)+(0\times2^3)+(0\times2^2)$
$+(0\times2^1)+(1\times2^0)$

$\Rightarrow 32+0+0+0+0+1$

$\Rightarrow 33$ Ans.

b) 100111

$\Rightarrow (1\times2^5)+(0\times2^4)+(0\times2^3)+(1\times2^2)$
$+(1\times2^1)+(1\times2^0)$

$\Rightarrow 32+0+0+4+2+1$

$\Rightarrow 39$ Ans.

c) 101010

$\Rightarrow (1\times2^5)+(0\times2^4)+(1\times2^3)+(0\times2^2)$
$+(1\times2^1)+(0\times2^0)$

$\Rightarrow 32+0+8+0+2+0$

$\Rightarrow 42$ Ans.

d) 111001

$\Rightarrow (1\times2^5)+(1\times2^4)+(1\times2^3)+(0\times2^2)+(0\times2^1)+(1\times2^0)$

$\Rightarrow 32+16+8+0+0+1$

$\Rightarrow 57$ Ans.

e) 1100000

$\Rightarrow (1\times2^6)+(1\times2^5)+(0\times2^4)+(0\times2^3)+(0\times2^2)+(0\times2^1)+(0\times2^0)$

$\Rightarrow 64+32+0+0+0+0+0$

$\Rightarrow 96$ Ans.

f) 11111101

$\Rightarrow (1\times2^7)+(1\times2^6)+(1\times2^5)+(1\times2^4)+(1\times2^3)+(1\times2^2)+(0\times2^1)+(1\times2^0)$

$\Rightarrow 128+64+32+16+8+4+0+1$

$\Rightarrow 253$ Ans.

g) 11110010

$\Rightarrow (1\times2^7)+(1\times2^6)+(1\times2^5)+(1\times2^4)+(0\times2^3)+(0\times2^2)+(1\times2^1)+(0\times2^0)$

$\Rightarrow 128+64+32+16+0+0+2+1$

$\Rightarrow 243$ Ans.

h) 11111111

⇒ (1x2^7) + (1x2^6) + (1x2^5) + (1x2^4) + (1x2^3) + (1x2^2) + (1x2^1) + (1x2^0)

⇒ 128 + 64 + 32 + 16 + 8 + 4 + 2 + 1

⇒ 255 Ans.

7. Convert binary numbers to decimal.

a) 110011.11

⇒ (1x2^5) + (1x2^4) + (0x2^3) + (0x2^2) + (1x2^1) + (1x2^0) + (1x2^-1) + (1*2^-2)

⇒ 32 + 16 + 0 + 0 + 2 + 1 + 0.5 + 0.25

⇒ 51.75 Ans.

b) 101010.01

⇒ (1x2^5) + (0x2^4) + (1x2^3) + (0x2^2) + (1x2^1) + (0x2^0) + (0x2^-1) + (1x2^-2)

⇒ 32 + 0 + 8 + 0 + ~~0 + 0 + 1~~ 2 + 0 + 0.25

⇒ 42.25 Ans.

c) 1000001.111

⇒ (1x2^6) + (0x2^5) + (0x2^4) + (0x2^3) + (0x2^2) + (0x2^1) + (1x2^0) + (1x2^-1) + (1x2^-2) + (1x2^-3)

⇒ 64 + 0 + 0 + 0 + 0 + 0 + 1 + 0.5 + 0.25 + 0.125

⇒ 65.875 Ans.

d) 1111000.101

$\Rightarrow (1\times2^6)+(1\times2^5)+(1\times2^4)+(1\times2^3)+(0\times2^2)+(0\times2^1)+(0\times2^0)+(1\times2^{-1})+(0\times2^{-2})+(1\times2^{-3})$

$\Rightarrow 64+32+16+8+0.5+0.125$

$\Rightarrow 120.625$ Ans.

e) 1011100.10101

$\Rightarrow (1\times2^6)+(0\times2^5)+(1\times2^4)+(1\times2^3)+(1\times2^2)+(0\times2^1)+(0\times2^0)+(1\times2^{-1})+(0\times2^{-2})+(1\times2^{-3})+(0\times2^{-4})+(1\times2^{-5})$

