

Combinational Ckts - II

Comprehensive Course on Digital Logic Design 2023/2024

NUMBER SYSTEMS

Any number is associated with **Base (or) Radix**

$$(734)_{10}$$

↓
Base (or) Radix

$$(734)_{10} = 7 \times (10^2) + 3 (10^1) + 4 (10^0)$$

$$(472.15)_{10} = 4 (10^2) + 7 (10^1) + 2 (10^0) + 1 (10^{-1}) + 5 (10^{-2})$$

A number system with base ‘ b ’, will have b different digits and they are from 0 to $b - 1$.

$$\underline{b = 3}$$

0, 1, 2

$$\underline{b = 7}$$

0, 1, 2, 3, 4, 5, 6

$$\underline{b = 1}$$

0 0 0

0 0 0 0

0 0 0 0 0 0 0 0 .

$$b \geq 2$$

$$\begin{array}{r} b=4 \\ \hline 0, 1, 2, 3. \end{array}$$

$$(\underline{4}21)_4 \times$$

$$(243)_{\underline{5}} \checkmark$$

$$(851)_9 \checkmark$$

Base (b) is always a positive integer .

In general $b \geq 2$

~~10~~ → A

Base	Different digits
2 (Binary)	0, 1
8(Octal)	0, 1, 2, 3, 4, 5, 6, 7
10 (Decimal)	0, 1, 2, 3, 4, 5, 6, 7, 8, 9
16 (Hexadecimal)	0, 1, 2, 3, 4, 5, 6, 7, 8, 9 A, B, C, D, E, F

Conversion of Number System

1. Decimal to Any Base

$$[N]_{10} \rightarrow [?]_b$$

2. Any base to Decimal

$$[N]_b \rightarrow [?]_{10}$$

3. one base to another base

$$[N_1]_{b_1} \rightarrow [?]_{b_2}$$

4. Required base = (Given Base)^{integer}

1. Decimal to Other Base

- Integer part, repeated division by the required base .
- Fractional part , repeated multiplication by the required base .

$$\left(\frac{327}{\downarrow} \cdot \frac{45}{\downarrow} \right)_{10}$$

integer part fractional part

Q) $(53.75)_{10} = (\dots)_{2}$

$$\begin{array}{r} 2 | 53 \\ \hline 2 | 26 - 1 \\ \hline 2 | 13 - 0 \\ \hline 2 | 6 - 1 \\ \hline 2 | 3 - 0 \\ \hline 1 - 1 \end{array}$$

$$\begin{array}{r} (110101 \cdot 11)_2 \\ 0.75 \\ \times 2 \\ \hline 0.50 \\ \times 2 \\ \hline 1.00 \end{array}$$

$$Q) (0.15)_{10} = (\dots)_2$$

$$(0.001001)_2$$

$$\begin{array}{r} 0.15 \\ \times 2 \\ \hline 0.30 \\ \times 2 \\ \hline 0.60 \\ \times 2 \\ \hline 1.20 \end{array}$$

$$\left| \begin{array}{r} 0.20 \\ \times 2 \\ \hline 0.40 \\ \times 2 \\ \hline 0.80 \\ \times 2 \\ \hline 1.60 \end{array} \right|$$

$$\begin{array}{r} 0.60 \\ \times 2 \\ \hline \end{array}$$

$$0.00\overline{1001}$$

Note :

It is possible to obtain the equivalent of integer part but may not possible for fractional part .

$$Q) (53.75)_{10} = (\underline{\hspace{2cm}} \underline{\hspace{2cm}} \underline{\hspace{2cm}})_4$$

$$\begin{array}{r} 4 \Bigg| 53 \\ \hline 13 - 1 \\ \hline 3 - 1. \end{array}$$

$$(311 \cdot 3)_4$$

$$\begin{array}{r} 0.75 \\ \times 4 \\ \hline 3.00 \end{array}$$

$$Q) (39.5)_{10} = (\underline{\hspace{2cm}} \underline{\hspace{2cm}} \underline{\hspace{2cm}})_8$$

$$\begin{array}{r} 39 \\ 8 \overline{)4 \cdot 7} \\ 4 - 7 \\ \hline 0 \cdot 5 \\ \times 8 \\ \hline 4 \cdot 0 \end{array}$$

$(47 \cdot 4)_8$

$$Q) (39.5)_{10} = (\underline{\hspace{2cm}} \underline{\hspace{2cm}} \underline{\hspace{2cm}})_{16}$$

$$\begin{array}{r} 16 \longdiv{39} \\ \underline{32} \\ - 7 \end{array}$$

$$(27.8)_{16}.$$

0.5

$$\begin{array}{r} 0.5 \\ \times 16 \\ \hline 8.0 \end{array}$$

2. Any base to Decimal

$$(x_2 x_1 x_0 + x_{-1} x_{-2} x_{-3})_b = (?)_{10}$$

Simply expand the polynomial and do addition in base 10.

$$x_2(b^2) + x_1(b^1) + x_0(b^0) + x_{-1}(b^{-1}) + x_{-2}(b^{-2}) + x_{-3}(b^{-3})$$

$$Q) \underset{2, 0^{-1} - 2}{(311.30)_4} = (\underline{\hspace{2cm}} \underline{\hspace{2cm}} \underline{\hspace{2cm}})_{}_{10}$$

$$3(4^2) + 1(4^1) + 1(4^0) + 3(4^{-1}) + 0(4^{-2})$$

$$= 3(16) + 4 + 1 + \frac{3}{4} + 0.$$

$$= (53.75)_{10}.$$

Q) Find the minimum decimal equivalent of $(3AB26)_x$

$$= 3(x^4) + 10(x^3) + 11(x^2) + 2(x^1) + 6(x^0)$$

$$= 3(12^4) + 10(12^3) + 11(12^2) + 2(12) + 6 \quad (3AB26)_{12}$$

$$= (81102)_{10}.$$

$$Q) (137.4)_8 = (\underline{\hspace{2cm}} \underline{\hspace{2cm}} \underline{\hspace{2cm}} \underline{\hspace{2cm}})_ {10}$$

$$= 1(8^2) + 3(8) + 7(8^0) + 4(8^{-1})$$

$$= (95.5)_{10}$$

$$Q) (DAD)_{16} = \underline{\hspace{2cm}}_{10}$$

$A \rightarrow 10$

$B \rightarrow 11$

$C \rightarrow 12$

$D \rightarrow 13$

$E \rightarrow 14$

$F \rightarrow 15$

$$13(16^2) + 10(16) + 13 = \underline{\hspace{2cm}}$$

$$Q) (ECE)_{16} = (- - - -)_{10}$$

$$14(16^2) + 12(16^1) + 14(16^0) = (3790)_10$$

$$Q) (EEE)_{16} = \underline{\hspace{4cm}}_{10}$$

$$14(16^2) + 14(16^1) + 14(16^0) = \underline{\hspace{2cm}}_{10}.$$

Q) Find b if $\sqrt{(41)_b} = \underline{(5)}_{10}$

$$\sqrt{(4b+1)_{10}} = (5)_{10}$$

$$4b+1 = 25$$

$$b = \frac{24}{4} = 6$$

3. One base to another base

$$[N]_{b_1} \rightarrow [?]_{b_2}$$

1. Convert the given number to the decimal system
2. After that convert to required base

$$Q) (3)_4 = (?)_8$$

$$(3)_4 = (3 \times (4^0))_{10} = (3)_{10}.$$

$$(3)_{10} = (3.)_8$$

$$\begin{array}{r} 8 \longdiv{3} \\ \quad \quad \quad 0 - 3 \end{array}$$

$$(3)_4 = (3)_8$$

$$Q) (7)_8 = (?)_9$$

$$(7)_8 = (7 \times 10^0)_{10} = \underline{(7)}_{10}$$

$$\checkmark (7)_8 = (?)_9$$

$$(7)_{10} = (?)_9.$$

$$q \quad \overbrace{7} \\ 0 - 7$$

Q) Find the value of x if $(193)_x = (623)_8$

$$(x^2 + 9x + 3)_{10} = (6(8^2) + 2(8) + 3)_{10}$$

$$x^2 + 9x + 3 = 403$$

$$x^2 + 9x - 400 = 0$$

$$(x + 25)(x - 16) = 0$$

$$x = -25 \quad \times$$

$$x = 16$$



Q) Find b_1 and b_2 if $(235)_{b_1} = (565)_{10} = (1065)_{b_2}$

$$b_1 > 10$$

$$b_2 < 10$$

$$b_2 \geq 7$$

$$(235)_{b_1} = (565)_{10}$$

$$2b_1^2 + 3b_1 + 5 = 565$$

$$2b_1^2 + 3b_1 - 560 = 0$$

$$\boxed{b_1 = 16}$$

$$b_2^3 + 6b_2 + 5 = 565$$

$$b_2^3 + 6b_2 = 560$$

$$\boxed{b_2 = 8}$$

Q) The solution to the quadratic equation $x^2 - 11x + 22 = 0$ is $x = 3$ and $x = 6$, what is the base of the system

