Free Study Material from All Lab Experiments

Electronics for NET/Gate Physical Sciences # Number System

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NUMBER SYSTEM

Base or Radix of Number system:-
no. of digits used in any number system. It represents

Number System	No. of digits
Binary (2)	0 — 1
Septal (7)	0 — 6
Octal (8)	0 — 7
Decimal (10)	0 — 9
Hexadecimal (16)	0 — 15 (F).

* Decimal to other Conversion
other to decimal Conversion
other to other Conversion
Arithmetic & logic operation among diff no. sys
Compliment of no. System.

* Desimal to other Conversion:-

$(25)_{10} \longrightarrow (11001)_2$

$(25)_{10} \longrightarrow (31)_8$ 8 | 25 | 1 ↑ / 3

$(25)_{10} \longrightarrow (34)_7$ 7 | 25 | 4 ↑ / 3

$(25)_{10} \longrightarrow (31)_8 \longrightarrow (34)_7$

"Base of the number system is inversely proportional to number inside the argument".or(bracket).

Q. Identify the values of R_1 and R_2 ?

$(235)_{R_1} = (565)_{10} = (1065)_{R_2}$?

(a) 12, 8 (b) 16, 8 (c) 8, 12 (d) 8, 16

Sol^n

16 | 565 — 5
16 | 35 — 3
2

$(565)_{10} \longrightarrow (235)_{16}$

Q. Identify x ?

$(123)_x = (12x)_3$

(a) 3 (b) −4 (c) 5 (d) None ✓

Q. $(25.625)_{10} \longrightarrow (\ ?\ )_2$

Sol^n

$(25)_{10} \longrightarrow (11001)_2$

0.625 × 2 = 1.250 (1) out
0.25 × 2 = 0.50 (0) out
0.50 × 2 = 1.00 (1) out

So $(25.625)_{10} \longrightarrow (11001.101)_2$

Q. $(25.625)_{10} \longrightarrow (\ ?\ )_2$

$(25)_{10} \longrightarrow (31)_8$

$$\begin{array}{r} 0.625 \\ \times\ 8 \\ \hline 5.000 \end{array}$$

So $(25.625)_{10} \longrightarrow (31.5)_8$

* Other to decimal Conversion :-

Q. $(11001)_2 \longrightarrow (\quad)_{10}$

MSB ← (11001)$_2$ → LSB

4 3 2 1 0

$1 \times 2^0 + 0 \times 2^1 + 0 \times 2^2 + 1 \times 2^3 + 1 \times 2^4$

$= 1 + 8 + 16 = 25$

$(11001)_2 \longrightarrow (25)_{10}$ Ans

Q. $(11001.101)_2 \longrightarrow (\quad)_{10}$

4 3 2 1 0 −1 −2 −3

$1 \times 2^0 + 0 \times 2^1 + 0 \times 2^2 + 1 \times 2^3 + 1 \times 2^4 + 1 \times 2^{-1} + 0 \times 2^{-2} + 1 \times 2^{-3}$

$= 1 + 8 + 16 + \frac{1}{2} + \frac{1}{8}$

$25 + \frac{5}{8} = 25 + 0.625$

$= 25.625$

$(11001.101)_2 \longrightarrow (25.625)_{10}$ Ans

Q. $(31)_8 \longrightarrow (\quad)_{10}$

Soln

$1 \times 8^0 + 3 \times 8^1$

$1 + 24 = 25$

$(31)_8 \longrightarrow (25)_{10}$

Q. $(31.5)_8 \longrightarrow (\quad)_{10}$

Soln

$1 \times 8^0 + 3 \times 8^1 + 5 \times 8^{-1}$

$25 + \frac{5}{8} = 25.625$

$(31.5)_8 \longrightarrow (25.625)_{10}$

Imp Q. $(123)_a = (12a)_3$

$\Rightarrow 3 \times a^0 + 2 \times a^1 + 1 \times a^2 = a \times 3^0 + 2 \times 3^1 + 1 \times 3^2$

$3 + 2a + a^2 = a + 6 + 9$

$a^2 + a - 12 = 0$

$a = \frac{-1 \pm \sqrt{1^2 - 4 \times -12}}{2}$

$a = \frac{-1 \pm 7}{2} = 3, -4.$

$a = 3, -4$ It is not satisfies so option is none of these.

* Octal Number System :-

Octal numbers can be represented in range of 3-bit banary since the ranges are satified.

000 → 0
001 → 1
010 → 2
011 → 3
100 → 4
101 → 5
110 → 6
111 → 7

* Hexadecimal Number System :-

Hexadecimal can be represented interms of 4-bit binary.