$\Rightarrow 64+16+8+4+0.5+0.125+0.03125$

$\Rightarrow 92.65625$ Ans.

f) 1110001.0001

$\Rightarrow (1\times2^6)+(1\times2^5)+(1\times2^4)+(0\times2^3)+(0\times2^2)+(0\times2^1)+(1\times2^0)+(0\times2^{-1})+(0\times2^{-2})+(0\times2^{-3})+(1\times2^{-4})$

$\Rightarrow 64+32+16+1+0.0625$

$\Rightarrow 113.0625$ Ans.

g) 1011010.1010

$\Rightarrow (1\times2^6)+(0\times2^5)+(1\times2^4)+(1\times2^3)+(0\times2^2)+(1\times2^1)+(0\times2^0)+(1\times2^{-1})+(0\times2^{-2})+(1\times2^{-3})+(0\times2^{-4})$

$\Rightarrow 64+16+8+2+0.5+0.125$

$\Rightarrow 90.625$ Ans.

h) 1111111.11111

$\Rightarrow (1\times2^6)+(1\times2^5)+(1\times2^4)+(1\times2^3)+(1\times2^2)+(1\times2^1)+(1\times2^0)+(1\times2^{-1})+(1\times2^{-2})+(1\times2^{-3})+(1\times2^{-4})+(1\times2^{-5})$

$\Rightarrow 64+32+16+8+4+2+1+0.5+0.25+0.125+0.0625+0.03125$

$\Rightarrow 127.96875$ Ans.

2.3

DECIMAL TO BINARY CONVERSION:-

Example 2.5

a) 12

$= 8+4 = 2^3+2^2 = 1100$

b) 25

$= 16+8+1 = 2^4+2^3+2^0 = 11001$

c) 58

$= 32+16+8+2 = 2^5+2^4+2^3+2^1 = 111010$

d) 82

$= 64+16+2 = 2^6+2^4+2^1 = 1010010$

Example 2.6

a) 19

2	19
2	9 — 1
2	4 — 1
2	2 — 0
2	1 — 0

$(19)_{10} = (10011)_2$ Ans.

b) 45

2	45
2	22 — 1
2	11 — 0
2	5 — 1
2	2 — 1
	1 — 0

$(45)_{10} = (101101)_2$ Ans.

Section 2.3

13. Convert each decimal number to binary.

a) 13

2	13
2	6 — 1
2	3 — 0
	1 — 1

$(13)_{10} = (1101)_2$ Ans.

b) 17

2	17
2	8 — 1
2	4 — 0
2	2 — 0
	1 — 0

$(17)_{10} = (10001)_2$

Ans.

c) 23

2	23
2	11 — 1
2	5 — 1
2	2 — 1
	1 — 0

$(23)_{10} = (10111)_2$

Ans.

d) 30

2	30
2	15 — 0
2	7 — 1
2	3 — 1
	1 — 1

$(30)_{10} = (1110)_2$

Ans.

(e) 35

2	35
2	17 — 1
2	8 — 1
2	4 — 0
2	2 — 0
	1 — 0

$(35)_{10} = (100011)_2$ Ans.

f) 40

2	40
2	20 — 0
2	10 — 0
2	5 — 0
2	2 — 1
	1 — 0

$(40)_{10} = (101000)_2$ Ans.

g) 49

2	49
2	24 — 1
2	12 — 0
2	6 — 0
2	3 — 0
	1 — 1

$(49)_{10} = (110001)_2$ Ans.

h) 60

2	60	
2	30	0
2	15	0
2	7	1
2	3	1
	1	1

$(60)_{10} = (111100)_2$

Ans.