$$\left[x^2 - 11x + 22 = 0 \right]_b$$

$$(3)_b = (3)_{10}$$

$$(6)_b = (6)_{10}$$

$$x^2 - 11x + 22 = (x-3)(x-6)$$

$$\left[(x-3)(x-6) = 0 \right]_b$$

$$x^2 - 11x + 22 = (x-3)(x-6)$$

$$\left[(x-3)(x-6) = 0 \right]_{10}$$

$$(x^2 - 11x + 22)_b = (x^2 - 9x + 18)_{10}$$

$$(11)_b = (9)_{10}$$

$$(22)_b = (18)_{10}$$

$b+1 = 9$ $b = 8$	$2b+2 = 18$ $2b = 16$ $b = 8$
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\approx

4. Required base = (*Given Base*)^{integer}

$$Q) \overset{\infty}{(} 1011010110.010110010 \overset{..}{\underset{2}{)}} = (- - - -)_8$$

| | | | | | | | | |
1 3 2 6 · 2 6 2

$$(1326 \cdot 262)_8$$

$$8 = \overset{3}{\underset{2}{\circ}}$$

$n = \overset{3}{\underset{2}{\circ}}$.

Q) $(10\underset{2}{|}1\underset{3}{|}10\underset{1}{|}01\underset{1}{|}10.0\underset{2}{|}10\underset{1}{|}100\underset{1}{|}10)_2 = (- - - -)_4$

$\underset{2}{|}\underset{3}{|}\underset{1}{|}\underset{1}{|}\underset{2}{|}\underset{1}{|}\underset{1}{|}\underset{2}{|}\underset{1}{|}\underset{0}{|}$

$$\left(23\underset{4}{|}1\underset{4}{|}2 \cdot 1\underset{4}{|}12\underset{4}{|}\right)_4 \quad n=2$$

$$Q) \stackrel{oo}{(10|1101|0110.0101|1001|0)_2 = (- - - -)_{16}}$$

$\begin{matrix} 2 & | & D & | & 6 & . & 5 & | & 9 & | \end{matrix}$

$$(2D6 \cdot 59)_{16}$$

$n=4$

$$Q) (22|10|12|10|12.20|11|02|2)_3 = (\underline{\hspace{2cm}}\underline{\hspace{2cm}}\underline{\hspace{2cm}}\underline{\hspace{2cm}}\underline{\hspace{2cm}})_9 \\ = (83535 \cdot 6426)_9.$$

$$(22)_3 = (2(3)+2)_{10} = (8)_{10} = (8)_9$$

$$(10)_3 = (3)_{10} = (3)_9 \quad | \quad (20)_3 = (6)_{10} = (6)_9$$

$$(12)_3 = (5)_{10} = (5)_9$$

$$(10)_3 = (3)_{10} = (3)_9.$$

$$(12)_3 = (5)_{10} = (5)_9.$$

$$(11)_3 = (4)_{10} = (4)_9$$

$$(62)_3 = (2)_{10} = (2)_9$$

$$(20)_3 = (6)_{10} = (6)_9.$$

$$Q) (32|10|33|2101.22|10)_4 = (- - - -)_{16}$$

$$(32)_4 = (14)_{10} = (E)_{16} \quad | \quad (22)_4 = (10)_{10} = (A)_{16}$$

$$(10)_4 = (4)_{10} = (4)_{16} \quad | \quad (10)_4 = (4)_{10} = (4)_{16}$$

$$(33)_4 = (15)_{10} = (F)_{16} \quad | \quad (E4F91.A4)_{16}$$

$$(21)_4 = (9)_{10} = (9)_{16}$$

$$(01)_4 = (1)_{10} = (1)_{16}$$

Q) Find the number of solutions of 'Y' exists for $(123)_5 = (X8)_Y$

$$(123)_5 = (X8)_Y$$

$$5^2 + 2(5) + 3 = XY + 8$$

$$25 + 10 + 3 = XY + 8$$

$$\boxed{XY = 30}$$

$$\begin{array}{l} Y \geq 8 \\ Y > x \end{array}$$

$$x=1$$

$$x=2$$

$$x=3$$

$$x=5$$

$$x=6$$

$$y=30 \checkmark$$

$$y=15 \checkmark$$

$$y=10 \checkmark$$

$$y=6 \times$$

$$y=5 \times$$

③

Q) Find the number of solutions of 'x' exists for $(123)_x = (12X)_3$

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

$$\underline{x > 3}$$

$$\underline{3 > x}$$

No Solutions exists

Q) Find the base of the following system such that given operation is valid

$$24+14=41$$

$$(24)_b + (14)_b = (41)_b.$$

$$2b+4 + b+4 = 4b+1$$

$b = ?$

Q) Find the base of the following system such that given operation is valid

$$\left(\frac{66}{6}\right)_b = (11)_b$$

$$\begin{array}{rcl} \frac{6b+6}{6} & = & b+1 \\ \boxed{b+1} & = & b+1 \end{array} \checkmark$$

