COMPUTER SCIENCE & IT

DIGITAL LOGIC

Lecture No: 02

Miscellaneous Topics

By- Chandan Gupta Sir

Recap of Previous Lecture

Number System

Number system Cont.

Concept of Compliments

→ defined for weighted no. system with base-r

- $(r-1)'s$ compliment & $r's$ compliment

- If no. is of n-digit

  $(r-1)'s$ compliment of no. = (maximum no. of n-digit in r-base system − no.)

  $r's$ compliment of no. = $(r-1)'s$ compliment + 1

- Decimal no. system → base = 10
  - 9's compliment
  - 10's compliment
- Binary no. system → base = 2
  - 1's compliment
  - 2's compliment

[9's and 10's compliments & 1's and 2's compliments]

Lets understand with examples → 9's and 10's compliments

- $(2796)_{10} \xrightarrow{9's} 9999 - 2796 = (7203)_{10}$

  $\xrightarrow{10's} (7203)_{10} + 1 = (7204)_{10}$

- $(31542)_{10} \xrightarrow{9's} (99999)_{10} - (31542)_{10} = (68457)_{10}$

  $\xrightarrow{10's} (68457)_{10} + 1 = (68458)_{10}$

- $(234 \cdot 57)_{10} \xrightarrow{9's} (76542)_{10} \longrightarrow (765.42)_{10} \rightarrow$ final 9's compliment.

  $\xrightarrow{10's} 76542 + 1 = 76543$

  $\downarrow$

  $(765.43)_{10} \longrightarrow$ final 10's compliment

- $(576 \cdot 342)_{10} \xrightarrow{9's} (423 \cdot 657)_{10}$

  $\xrightarrow{10's} (423 \cdot 658)_{10}$

- $(486 \cdot 20)_{10} \xrightarrow{9's} (513 \cdot 79)_{10}$

  $\xrightarrow{10's} (513 \cdot 80)_{10}$

Lets understand with examples → 1's and 2's compliments

- $(1011)_2 \xrightarrow{1's} (1111)_2 - (1011)_2 = (0100)_2$

  $\xrightarrow{2's} (0100)_2 + 1 = (0101)_2$

- $(1101.01)_2 \xrightarrow{1's} (0010.10)_2$

  $\xrightarrow{2's} (0010.11)_2$

- $(10111010100)_2 \xrightarrow{1's} (01000101011)_2$

  $\xrightarrow{2's} (01000101100)_2$

- $(1011011110101101000)_2$

  $\downarrow 2's$

  $(0100100001010011000)_2$

$$(0000)_{10} \xrightarrow{9's} (9999)_{10}$$

$$\xrightarrow{10's} \begin{array}{r} 9999 \\ +\quad 1 \\ \hline \underline{①0000} \end{array} \xrightarrow{10's} (0000)_{10}$$

discard

$$(00000)_r \xrightarrow{r's} (00000)_r$$

$$(0000)_2 \xrightarrow{1's} (1111)_2$$

$$\xrightarrow{2's} (0000)_2$$

$$\begin{array}{r} 1111 \\ 1 \\ \hline \underline{①0000} \end{array} \xrightarrow{2's} (0000)_2$$

discard

$$(0000)_8 \xrightarrow{7's} (7777)_8$$

$$\xrightarrow{8's} \begin{array}{r} 7777 \\ 1 \\ \hline \underline{①0000} \end{array} \xrightarrow{8's} (0000)_2$$

discard

$$(00000)_2 \xrightarrow{2's} (00000)_2$$

$$(10000)_2 \xrightarrow{2's} (10000)_2$$

$\xrightarrow{1's} (01111)_2$

$\xrightarrow{2's}$

$$\begin{array}{r} 01111 \\ +\quad\;\; 1 \\ \hline (10000)_2 \end{array}$$

$1 \underline{\quad n \text{ zeros} \quad}. \xrightarrow{2's} 1 \underline{\quad n \text{ zeros} \quad}.$

(same no)

- $(124)_6 \xrightarrow{5's} (555)_6 - (124)_6 = (431)_6$

  $\xrightarrow{6's} (432)_6$

- $(2350)_6 \xrightarrow{5's} (3205)_6$

  $\xrightarrow{6's}$

$$\begin{array}{r} 3205 \\ +\quad\quad 1 \\ \hline (3210)_6 \end{array}$$

- $(2473.20)_8 \xrightarrow{7's} (5304.57)_8$

  $\xrightarrow{8's} (5304.60)_8$

Question

9's and 10's compliment of no. 123.123 is

(a) 876.876 , 877.876

(b) 876.876 , 876.877

(c) 987.987 , 988.987

(d) 987.987 , 987.988

$$123.123 \xrightarrow{9's} 876.876 \xrightarrow{10's} 876.877$$

Question

1's and 2's compliment of 110.110 will be :