BINARY ARITHMETIC

Example 2.7

Add following binary numbers.

a) 11 + 11

```
  11          3
+ 11        + 3
-----       ---
 110          6
```

b) 100 + 10

```
 100          4
+ 10        + 2
-----       ---
 110          6
```

c) 111 + 11

```
 1 1 1
+  1 1
-------
 1 0 1 0
```

```
  7
+ 3
----
 10
```

d) 110 + 100

```
  1 1 0
+ 1 0 0
-------
 1 0 1 0
```

```
  6
+ 4
----
 10
```

Example 2.8

Perform following subtraction:-

a) 11 - 01

```
 1 1
- 0 1
-----
 1 0
```

```
 3
-1
--
 2
```

b) 11 - 10

```
 1 1
- 1 0
-----
 0 1
```

```
 3
-2
--
 1
```

Example 2.9

Subtract 011 from 101

```
  1 0 1
- 0 1 1
-------
  0 1 0
```

```
 5
-3
--
 2
```

Example 2.10

Binary Multiplication.

a) 11 x 11

```
   11
 x 11
-----
   11
  11
-----
  1001
```

b) 111 x 101

```
   111
 x 101
-------
   111
  000
 111
-------
 10001
```

Example 2.11

Binary Division.

a) 110 ÷ 11

```
    10
  ------
11 | 110
     11
  -----
     000
       0
     ---
       x
```

b) 110 ÷ 10

```
    11
  ------
10 | 110
     10
  -----
     010
      10
     ---
      x
```

Section 2.4 :-

15. Add the binary numbers.

a) $10 + 10$

$$\begin{array}{r} 10 \\ +\ 10 \\ \hline 100 \end{array}$$

b) $10 + 11$

$$\begin{array}{r} 10 \\ +\ 11 \\ \hline 101 \end{array}$$

c) $100 + 11$

$$\begin{array}{r} 100 \\ +\ 11 \\ \hline 111 \end{array}$$

d) $111 + 101$

$$\begin{array}{r} {}^{1}1^{1}11 \\ +\ 101 \\ \hline 1100 \end{array}$$

16. Subtract the following numbers.

a) $10 - 1$

$$\begin{array}{r} \cancel{1}0 \\ -\ 1 \\ \hline 01 \end{array}$$

b) $100 - 11$

$$\begin{array}{r} {}^{0}\cancel{1}{}^{1}\cancel{0}{}^{1}0 \\ -\ 11 \\ \hline 001 \end{array}$$

c) $110 - 100$

$$\begin{array}{r} 110 \\ -\ 100 \\ \hline 010 \end{array}$$

d) $1111 - 11$

$$\begin{array}{r} 1111 \\ -\ 11 \\ \hline 1100 \end{array}$$

17. Perform binary Multiplication.

a) 11 × 10

```
  11
 x 10
------
  00
+ 11
------
 110
```

b) 101 × 11

```
  101
 x 11
------
  101
+101
------
 1111
```

c) 111 × 110

```
  111
 x 110
-------
  000
 111
+111
-------
10110
```

d) 1100 × 101

```
 1100
 x101
------
 1100
0000
+1100
------
111100
```

18. Perform binary division.

a) 110 ÷ 11

```
  10
11|110
  11
  --
   0
```

b) 1010 ÷ 10

```
  11
10|1010
  10
  --
  10
  10
  --
```

c) 1111 ÷ 101

```
      11
101 | 1111
     101
     ---
      101
      101
      ---
        0
```

COMPLEMENTS OF BINARY NUMBERS :-

Example 2.12

Find 2's complement of 10110010

```
 10110010
 01001101      1's complement
+       1
----------
 10000000
```

```
 10110010
 01001101      1's complement
         +1
----------
 01001110
```

Section 2.5

21. Determine 1's complement in each number.

a) 100
011

b) 111
000

c) 1100
0011

d) 10111011
01000100

22. Determine 2's complement

a) 11
11
00 1's comp.
+ 1

01

b) 110
110
001 1's com
+ 1

010

c) 1010
1010
0101
+ 1

0110

d) 1001
1001
0110
+ 1

0111

SIGNED NUMBERS.

Example 2.14

Express -39 as 8 bit number in sign magnitude, 1's complement 2's complement

8 bit number for -39

2	39
2	19 — 1
2	9 — 1
2	4 — 1
2	2 — 0
2	1 — 0

00100111

Sign magnitude form

10100111 Ans.

1's complement form.