$$b=0$$

$$b=1$$

$$b=2$$

$$b=10$$

$$b=100$$

$$b=PR.$$

a) 2 \checkmark ~~b~~ \neq

c) 6

d) 10

$$(66)_b$$

$$(66) \checkmark \neq$$

Q) Find the base of the following system such that given operation is valid

$$\left(\sqrt{121}\right)_b = (11)_b.$$

$$b \geq 3.$$

$$b=3$$

Q) Find the base of the following system such that given operation is valid

$$\sqrt{41} = 5$$

$$4b+1 = 25$$

$$b = 6$$

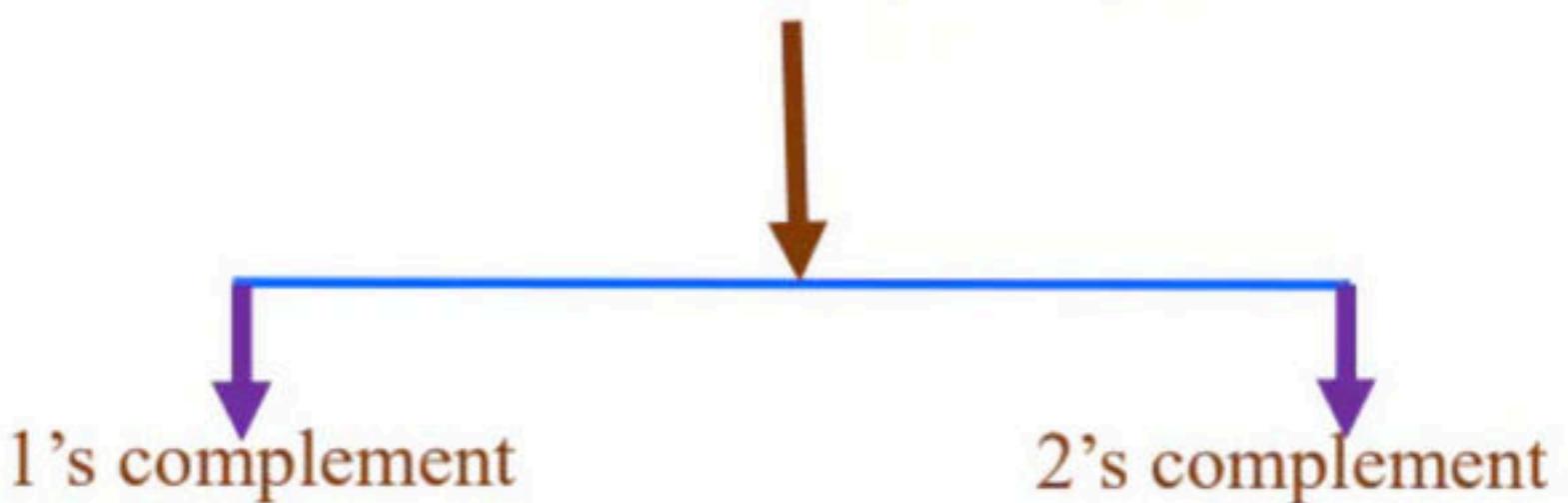
Complement Analysis

$|N|_r$

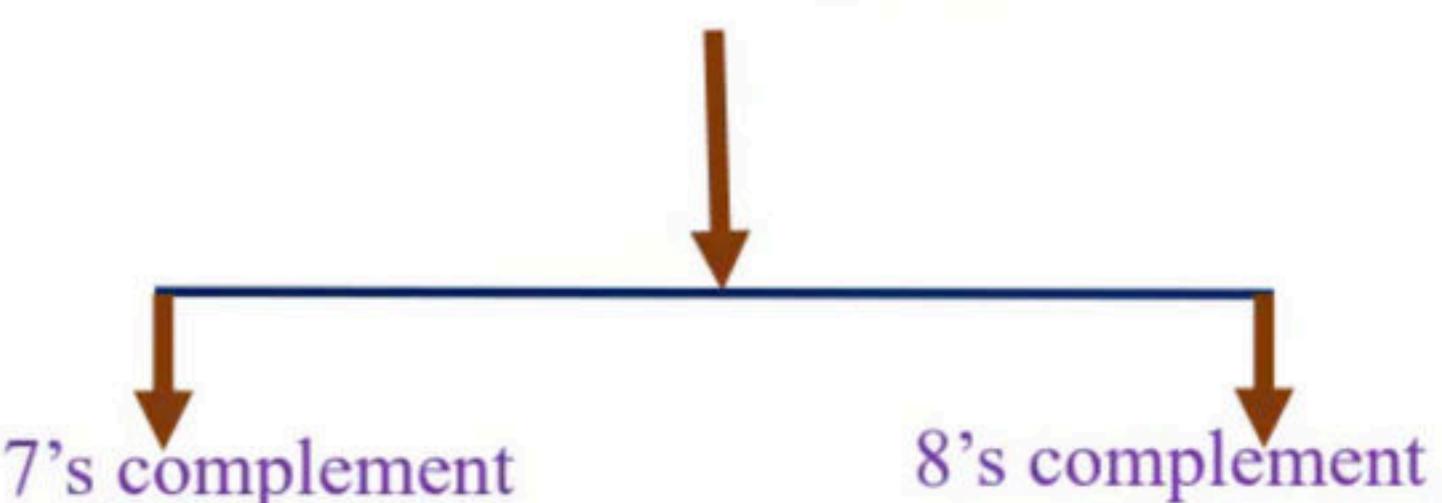
1. r's complement

2. (r-1)'s complement

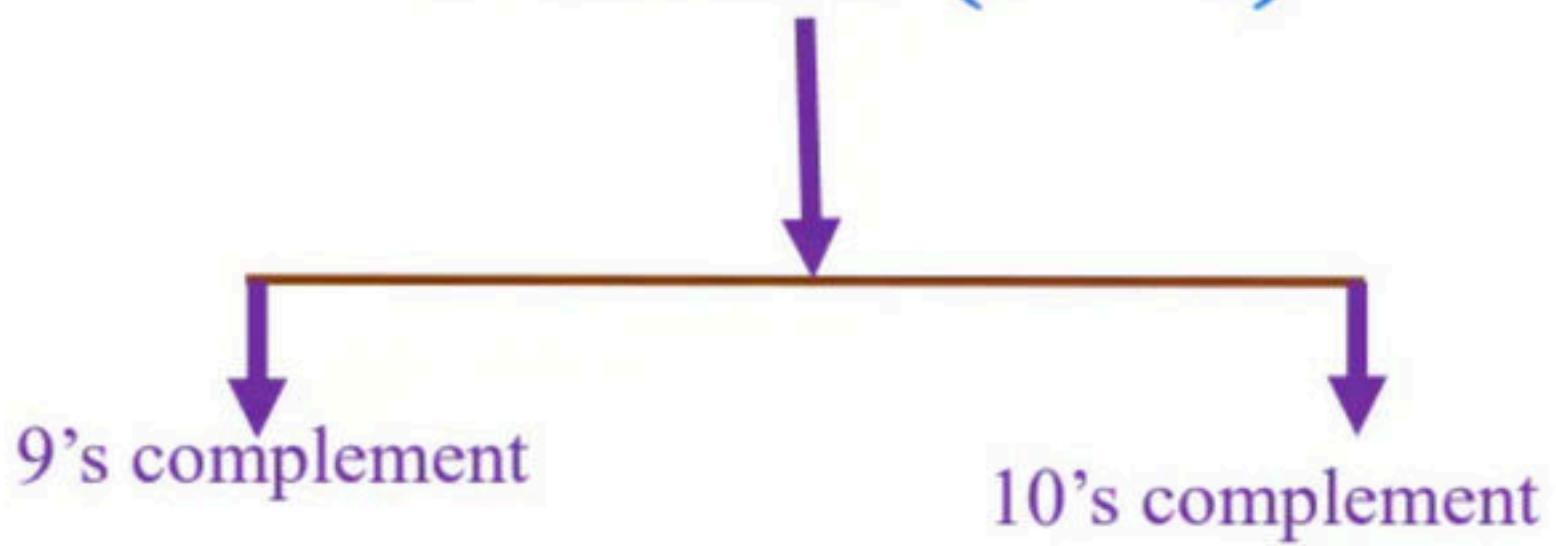
Binary (r=2)



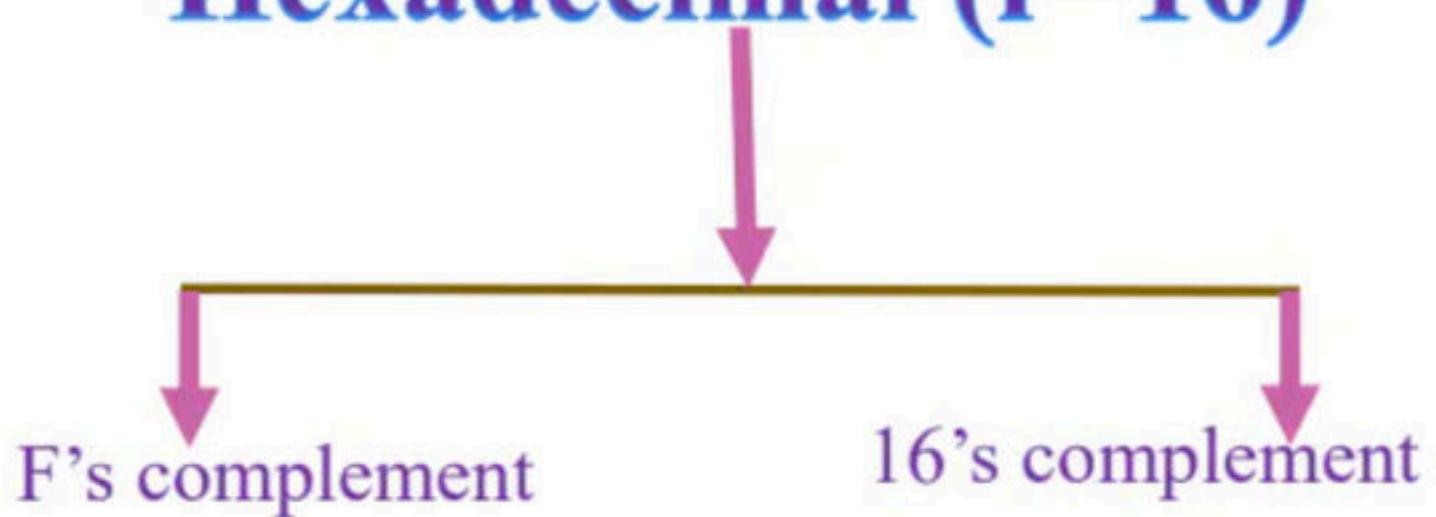
Octal (r=8)