0000
0001
0010
0011
0100
0101
0110
0111
1000
1001 9
1010 9+1 = A
1011 9+2 = B
1100 9+3 = C
1101 9+4 = D
1110 9+5 = E
1111 9+6 = F

Q. Perform the conversion $(123.73)_8 \longrightarrow (\quad)_{16}$

Soln

$(123.73)_8 \longrightarrow (053.FC)_{16}$

001 010 011 . 111 011 100
0 5 3 . E C

Q. Find the minimum decimal equivalent of $(11C.0)_{13}$

(a) 194 (b) 283 (c) 384 (d) 333

$C \times 16^0 + 1 \times 16^1 + 1 \times 16^2$

∵ we find minimum decimal equivalent so for minimum we have base = 13

So $(11C.0)_{13}$ 12 | 13 | 14 | 15 | 16

$12 \times 13^0 + 1 \times 13^1 + 1 \times 13^2 = 12 + 13 + \ldots = 194$ Ans

Q. Perform the addition $(127)_8 + (172)_8$

Soln

$$\begin{array}{r} {\scriptstyle 1\ 1} \\ 127 \\ 172 \\ \hline 321 \end{array}$$

$8 \mid 9 \quad 1$ (1)

$8 \mid 10 \quad 2$ (1)

So $= (321)_8$ Ans

Q. The addition of two numbers are given as $12.3 + 13.0 = (32.0)$ Then perform the substraction ?

$322 - 133$

Soln

$$\begin{array}{r} {\scriptstyle 1} \\ 12.3 \\ +\ 13.0 \\ \hline 32.0 \end{array}$$

$4 \mid 4 \quad 0$ (1) $= 10$

$$\begin{array}{r} 4 \\ \hline 4 \end{array}$$

$(322)_4$

$-(133)_4$

$(123)_4$ Ans

Q. Perform the multiplication $(1111)_2 \times (1111)_2$

Soln

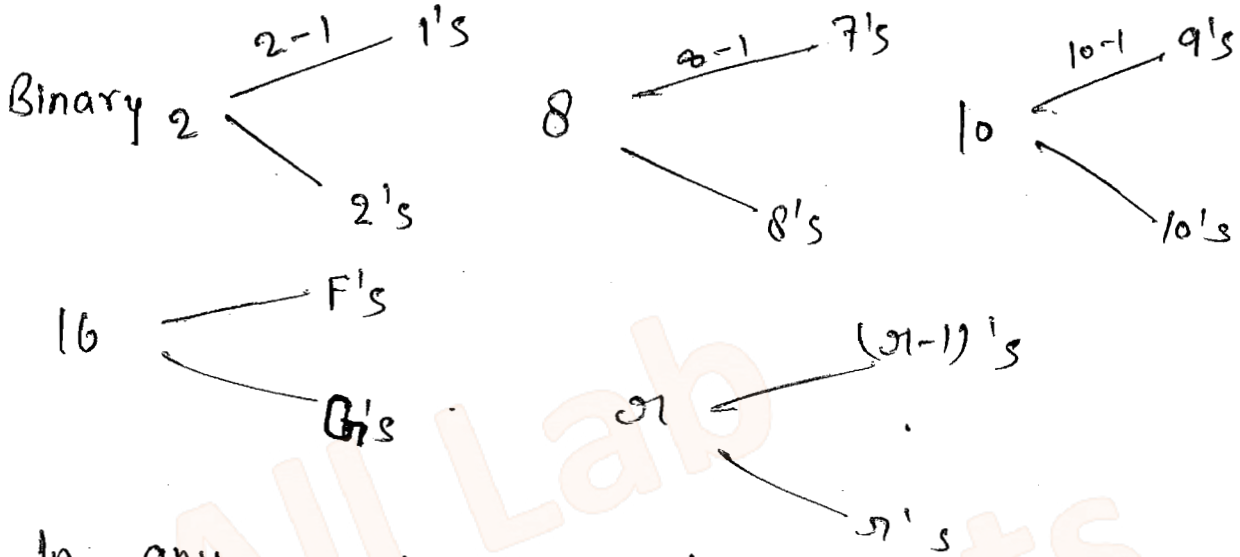
$$\begin{array}{r} 1111 \\ \times\ 1111 \\ \hline 1111 \\ 1111\ \times \\ 1111\ \times\ \times \\ 1111\ \times\ \times\ \times \\ \hline 11100001 \end{array}$$

$$\begin{array}{r} 10 \\ 10 \\ \hline 100 \end{array} \qquad \begin{array}{r} {\scriptstyle 1} \\ 11 \\ 11 \\ \hline 110 \end{array} \qquad \begin{array}{r} 11 \\ 10 \\ \hline 101 \end{array}$$

* Compliment of Number System :-

In modern computer system Two's (2's) Compliment representation is mainly used for performing arithmetic operations.