11011000 Ans.

2's complement form.

$$\begin{array}{r} 11011000 \\ + \qquad\quad 1 \\ \hline 11011001 \end{array}$$

Ans.

Signed Magnitude

Example 2.15

10010101

$\Rightarrow (0\times2^6)+(0\times2^5)+(1\times2^4)+(0\times2^3)+(1\times2^2)+(0\times2^1)+(1\times2^0)$

$\Rightarrow 16+4+1 \Rightarrow 21$

sign-bit is 1 so decimal number is −21. Ans.

1's complement.

Example 2.16

a) 00010111

$\Rightarrow -(0\times2^7)+(0\times2^6)+(0\times2^5)+(1\times2^4)+(0\times2^3)+(1\times2^2)+(1\times2^1)+(1\times2^0)$

$\Rightarrow 16+4+2+1$

$\Rightarrow +23$ Ans.

b) 11101000

$\Rightarrow -(1\times2^7)+(1\times2^6)+(1\times2^5)+(0\times2^4)+(1\times2^3)+(0\times2^2)+(0\times2^1)+(0\times2^0)$

$\Rightarrow -128+64+32+8$

$\Rightarrow -24$

Adding 1 to result.

$\Rightarrow -24+1 \Rightarrow -23$ Ans.

Example 2.17

a) 01010110

$\Rightarrow -(0\times2^7)+(1\times2^6)+(0\times2^5)+(1\times2^4)+(0\times2^3)$
$+(1\times2^2)+(1\times2^1)+(0\times2^0)$

$\Rightarrow 64+16+4+2$

$\Rightarrow +86$ Ans.

b) 10101010

$\Rightarrow -(1\times2^7)+(0\times2^6)+(1\times2^5)+(0\times2^4)+(1\times2^3)$
$+(0\times2^2)+(1\times2^1)+(0\times2^0)$

$\Rightarrow -128+32+8+2$

$\Rightarrow -86$ Ans.

Example 2.18

Convert decimal to binary

$\Rightarrow 3.248\times10^4 = 32480$

$= 1111110111100000_2$

$= 1.11111011100000\times2^{14}$

$\Rightarrow 14+127 = 141$

$= 10001101_2$

2	141
2	70 – 1
2	35 – 0
2	17 – 1
2	8 – 1
2	4 – 0
2	2 – 0
2	1 – 0

2	32480
2	16240 – 0
2	8120 – 0
2	4060 – 0
2	2030 – 0
2	1015 – 0
2	507 – 1
2	253 – 1
2	126 – 1
2	63 – 0
2	31 – 1
2	16 – 0
2	8 – 0
2	4 – 0
2	2 – 0

The complete floating-point number is:

0	10001101	11111011100000000000000

Section 2.6

23. Express each decimal number in binary as an 8 bit sign magnitude numb

a) +29

8-bit number for +29

⇒ 0011101 Ans.

2	29
2	14 – 1
2	7 – 0
2	3 – 1
2	1 – 1
	0 – 1

b) −85

8 bit number for -85

⇒ 1010101 ~~Ans~~.

⇒ −85 = 11010101

2	85
2	42 – 1
2	21 – 0
2	10 – 1
2	5 – 0
2	2 – 1
	1 – 0

c) +100

8-bit number for +100

~~⇒ 11001000~~

⇒ 1100100

⇒ +100 = 01100100 Ans.

2	100
2	50 – 0
2	25 – 0
2	12 – 1
2	6 – 0
2	3 – 0
	1 – 1

d) −123

binary number for 123

⇒ 1111011

8-bit signed number for −123

⇒ 11111011 Ans.

2	123
2	61 – 1
2	30 – 1
2	15 – 0
2	7 – 1
2	3 – 1
	1 – 1

4. Express each decimal number as an 8-bit number in 1's complement.

a) -34

Binary representation for 34

$\Rightarrow 0100010$

$\Rightarrow -34 = 10100010$

2	34
2	17 – 0
2	8 – 1
2	4 – 0
2	2 – 0
	1 – 0

1's complement = 11011101 Ans.

b) $+57$

$\Rightarrow 57 = 0111001_2$

$\Rightarrow +57 = 00111001$ Ans.