Decimal ($r=10$)



Hexadecimal ($r=16$)



r' s complement

r' s complement of the number (N) = $r^n - N$

$$N = \underline{(12475 \cdot 327)}_8$$

r -----> Radix

n -----> number of integer digits $r = 8$

N -----> given number $n = 5$

(r-1) ' s complement

(r-1) ' s complement of the number (N) = $r^n - r^{-m} - N$

$$N = (12475 \cdot \underline{32})_8$$

r -----> Radix

$r = 8$

n -----> number of integer digits

$n = 5$

m -----> number of decimal digits

$m = 2$

N -----> given number

$(r-1)$'s complement of the number $(N) = r^n - r^{-m} - N$

r 's complement of the number $(N) = (r-1)$'s complement + r^{-m}

If $m = 0$

r 's complement of the number $(N) = (r-1)$'s complement + 1

Q) Find the 10's complement of $(327.452)_{10}$

Q) Find the 9's complement of $(327.452)_{10}$

Q) Find the 10's complement of $(784732179)_{10}$

Q) Find the 2's complement of $(101100)_2$

Q) Find the 2's complement and 1's complement of $(0.0110)_2$

Q) Find the 9's and 10's complement of $(52520)_{10}$

Q) Find the 9's and 10's complement of $(0.3267)_{10}$

Q) Find 1's and 2's complement of $(10100100111)_2$

Q) Find 8's and 9's complement of $(278421)_9$

Q) Find F's and 16's complement of $(792410)_{16}$

Q) Find 1's and 2's complement of $(11000100)_2$

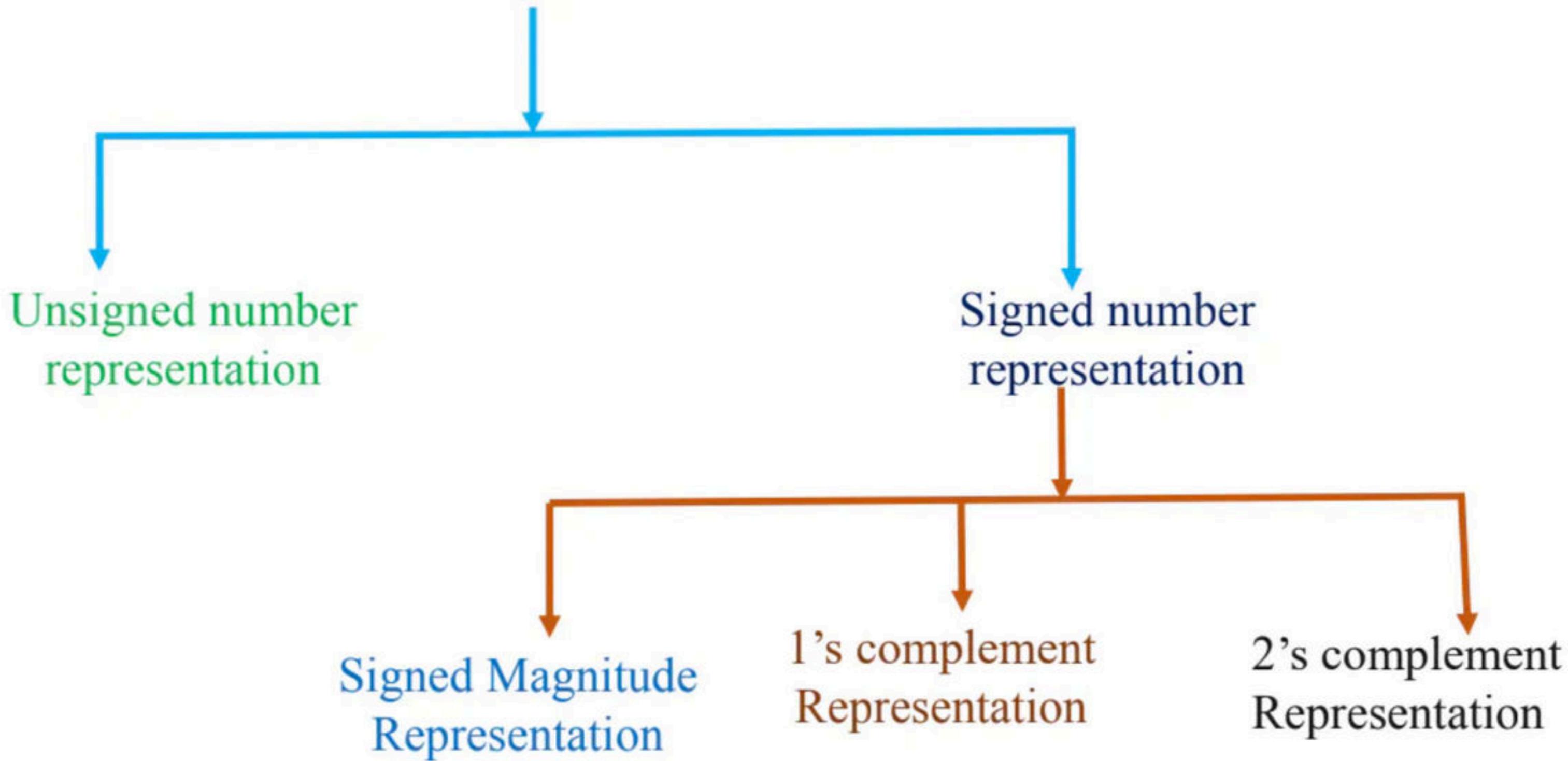
Q) Find 1's and 2's complement of $(11010.11)_2$

Q) Find 8's complement of $(2670)_8$

Q) Find 10's complement of $(7492)_{10}$

Q) Find 16's complement of $(9623)_{16}$

Data Representation



Unsigned Number Representation

- Strictly applicable for positive numbers
- There is no sign bit concept

+ 5 ----->

- 5 ----->

Decimal number	Unsigned number representation (4-bits)
0	
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	

Range with 4 bits =

Range with 5 bits =

Range with n- bits =

Signed Number Representation

- 1.Signed magnitude representation
- 2.1's complement representation
- 3.2's complement representation

Signed Magnitude representation

- Valid for both positive and negative numbers .
- Sign bit concept is used .