It reduces the hardware requirement.



In any number system in general base r then there exist two types of Compliment -

(1) (r-1)'s Complinent

(2) r's Compliment.

Example Calculate 1's Complinent of 1010 ?

Soln

```
  1 1 1 1   <-- largest no. of this no. system.
  1 0 1 0
  | | | |
  0 1 0 1
```

and sub. it find 1's Complinent

Imp *

"To calculate (r-1)'s Compliment select maximum digit of that no. system subtract each and every bit with that maximum value. the result is (r-1)'s Compliment."

(8493) 10 ← 10's

9999
−8793
1206 ← 9's Compliment.

Q. Find the F's Compliment of (3,2,C,A) ?

Sol^n

FFFF
3 2 C A
CD35 ← F's Compliment.

* "To Calculate r's Compliment from (r-1)'s Complimen add 1 at Least significant Bit (LSB)."

1010
First time 1's: 0101
Second time 1's: 1010

9999
6798 10 ← 9's
3201 → 9's Comp. first time.

9999
3201
6798 — 9's Comp. Secon

In any number system two times (r-1)'s Compliment produces same result.

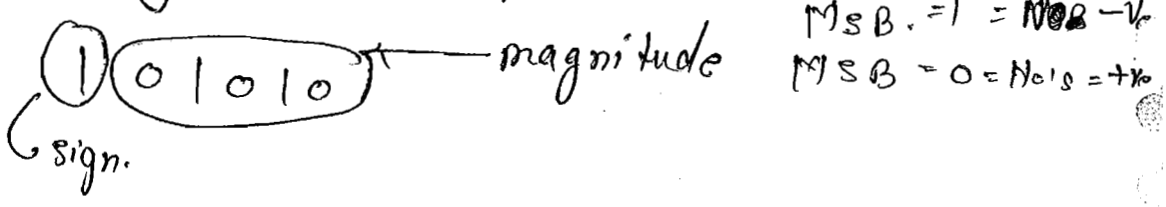
1010
1's - 0101
+1
2's - 0110
1's 1001
2's +1
1010

9999
3202
1's 6797
+1
2's 6798

9999
6798
3201
+1
3202

"In any no. system in general two times either (r-1)'s Complement or r's Compliment produces same result."

* Signed Magnitude Representation :-



In an n-bit binary representation M.S.B. will give sign. If MSB = 1 ⇒ No = -ve
MSB = 0 ⇒ No = +ve.
Rest (n-1) bit will give the magnitude of the number.

3-bit binary	Sign magnitude	1's Compliment	2's Compliment
0 0 0	+ 0	+ 0 (No change)	+ 0
0 0 1	+ 1	+ 1	+ 1
0 1 0	+ 2	+ 2	+ 2
0 1 1	+ 3	+ 3	+ 3
1 0 0	- 0	+ 3	- 4
1 0 1	- 1	- 2	- 3
1 1 0	- 2	- 1	- 2
1 1 1	- 3	- 0	- 1
	Rang -3 to +3	rang -3 to +3	increas range (-4 to +4)

The disadvantage of sign magnitude is separate representation of +0, -0 require excess (large) memory space. Hence hardware requirement increases.

Note :- Compliment of any number system are only calculated for -ve nubers.

* ~~2's Compliment~~ The advantage of 2's Compliment is -0 removed.
Range of representation also increases.

* Range of Representation of sign magnitude and 1's Compliment :-

Range :- -3 to $+3$

$$-[2^{(3-1)}-1] \text{ to } +[2^{(3-1)}-1]$$

for n bit

$$\boxed{-[2^{(n-1)}-1] \text{ to } +[2^{n-1}-1]}$$

* Range of Rep. of ~~Sng~~ 2's Compliment :-

$$\boxed{-[2^{(n-1)}] \text{ to } +[2^{(n-1)}-1]}$$

Q. Find the 2's compliment of $(-17)_{10}$.

```
      1 1 1 1 1
      1 0 0 0 1
1's  ------------
      0 1 1 1 0
            + 1
2's  ------------
      0 1 1 1 1
```

2	17	1
2	8	0
2	4	0
2	2	0
	1	

For sign (for -ve sign use 1

So $(-17)_{10} = (101111)$ ← 2's Comp.