2	57
2	28 – 1
2	14 – 0
2	7 – 0
2	3 – 1
	1 – 1

~~A's~~

c) -99

$\Rightarrow 99 = 1100011_2$

$\Rightarrow -99 = 11100011$

2	99
2	49 – 1
2	24 – 1
2	12 – 0
2	6 – 0
2	3 – 0
	1 – 1

1's complement = 10011100 Ans.

d) $+115$

$\Rightarrow 115 = 1110011$

$\Rightarrow +115 = 01110011$ Ans.

2	115
2	57 – 1
2	28 – 1
2	14 – 0
2	7 – 0
2	3 – 1
	1 – 1

25. Express each decimal number as an 8-bit number in 2's complement

a) $+12$

$\Rightarrow 12 = 0001101_2$

$\Rightarrow +12 = 00001101$ Ans.

2	12
2	6 – 0
2	3 – 0
	1 – 1

b) -68

$\Rightarrow 68 = 1000100_2$

$\Rightarrow -68 = 11000100$

Negative No so taking 1's and 2's complement

$\Rightarrow$ 1's complement = 10111011

$\Rightarrow$ 2's complement = 10111011 + 1

10111100 Ans

2	68
2	34 – 0
2	17 – 0
2	8 – 1
2	4 – 0
2	2 – 0
	1 – 0

c) $+101$

$\Rightarrow 101 = 1100101$

$\Rightarrow +101 = 01100101$ Ans.

+ve number so no need of 1's and 2's complement.

2	101
2	50 – 1
2	25 – 0
2	12 – 1
2	6 – 0
2	3 – 0
	1 – 1

d) - 125

⇒ 125 = 1111101,

⇒ - 125 = 1111101

2	125
2	62 — 1
2	31 — 0
2	15 — 1
2	7 — 1
2	3 — 1
	1 — 1

⇒ 1's complement = 1000010

⇒ 2's complement =

$$\begin{array}{r} 1000010 \\ +\quad 1 \\ \hline 1000011 \end{array}$$ Ans.

26. Determine decimal value of each signed binary number in sign-magnitude form.

a) 10011001

⇒ ~~(1×2^7)~~ $+ (0\times2^6) + (0\times2^5) + (1\times2^4) +$
$(1\times2^3) + (0\times2^2) + (0\times2^1) + (1\times2^0)$

⇒ ~~128~~ + 16 + 8 + 1

⇒ ~~103~~ 25

Sign bit is 1 so decimal number is ~~103 Ans~~ ~~-5~~ -25 Ans.

b) 01110100

$\Rightarrow (1\times2^6)+(1\times2^5)+(1\times2^4)+(0\times2^3)$
$+(1\times2^2)+(0\times2^1)+(0\times2^0)$

$\Rightarrow 64+32+16+4$

$\Rightarrow 116$

Sign bit is 0 so decimal number is +116 Ans.

c) 10111111

$\Rightarrow (0\times2^6)+(1\times2^5)+(1\times2^4)+(1\times2^3)+$
$(1\times2^2)+(1\times2^1)+(1\times2^0)$

$\Rightarrow 32+16+8+4+2+1$

$\Rightarrow 64$

Sign bit is 1 so decimal number is −64 Ans.

27. Determine decimal number of each signed binary number in 1's complement.

a) 10011001

$\Rightarrow -(1\times2^7)+(0\times2^6)+(0\times2^5)+(1\times2^4)$
$+(1\times2^3)+(0\times2^2)+(0\times2^1)+(1\times2^0)$

$\Rightarrow -128+16+8+1 \Rightarrow -103$

Adding 1 to −103

$\Rightarrow -102$ Ans.

b) 01110100

$\Rightarrow -(0\times2^7)+(1\times2^6)+(1\times2^5)+(1\times2^4)+(0\times2^3)+(1\times2^2)+(0\times2^1)+(0\times2^0)$

$\Rightarrow 64+32+16+4$

$\Rightarrow +116$ Ans.

c) 10111111

$\Rightarrow -(1\times2^7)+(0\times2^6)+(1\times2^5)+(1\times2^4)+(1\times2^3)+(1\times2^2)+(1\times2^1)+(1\times2^0)$

$\Rightarrow -128+32+16+8+4+2+1$

$\Rightarrow -65$

Adding 1 to -65

$\Rightarrow -64$ Ans.