Sign bit = 0 , for \oplus Ve number
= 1, for \ominus ve number

$+5 =$

--	--	--	--

$- 5 =$

--	--	--	--

$+5 =$

--	--	--	--	--	--	--	--

$- 5 =$

--	--	--	--	--	--	--	--

Decimal number	Signed Magnitude Representation (4-bits)
+0	
+1	
+2	
+3	
+4	
+5	
+6	
+7	
-0	
-1	
-2	
-3	
-4	
-5	
-6	
-7	

Range with 4 bits =

Range with 5- bits =

Range with n- bits =

1's Complement Representation

- In this **⊕Ve numbers** are represented as **normal binary number with MSB '0'**

Representation of ⊖ ve number

1. Write the binary equivalent of magnitude
2. Take its 1's complement

$+6 =$

--	--	--	--

$- 6 =$

--	--	--	--

$+6 =$

--	--	--	--	--	--	--	--

$- 6 =$

--	--	--	--	--	--	--	--

Decimal number	1's complement Representation (4-bits)
+0	
+1	
+2	
+3	
+4	
+5	
+6	
+7	
-0	
-1	
-2	
-3	
-4	
-5	
-6	
-7	

Range with 4 bits =

Range with 5- bits =

Range with n- bits =

2's complement Representation

- In this +Ve numbers are represented as *normal binary number with MSB '0'*

Representation of +ve number

1. Write the binary equivalent of magnitude
2. Take its 2's complement

$+6 =$

--	--	--	--

$- 6 =$

--	--	--	--

$+6 =$

--	--	--	--	--	--	--	--

$- 6 =$

--	--	--	--	--	--	--	--

Decimal number	2's complement Representation
+0	
+1	
+2	
+3	
+4	
+5	
+6	
+7	
-0	
-1	
-2	
-3	
-4	
-5	
-6	
-7	
-8	

Range with 4 bits =

Range with 5- bits =

Range with n- bits =

Q) Find the Decimal equivalent of the **unsigned number representation** given below

a) 01101

b) 11101

Q) Find the Decimal equivalent of the **Signed magnitude representation** given below

a) 01101

b) 11101

Q) Find the Decimal equivalent of the **1's complement representation** given below

a) 01101

b) 11101

Q) Find the Decimal equivalent of the **2's complement representation** given below

a) 01101

b) 11101

Q) 1's complement representation of the numbers given below , find the decimal equivalents

a) 01001

b) 001001

c) 0001001

d) 11001

e) 111001

f) 1111001

Q) 2's complement representation of the numbers given below , find the decimal equivalents

a) 01001

b) 001001

c) 0001001

d) 11001

e) 111001

f) 1111001

Q) Find the **2's complement representation** of the following

$$-2 =$$

$$-4 =$$

$$-8 =$$

$$-16 =$$

$$-2^n =$$

Note :

The minimum number of bits required for - 2^n , using 2's complement representation = -----

Q) A number in 4-bit 2's complement is $x_3x_2x_1x_0$, this number when stored using 8-bits will be

- a) 0000 $x_3x_2x_1x_0$
- b) 1111 $x_3x_2x_1x_0$
- c) $x_3x_3x_3x_3x_3x_2x_1x_0$
- d) $\overline{x_3} \ \overline{x_2} \ \overline{x_1} \ \overline{x_0} \ x_3x_2x_1x_0$

**Q. How many one's are present in the binary representation of
 $(8 \times 4096) + (4 \times 256) + (9 \times 16) + 5$**

- (a) 6
- (b) 5
- (c) 3
- (d) 4

Binary Subtraction using 1's complement

1. Represent the given numbers in the 1's complement form.
2. Add the two numbers.
3. If carry is generated ,then the result is positive and in the true form , add carry to the LSB to get the final answer .
4. If carry is not generated , then the result is negative , and in the 1's complement form . To get final answer take 1's complement of the result.

Q) Perform the following operation for the given numbers using 1's complement form .

a) $8 - 4$

b) $4 - 8$

Binary Subtraction using 2's complement

1. Represent the given numbers in the 2's complement form
2. Add the two numbers
3. If carry is generated ,ignore it .
4. If MSB is 0, then the result is positive and in the true form .
5. If MSB is 1, then the result is negative and is in 2's complement form .
(whether there is a carry (or) no carry does not matter)

Q. Perform the following operation for the given numbers using 2's complement form .

$$46 - 14$$

Q. Perform the following operation for the given numbers using 2's complement form .

$$-75 + 26$$

Q) Simplify the following using 2's complement form

$$9 + 4$$

Q) Simplify the following using 2's complement form

9- 4

Q) Simplify the following using 2's complement form

$$-9 + 4$$

Q) Simplify the following using 2's complement form

$$-9 - 4$$

Q) Simplify the following using 2's complement form

$$9 + 8$$

Q) Simplify the following using 2's complement form

$$-9 - 8$$

Overflow

Over flow occurs in signed arithmetic operations if two same sign numbers are added and result exceeds with given number of bits.

Over flow can be detected by using 2- methods

1. by using carry bits

2. by using sign bit

1. By using carry bits

C_{in} ----- *carry into MSB*

C_{out} ----- *carry out from MSB*

if $C_{in} \oplus C_{out} =$

$C_{in} \oplus C_{out} =$

2. By using sign bit

X -----> Sign bit of 1st number

Y -----> Sign bit of 2nd number

Z-----> Sign bit of Resultant

Over flow =

NOTE :

to avoid the overflow , increase the number of bits .

Q) Let x be the sign bit of N_1 , y be the sign bit of N_2 , and z be the sign bit of $N_1 + N_2$, then the condition for overflow .

- a) $x \neq y \neq z$
- b) $x \neq y = z$
- c) $x = y \neq z$
- d) $x = y = z$

Q. Let R1 and R2 be two 4-bit registers that store number in 2's complement form , for operation $R1 + R2$, which of the following values of R1 and R2 gives overflow.

- a) R1= 1100 , R2 = 1010
- b) R1= 1001 , R2 = 1111
- c) R1= 1011 , R2 = 1110
- d) R1= 0011 , R2 = 0100

Q) Two numbers represented in signed 2's complement form as $P = 11101101$, $Q = 11100110$, if Q is subtracted from P , then the value obtained in signed 2's complement form is

- a) 100000111
- b) 00000111
- c) 11111001
- d) 111111001

BINARY CODES

Numeric Codes

- 1.BCD Code
- 2.Excess-3 Code
- 3.Gray Code
- 4.Self-complementing code

1. BCD (Binary Coded Decimal) Code :

In this code each decimal number is represented by a separate group of 4- bits.

(2 3 4 5)₁₀=

- It uses only 0 to 9
- 0 to 9 are valid BCD Code
- 10, 11, 12, 13, 14, 15 are invalid BCD Code
- Coding method is very simple but it requires more number of bits .

Eg. of BCD Codes

8 4 2 1
2 4 2 1
3 3 2 1
4 2 2 1
5 2 1 1
5 3 1 1
5 4 2 1
6 3 1 1
7 4 2 1
7 4 2 1
8 4 2 1

BCD Addition

1. Express the given numbers in BCD form
2. Add the corresponding digits of the decimal numbers of each group .
3. If there is no carry and the sum term is valid code , no correction is needed
4. If there is a carry out of one group to next group , (or) if the sum term is an invalid BCD code , then add 6_{10} (0110) to the sum term of that group and the resulting carry is added to the next group .

Q) Perform the following using BCD addition

$$25+13$$

Q) Perform the following using BCD addition

$$679.6 + 536.8$$

Q. When two BCD numbers are added, under what conditions a correction factor of 6 is added to a 4-bit nibble

- a) When the nibble value is one of 1010, 1011, 1100, 1101, 1110, or 111
- b) When there is a carry out of the nibble to the next higher significant nibble
- c) When a final carry is generated
- d) When the nibble value is one of 0001, 0010, 0100, 1000,

BCD Subtraction

1. Express the given numbers in BCD form
2. Subtract the corresponding digits of the decimal numbers of each group .
3. If there is no barrow no correction is needed.
4. If there is a barrow from the next group ,or if the difference term is an invalid BCD code then 6_{10} (0110) is subtracted from the difference term of that group .

Q) Perform the following using BCD subtraction

38-15

Q) Perform the following using BCD subtraction

$$206.7 - 147.8$$

EXCESS-3 CODE

The EX-3 code can be derived from the natural BCD code by adding 3 to each coded number.