$110.110 \xrightarrow{1's} 001.001$

$110.110 \xrightarrow{2's} (001.010)$

(a) 001.001, 010.001

(b) 001.001, 011.001

(c) 001.001, 001.010

(d) 011.011, 011.010

$(00.00)_2 \xrightarrow{2's} (00.00)_2$

$(00.00)_2 \xrightarrow{1's} (11.11)_2$

$$\begin{array}{r} 1111 \\ 1 \\ \hline 10000 \end{array}$$

discard $\leftarrow$ 1 0000 $\xrightarrow{2's} (00.00)_2$

Question

A no. N_1 is given as $N_1 = (1010111010000000)_2$ the 2's compliment of N_1 is N_2. Total no. of 1's in N_2 is ____4____.

$$N_2 = (0101000110000000)_2$$

[**Question**]

2's compliment of no. N_1 is given as $(110.011)_2$ then no. N_1 is

(a) $(001.101)_2$

(b) $(001.100)_2$

(c) $(010.100)_2$

(d) $(001.011)_2$

$\big\downarrow$ 2's

$N_1 = (001.101)_2$

$N = 11010 \xrightarrow{2's} (00110)_2 \xrightarrow{2's} (11010)_2$ N

$\xleftarrow{2's}$ N'

$N = 11010 \xrightarrow{1's} (00101)_2$

$\xleftarrow{1's}$ N_2

Signed No. Representation

Sign magnitude Method

1's compliment method

2's compliment method

- +ve no. in all the methods is represented in same manner, only -ve no. representation is different in different methods.

Sign Magnitude Method

$n = 4$-bit

two different representations of same zero

↓

that's why one representation wasted.

$\boxed{0000 \longrightarrow +0}$		$\boxed{1000 \longrightarrow (-0)}$	
0001 ⟶	+1	1001 ⟶	(−1)
0010 ⟶	+2	1010 ⟶	(−2)
0011 ⟶	+3	1011 ⟶	−3
0100 ⟶	+4	1100 ⟶	−4
0101 ⟶	+5	1101 ⟶	−5
0110 ⟶	+6	1110 ⟶	−6
0111 ⟶	+7	1111 ⟶	−7

-7 to $+7$, $\quad -(2^{4-1}-1)$ to $(2^{(4-1)}-1)$

- Total no. of numbers that can be represented using n-bits in sign magnitude method

$$= (2^{n} - 1)$$

- Range of the no.s $= -(2^{n-1} - 1)$ to $+(2^{(n-1)} - 1)$

$$(1\underbrace{01101})_2 \xrightarrow[\text{magnitude}]{\text{sign}} -(13)_{10}$$

$$(1\underbrace{101101})_2 \xrightarrow[\text{mgn.}]{\text{sign}} -(45)_{10}$$

1's Compliment Method

$n = 4$ bit

two different representations of same zero

$\downarrow$

one representation got wasted.

$$\boxed{0000 \longrightarrow +0 \xrightarrow{1's} (1111)_2 = (-0)}$$

$$0001 \longrightarrow +1 \xrightarrow{1's} (1110)_2 = -1$$

$$0010 \longrightarrow +2 \xrightarrow{1's} (1101)_2 = (-2)$$

$$0011 \longrightarrow +3 \xrightarrow{1's} (1100)_2 = -3$$

$$0100 \longrightarrow +4 \xrightarrow{1's} (1011)_2 = -4$$

$$0101 \longrightarrow +5 \xrightarrow{1's} (1010)_2 = -5$$

$$0110 \longrightarrow +6 \xrightarrow{1's} (1001)_2 = -6$$

$$0111 \longrightarrow +7 \xrightarrow{1's} (1000)_2 = -7$$

$$(-7 \text{ to } +7)$$

$$\boxed{A \xrightarrow{1's} -A}$$

Could be +ve or -ve

$$\underset{(-3)}{(1100)_2} \xrightarrow{1's} \underset{(+3)}{(0011)}$$

- Total no. of numbers (distinct numbers) that can be represented using n-bits in 1's compliment representation $= (2^n - 1)$

- Range $= -\left[2^{(n-1)} - 1\right]$ to $+\left[2^{(n-1)} - 1\right]$

$(-18)_{10}\ (101101)_2 \longrightarrow -(18)_{10}$

$\downarrow$ 1's

$+(18)_{10}\ (010010)_2$ $\quad -(-18) = +18$

$(01011)_2 \longrightarrow +(11)_{10}$

$n = 5$ bits

$$(-9)_{10} \Longrightarrow \underset{+9}{(01001)_2} \xrightarrow{1's} \underset{(-9)_{10}}{(10110)_2}$$

$$(-12)_{10} \Longrightarrow \underset{(+12)}{(01100)_2} \xrightarrow{1's} \underset{(-12)_{10}}{(10011)_2}$$

$n = 6$ bits

$$(-9)_{10} \longrightarrow \underset{+9}{(001001)_2} \xrightarrow{1's} \underset{(-9)_{10}}{(110110)_2}$$

$$(-12)_{10} \longrightarrow \underset{(+12)}{(001100)_2} \longrightarrow \underset{(-12)_{10}}{(110011)_2}$$

Topic : 2 Min Summary

→ Number system

Thank you

GW

Soldiers !