28. Determine the decimal value of each signed binary in 2's complement.

a) 10011001

$\Rightarrow (-1\times2^7)+(0\times2^6)+(0\times2^5)+(1\times2^4)+(1\times2^3)+(0\times2^2)+(0\times2^1)+(1\times2^0)$

$\Rightarrow -128+16+8+1$

$\Rightarrow -103$ Ans.

b) 01110100

$\Rightarrow -(0\times2^7)+(1\times2^6)+(1\times2^5)+(1\times2^4)$
$+(0\times2^3)+(1\times2^2)+(0\times2^1)+(0\times2^0)$

$\Rightarrow 64+32+16+4$

$\Rightarrow +116$ Ans

c) 10111111

$\Rightarrow -(1\times2^7)+(0\times2^6)+(1\times2^5)+(1\times2^4)$
$+(1\times2^3)+(1\times2^2)+(1\times2^1)+(1\times2^0)$

$\Rightarrow -128+32+16+8+4+2+1$

$\Rightarrow -65$ Ans.

29. Express each of the following sign-magnitude binary numbers in single-precision floating point.

a) 01111100001011

$\Rightarrow 1.11110000101011\times2^{14}$

$\Rightarrow$ Exponent $= 14+127$

$= 141 = 10001101_2$

Mantissa $= 11110000101011000000000$

Complete floating point number is:

→ 01000110111110000101011
00000000 Ans.

b) 1001100000011000

Sign = 1

$\Rightarrow 1.1000000011000 \times 2^{11}$

Exponent = 11 + 127

= 138 = 10001010_2

2	138
2	69 - 0
2	34 - 1
2	17 - 0
2	8 - 1
2	4 - 0
2	2 - 0
	1 - 0

Mantissa = 10000001100000000000000

Complete floating point number can be expressed as

11000101011000001100000000000000 Ans.

30. Determine the values of following single-precision floating point numbers.

a) 11000000101001001110001000000000

$\Rightarrow$ Sign = 1

$\Rightarrow$ Exponent = 10000001

$(1 \times 2^7) + (1 \times 2^0)$
$= 128 + 1$

= 129 - 127 = 2

$\Rightarrow$ Mantissa = $1.01001001110001 \times 2^2$

= 101.00100111000 1

$\Rightarrow -101.00100111000 1 = -5.15258789$

Ans.

b) 01100110010000111110100100000000

⇒ Sign = 0

⇒ Exponent = 11001100

= 204 - 127 = 77

⇒ Mantissa = 1.10000111110100100000000

$1.10000111110100100000000 \times 10^{77}$

ARITHMETIC OPERATIONS WITH SIGNED NUMBERS:-

Example 2.19

Add signed numbers. 01000100, 00011011, 00001110, 00010010

```
  01000100      1st
+ 00011011      2nd
----------
  01'0'1'1'111
+ 00001110      3rd
----------
  01101101
+ 00010010      4th.
----------
  01111111      Ans.
```

Example 2.20

Perform Subtraction.

a) 00001000 - 00000011

2's complement of 00000011

~~00000011~~ 11111100

~~111100~~ +1

11111101

Now,

'0'0'001000

+11111101

100000101

b) 00001100 - 11110111

2's complement 11110111

00001000

+1

00001001

000'01100

+00001001

00010101

Example 2.21 :-

Multiply the signed binary numbers 01001101 and 00000100

Decimal value of multiplier is 4 so multiplicand is added to itself 4 times.

```
  01001101      1'st time
+ 01001101      2nd time
----------
  10011010

+ 01001101      3rd time
----------
  11101111

+ 01001101      4th time
----------
  100110100     Ans.
```

Example 2.22