Valid EX -3 :

Invalid EX-3 :

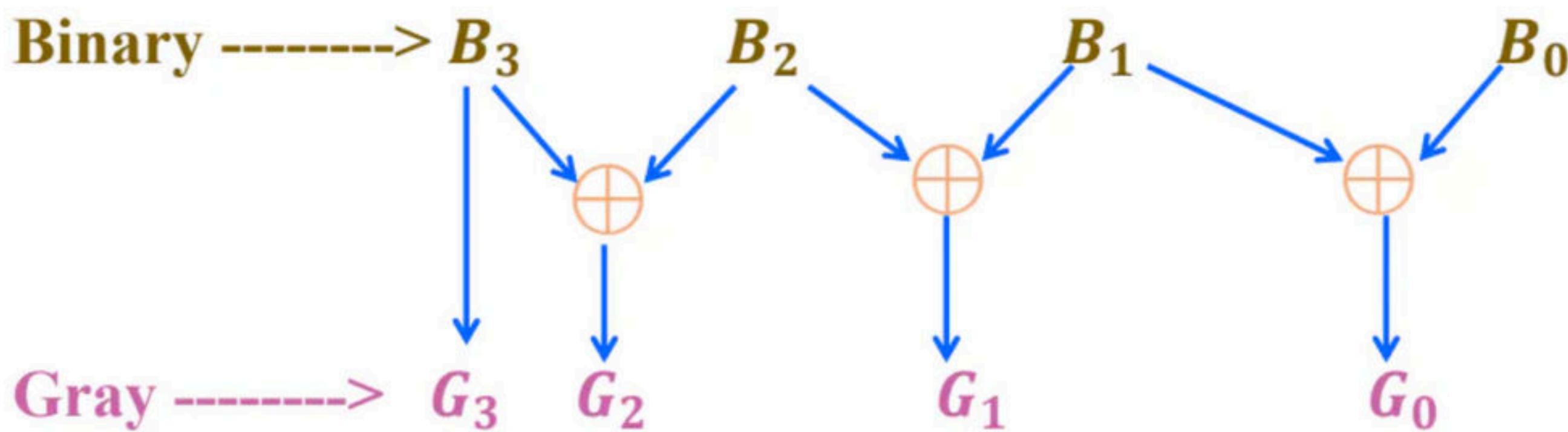
Gray Code

Gray code is a non-weighted code, successive decimal numbers are differ by only one bit .

- Non- weighted code
- Unit distance code
- Cyclic code
- Reflective code
- Minimum distance code

Decimal	1- bit Gray code	2- bit Gray code	3- bit Gray code
0			
1			
2			
3			
4			
5			
6			
7			