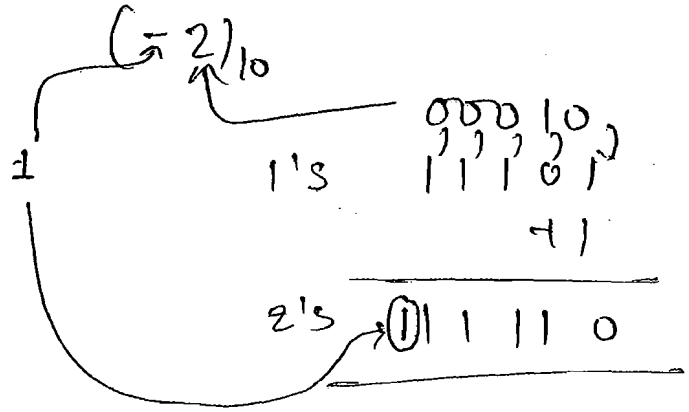
Q. Find the 2's Comp. of $(-2)_{10}$

```
  10
  01
  +1
  --
  10
```

So $(-2)_{10} \longrightarrow (110)$ ← 2's Comp.

Q. Repeate the previous ques for 6-bit comp.

Soln



Since in previous ques $(-2)_{10} = 110$

So

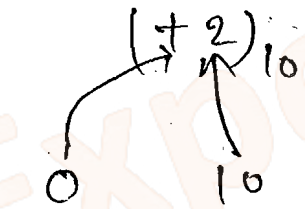
111	110
↑ Sign bit	110

Note:-

"Whenever it is required to represent the compliment of any no. system by using additional bits Copy sign bit to the additional places."

Q. Find the 2's Compliment of $(+2)_{10}$

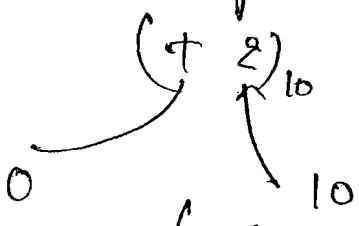
Soln



So (010) Ans

Q. Repeate the previous ques use 6-bit representation.

Soln



for 6-bit 00010

So

0 00010	
↑ Sign bit.	010

So (000010) Ans

* Weighted and Unweighted Code :-

Weighted Code :-

In the number system representati each and every bit is assigned by using significant ~~pott~~ positions. Such code representati is called Weighted Code.

If the codes are represented in the arbitrary manner in which each and every bit ~~doe~~ does not have significant bit are called as Unweighted Code.

Ex-

Weighted	Unweighted
B C D Code	Gray
Decimal Code.	Excess - 3
8 4 2 1	
2 4 2 1	
5 2 1 1	
3 3 2 1	

* B.C.D Code :-

Self Complimentary

8 4 2 1	5 2 1 1	2 4 2 1
0 - 0 0 0 0	0 0 0 0 - 0	0 0 0 0 - 0
1 - 0 0 0 1	0 0 0 1 - 1	0 0 0 1 - 1
2 - 0 0 1 0	0 0 1 1 - 2	0 0 1 0 - 2
3 - 0 0 1 1	1 1 0 1 - 3	0 0 1 1 - 3
4 - 0 1 0 0	0 1 1 1 - 4	0 1 0 0 - 4
5 - 0 1 0 1	1 0 0 0 - 5	0 0 1 1 - 5
6 - 0 1 1 0	1 0 1 0 - 6	1 1 0 0 - 6
7 - 0 1 1 1	1 1 0 0 - 7	1 1 0 1 - 7
8 - 1 0 0 0	1 1 1 0 - 8	1 1 1 0 - 8
9 - 1 0 0 1	1 1 1 1 - 9	1 1 1 1 - 9

By Calculation of 9's Compliment the resultent also gives 1's Comp. Such codes are also called as self Complementary Codes.

forex- 5211, 3221, 2421

8421 is non-self Complementary Code.

* Excess-3 Code :-

Excess-3 represents values from 0 to 9 but by adding 3 [(0 to 9)+3] in each value.

8421	Excess-3
0 0 0 0	0 0 1 1
0 0 0 1	0 1 0 0
0 0 1 0	0 1 0 1
0 0 1 1	0 1 1 0
0 1 0 0	0 1 1 1
0 1 0 1	1 0 0 0
0 1 1 0	1 0 0 1
0 1 1 1	1 0 1 0
1 0 0 0	1 0 1 1
1 0 0 1	1 1 0 0

self Complementary

Some thing leakage.