Binary to Gray Code



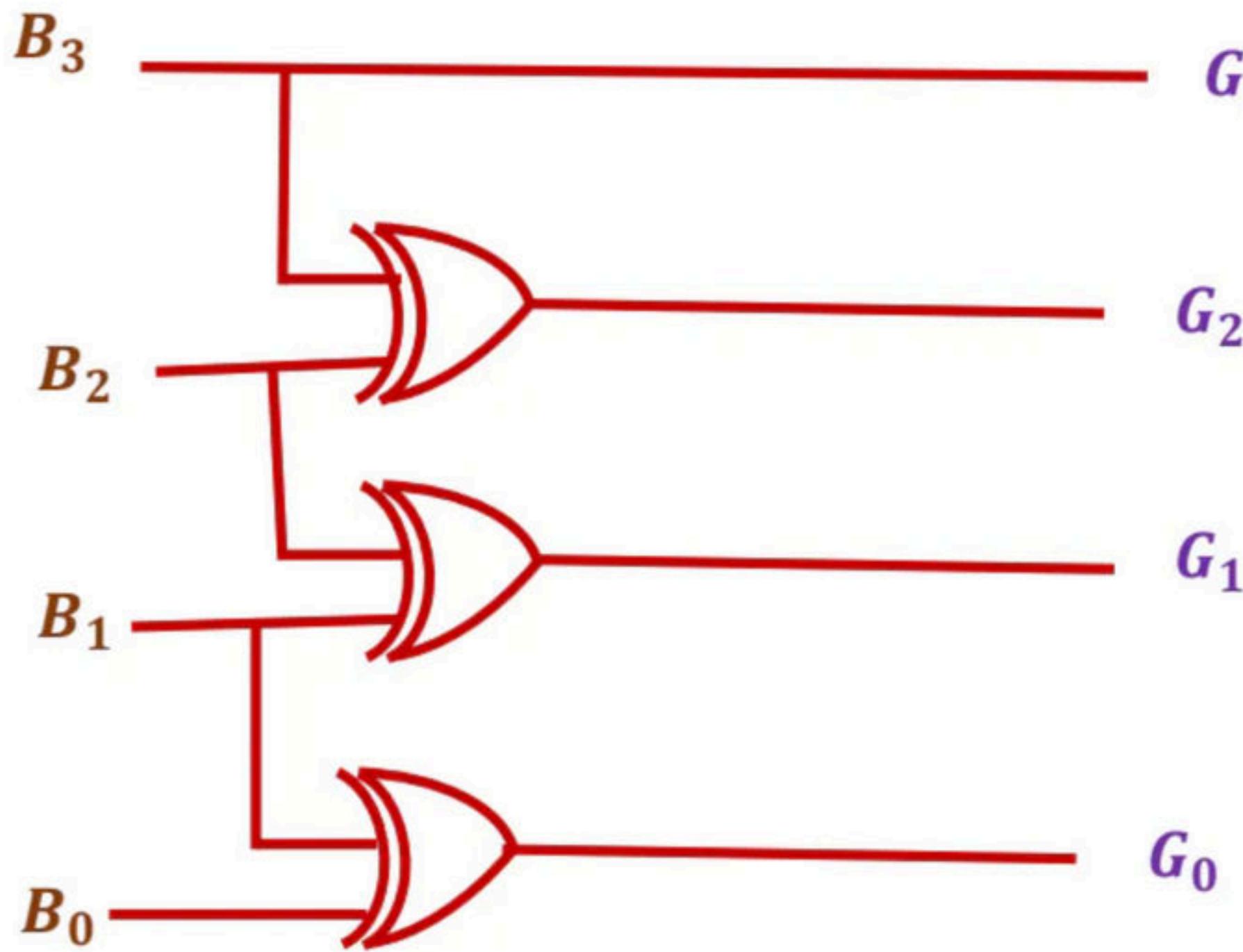
Q) Find the Gray code of the following

1 1 0 0 1 0

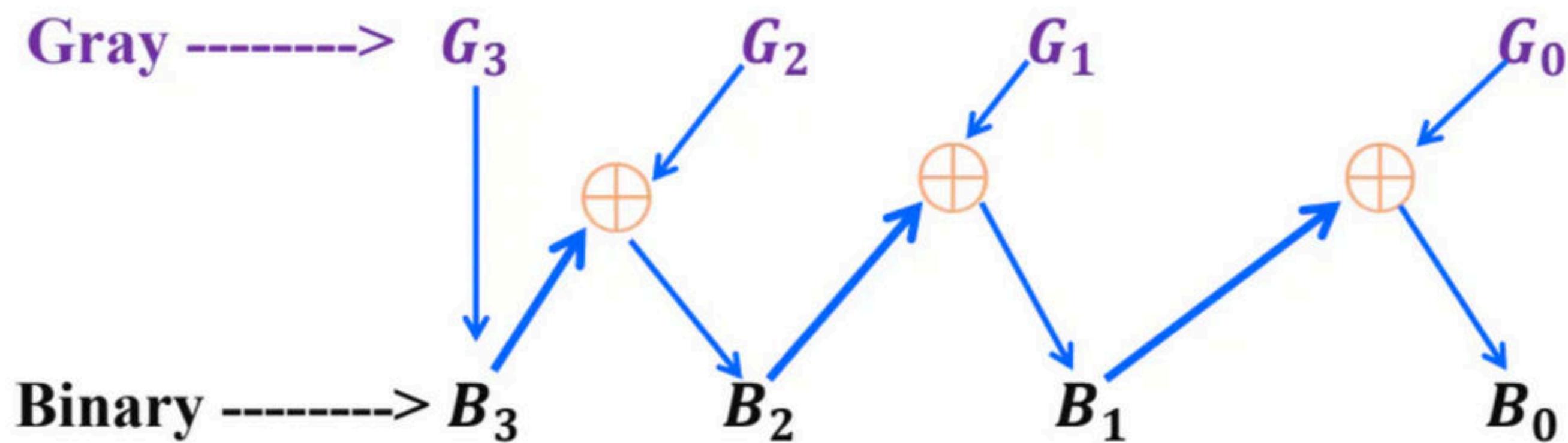
Q) Find the Gray code of the following

1 1 1 0 0 1 1 0

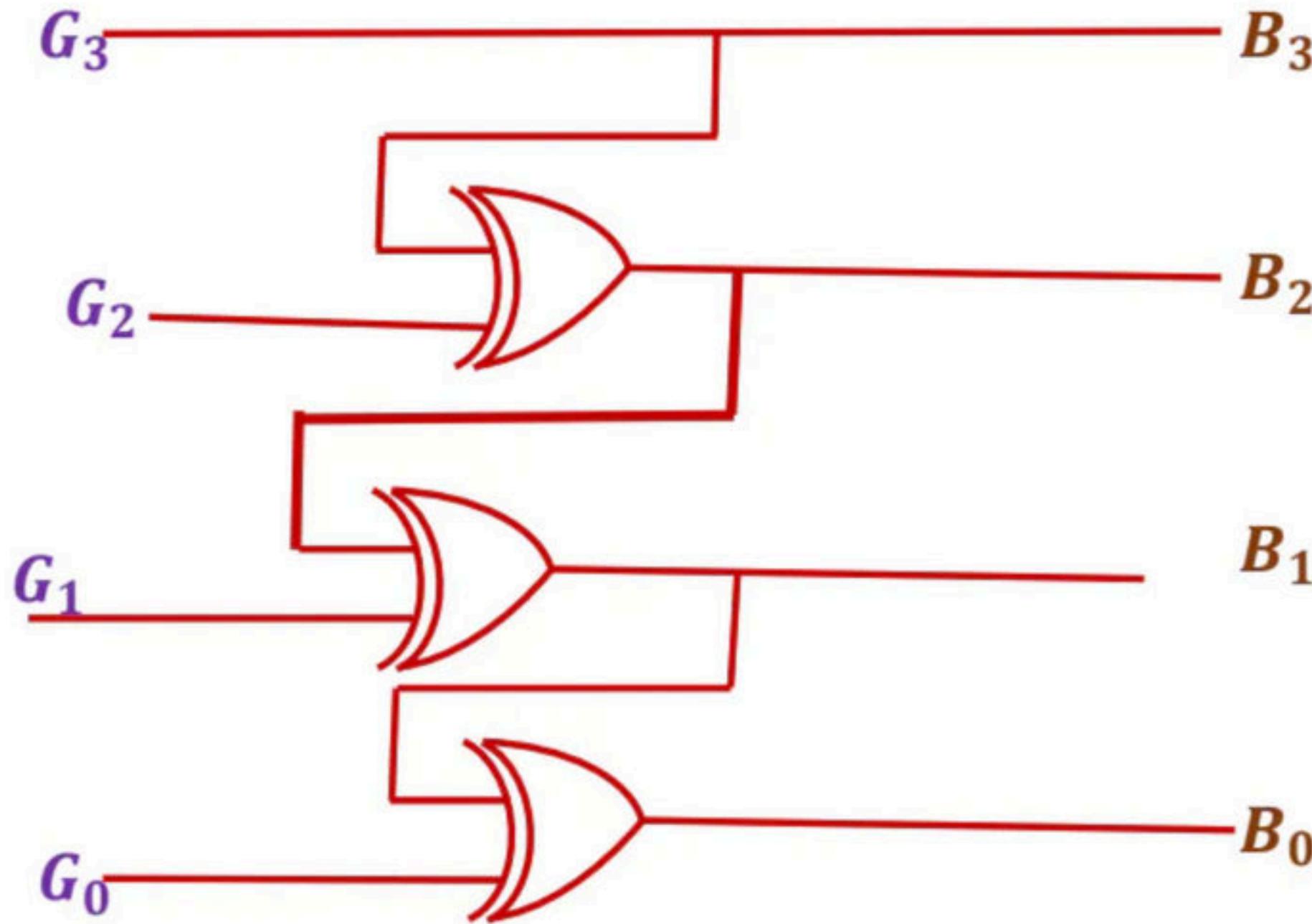
Logic gate



Gray to Binary Code



Gray Code to Binary Code



Q) Find the binary code of the following

1 0 1 0 1 1

Q) Find the binary code of the following

1 1 1 0 0 1 1 0

Self Complementing Codes

- A code is said to be self complementing, if the 1' complement of a number N is equal to the 9's complement of the number
- For a code to be self complementing, the sum of all its weights must be 9 .

Eg. of Self Complementing Codes

2	4	2	1
5	2	1	1
4	3	1	1
3	3	2	1
XS-3			

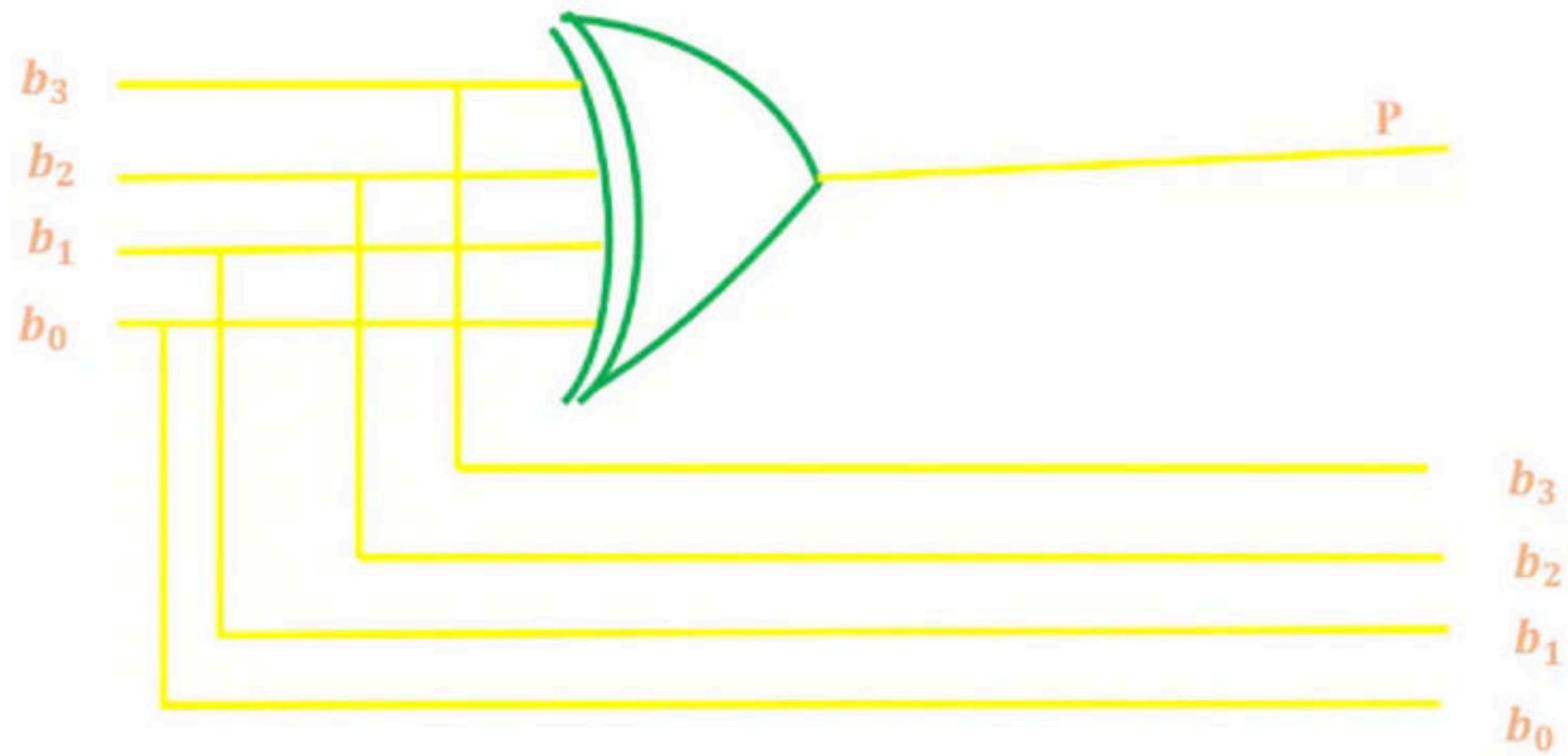
PARITY BIT

A parity bit is used for the purpose of detecting errors during transmission of binary information . A parity bit is an extra bit included with a binary message to make the number of 1's either odd or even. The message including the parity bit is transmitted and then checked at the receiving end for errors. The circuit that generates the parity bit in the transmitter is called a parity generator and the circuit that checks the parity in the receiver in called a parity checker .

Even parity

In case of even parity , the added parity bit will make the total number of 1's is an even number .

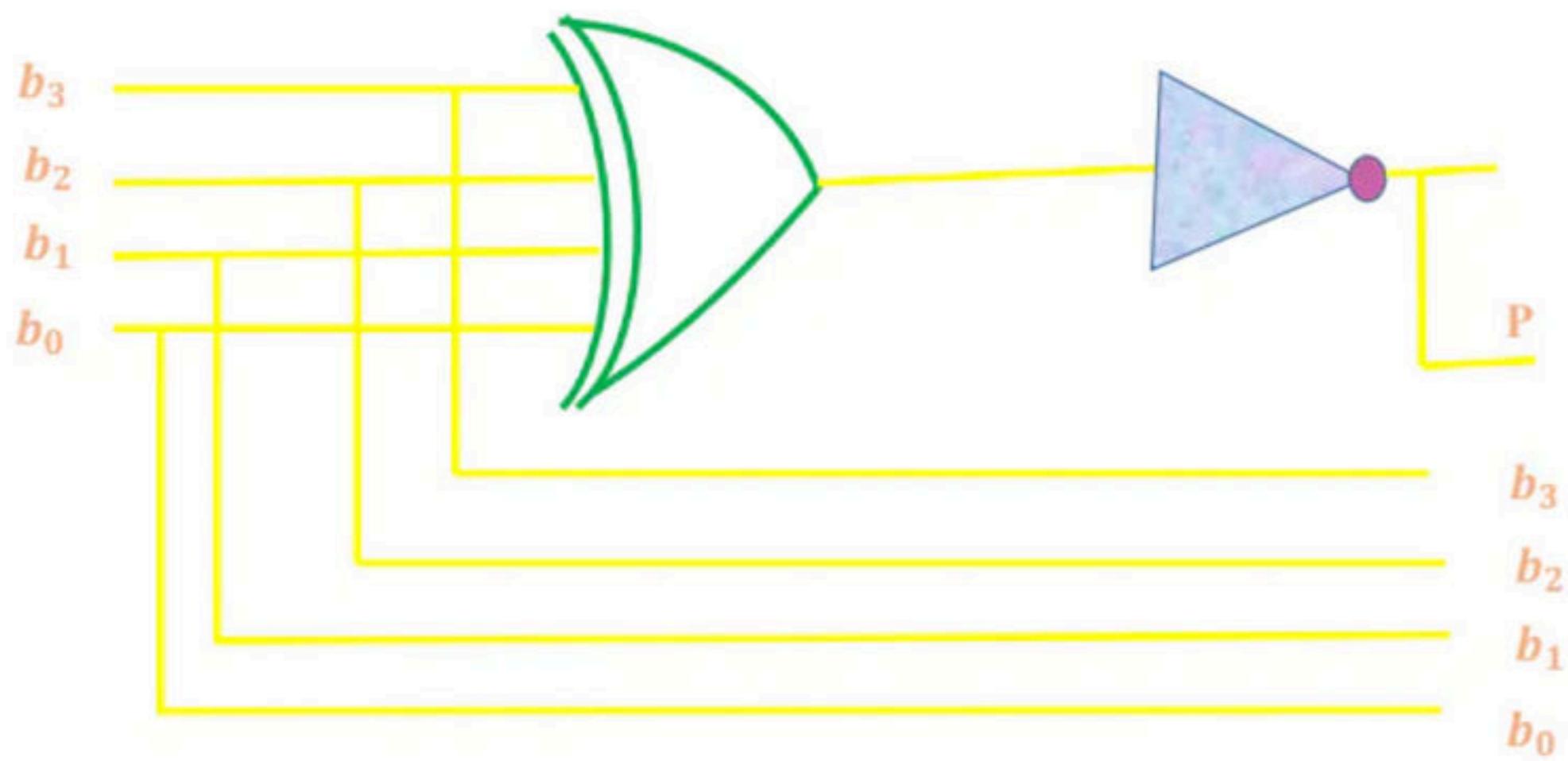
3- bit message	Message with even parity	
	message	Parity



Odd parity

In case of odd parity , the added parity bit will make the total number of 1's is an odd number .

3- bit message	Message with odd parity	
	message	Parity



Q, P, Q and R are the decimal integers corresponding to the 4-bit binary number 1100 considering in signed magnitude, 1's complement and 2's complement representations, respectively . The 6-bit 2's complement representation of $(P+Q+R)$ is.....

- a) 111101
- b) 110101
- c) 110010
- d) 111001

Q. Which of the following represents ‘E3₁₆’?

(a) (CE)₁₆ + (A2)₁₆

(b) (1BC)₁₆ – (DE)₁

(c) (2BC)₁₆ – (1DE)₁₆

(d) (200)₁₆ – (11D)₁₆

Q. A new Binary Coded Pentary (BCP) number systems is proposed in which every digit of a base -5 number is represented by its corresponding 3-bit binary code. For example, the base-5 number 24 will be represented by its BCP code 010100 . In this numbering system, the BCP code 100010011001 corresponds to the following number in base -5 system

- a)423
- b)1324
- c)2201
- d)4231

Q. Consider the addition of numbers with different bases

$$(X)_7 + (Y)_8 + (W)_{10} + (Z)_5 = (K)_9$$

If X=36 , Y = 67 , W=98 and K =241 then Z is

- a)34
- b)15
- c)68
- d)25

Q. Let x_1 be the maximum value that can be represented in signed 2's complement form using 6 -bits.

Let x_2 be the minimum value that can be represented in signed 1's complement form using 5 bits.

Let x_3 be the minimum value that can be represented in signed 2's complement form using 7 bits.

Then find the value of $x_1 + \frac{x_2}{2} + 2x_3$

- (a) -180.5
- (c) 108.5

- (b) -104.5
- (d) 130.5

Q. The 4-bit binary number 1110 represents

- (a) $(-1)_{10}$ in signed magnitude system and $(-2)_{10}$ in signed 2's complement system
- (b) $(-1)_{10}$ in signed 1's complement system and $(-2)_{10}$ in signed 2's complement system
- (c) $(-2)_{10}$ in signed magnitude system and $(-1)_{10}$ in signed 2's complement system
- (d) $(-6)_{10}$ in signed magnitude system and $(-1)_{10}$ in signed 2's complement system

Q. A number N of base r is represented as $(N)_r$ let $(10_{16})^3 = (X)_{10}^2$

- a)64
- b)15
- c)22
- d)19